

CONTRACT DOCUMENTS & TECHNICAL SPECIFICATIONS

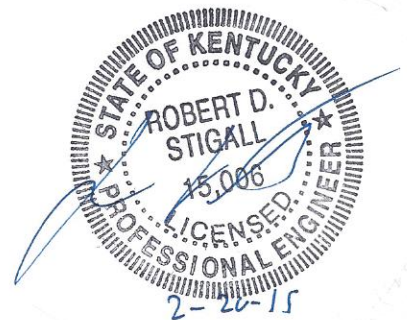
**MONROE COUNTY WATER DISTRICT
PHASE IX WATER SYSTEM IMPROVEMENTS
CONTRACT I: WATER TREATMENT PLANT**

Prepared By:

**STIGALL ENGINEERING ASSOCIATES, INC.
4117 Hillsboro Pike, Suite 206
Nashville, Tennessee 37215
615.460.7515**

Revised February, 2015

SEA Project No. 0323



Advertisement for Bids

Monroe County Water District
Phase IX Water System Improvements Contract I: Water Treatment Facility
205 Capp Harlan Road
Tompkinsville, Kentucky 46217

Separate sealed bids for the construction of Monroe County Water District's Phase IX Water System Improvement Contract I: Water Treatment Facility Project will be received by Monroe County Water District at its offices at 205 Capp Harlan Road, Tompkinsville, Kentucky 42167 until 1:00 p.m., (Central Daylight Time) Wednesday September 23, 2015 and then at said office publicly opened and read aloud at this location.

The project consists of the construction of a raw water intake structure, water treatment facility and appurtenances.

Bidding Documents for this project may be examined at:

Monroe County Water District, 205 Capp Harlan Road, Tompkinsville, Kentucky 42167
Stigall Engineering Associates, Inc., 4117 Hillsboro Pike, Suite 206, Nashville Tennessee 37215
Builders Exchange of Kentucky, 2300 Meadow Drive, Louisville, Kentucky 40218
Nashville Contractors Association, 240 Great Circle Rd., #316, Nashville, Tennessee 37228
Associated General Contractors, 2924 Foster Creighton, Nashville, Tennessee 37204
Builders Exchange of Tennessee, 2322 Winford Avenue, Nashville, Tennessee 37211

Bidding Documents may be obtained from Stigall Engineering Associates, Inc., 4117 Hillsboro Pike, Suite 206, Nashville, Tennessee 37215-2728, Telephone (615) 460-7515, upon payment of \$400.00 for each set of bound copies or \$50.00 for a digital (compact disc) copy.

All bidders shall submit with their bid an acceptable bid bond or a certified check in the amount of five percent (5%) of the bid, payable to the Monroe County Water District.

The Owner reserves the right to waive any informalities or to reject any and all bids.

No bidder may withdraw its bid within 90 days after the date of the bid opening.

The award of this project will be to the lowest, responsive, responsible bidder.

The bidder awarded the contract shall complete this project with in 600 calendar days. Liquidated damages will be assessed at \$300.00 per calendar day.

This project is funded with funds provided by the Kentucky Drinking Water State Revolving Fund (SRF) with federal funds provided by the U.S. Environmental Protection Agency. SRF requirements and provisions must be met by the Bidder and all subcontractors. SRF requires the

higher of state or federal prevailing wage rates to be paid to all employees of the Bidder and all employees of any subcontractor.

Bidders must comply with the Presidents Executive Order No. 11246 as amended, which prohibits discrimination in employment regarding race, creed, color, sex or national origin.

This project will be in compliance with Executive Order No. 11246 as amended.

This project is subject to American Iron & Steel Requirements.

Contractor/Subcontractor will comply with 41 CFR 60-4, in regard to affirmative action, to insure equal opportunity to females and minorities and will apply the time tables and goals set forth in 41 CFR 60-4a.

The bidder shall make positive efforts to use small, minority, women-owned and disadvantaged businesses.

This procurement will be subject to Division of Water Procurement Guidance, including the Davis-Bacon Act.

Small and Disadvantaged Business Enterprises are encouraged to bid on this project. Monroe County Water District is an Equal Opportunity Employer.

August, 2015

Mark Williams, Chairman

Instructions to Bidders

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ARTICLE 1 - DEFINED TERMS

1.01 Terms used in these Instructions to Bidders will have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

- A. Issuing Office--The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.

ARTICLE 2 - COPIES OF BIDDING DOCUMENTS

2.01 Complete sets of the Bidding Documents in the number and for the deposit sum, if any, stated in the Advertisement for Bids may be obtained from the Issuing Office. The deposit is non-refundable.

2.02 Complete sets of Bidding Documents must be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.03 Owner and Engineer in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

ARTICLE 3 - QUALIFICATIONS OF BIDDERS

3.01 To demonstrate Bidder's qualifications to perform the Work, within five days of Owner's request, Bidder shall submit written evidence such as financial data, previous experience, present commitments, and such other data as may be called for below.

ARTICLE 4 - EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND SITE

4.01 Subsurface and Physical Conditions

A. The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Bidding Documents.
2. Those drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Bidding Documents.

B. Copies of reports and drawings referenced in paragraph 4.01.A will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in paragraph 4.02 of the General Conditions has been identified and established in paragraph 4.02 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

4.02 Underground Facilities

A. Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.

4.03 Hazardous Environmental Condition

A. The Supplementary Conditions identify those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that ENGINEER has used in preparing the Bidding Documents.

- B. Copies of reports and drawings referenced in paragraph 4.03.A will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the “technical data” contained therein upon which Bidder is entitled to rely as provided in paragraph 4.06 of the General Conditions has been identified and established in paragraph 4.06 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any “technical data” or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.
- 4.04 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated conditions appear in paragraphs 4.02, 4.03, and 4.04 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work appear in paragraph 4.06 of the General Conditions.
- 4.05 On request, Owner will provide Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for submission of a Bid. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all applicable Laws and Regulations relative to locating of excavation and utility.
- 4.06 Additional Owner Provided Information:
- A. Reference is made to Article 7 of the Supplementary Conditions for the identification of the general nature of other work that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) that relates to the Work contemplated by these Bidding Documents. On request, Owner will provide to each Bidder for examination access to or copies of Contract Documents (other than portions thereof related to price) for such other work.
 - B. Paragraph 6.13.C of the General Conditions states that if an Owner safety program exists it will be noted in the Supplementary Conditions.
- 4.07 It is the responsibility of each Bidder before submitting a Bid to:
- A. Examine and carefully study the Bidding Documents, the other related data identified in the Bidding Documents, and any Addenda;
 - B. Visit the Site and become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

- C. Become familiar with and satisfy Bidder as to all Federal, State, and local Laws and Regulations that may affect cost, progress, or performance of the Work;
 - D. Carefully study all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in paragraph 4.02 of the General Conditions, and (2) reports and drawings of Hazardous Environmental Conditions at the Site which have been identified in the Supplementary Conditions as provided in paragraph 4.06 of the General Conditions;
 - E. Obtain and carefully study (or accept consequences for not doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto;
 - F. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents;
 - G. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;
 - H. Correlate the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents;
 - I. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder; and
 - J. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.
- 4.08 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 4, that without exception the Bid is premised upon performing and furnishing the Work required by the Bidding Documents and applying any specific means, methods, techniques, sequences, and

procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

ARTICLE 5 - PRE-BID CONFERENCE

5.01 A pre-Bid conference will not be held

ARTICLE 6 - SITE AND OTHER AREAS

6.01 The Site is identified in the Bidding Documents. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by Owner unless otherwise provided in the Bidding Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by Contractor.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by Engineer as having received the Bidding Documents. Questions received less than five days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.02 Addenda may be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

ARTICLE 8 - BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5 % of Bidder's maximum Bid price and in the form of a certified check or a Bid bond (EJCDC No. C-430, 2007 Edition) issued by a surety meeting the requirements of paragraphs 5.01 and 5.02 of the General Conditions.

8.02 The Bid security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required contract security and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within {15 days} after the Notice of Award, Owner may annul the Notice of Award and the Bid security of that Bidder will be forfeited. The Bid security

of other Bidders whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of seven days after the Effective Date of the Agreement or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be returned.

8.03 Bid security of other Bidders whom OWNER believes do not have a reasonable chance of receiving the award will be returned within seven days after the Bid opening.

ARTICLE 9 - CONTRACT TIMES

9.01 The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 - LIQUIDATED DAMAGES

10.01 Provisions for liquidated damages are set forth in the Agreement.

ARTICLE 11 - SUBSTITUTE AND "OR-EQUAL" ITEMS

11.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, or "or-equal" materials and equipment as defined in paragraph 6.05 of the General Conditions, or those substitute materials and equipment approved by the Engineer and identified by Addendum. The materials and equipment described in the Bidding Documents establish a standard of required type, function and quality to be met by any proposed substitute or "or-equal" item. Request for Engineer's clarification of materials and equipment considered "or-equal" prior to the Effective Date of the Agreement must be received by the Engineer at least 5 days prior to the date for receipt of Bids. No item of material or equipment will be considered by Engineer as a substitute unless written request for approval has been submitted by Bidder and has been received by Engineer at least 15 days prior to the date for receipt of Bids. Each request shall conform to the requirements of paragraph 6.05 of the General Conditions. The burden of proof of the merit of the proposed item is upon the Bidder. Engineer's decision of approval or disapproval of a proposed item will be final. If Engineer approves any proposed substitute item, such approval will be set forth in an Addendum issued to all prospective Bidders. Bidders shall not rely upon approvals made in any other manner.

ARTICLE 12 - SUBCONTRACTORS, SUPPLIERS, AND OTHERS

12.01 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, individuals, or entities to be submitted to Owner in advance of a specified date prior to the Effective Date of the Agreement, the apparent Successful Bidder, and any other Bidder so requested, shall within five days after Bid opening, submit to Owner a list of all such Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar

projects and other evidence of qualification for each such Subcontractor, Supplier, individual, or entity if requested by Owner. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit a substitute, without an increase in the Bid.

- 12.02 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest responsible Bidder that proposes to use acceptable Subcontractors, Suppliers, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner and Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to revocation of such acceptance after the Effective Date of the Agreement as provided in paragraph 6.06 of the General Conditions.
- 12.03 Contractor shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom Contractor has reasonable objection.
- 12.04 The Contractor shall not award work to Subcontractor(s) in excess of the limits stated in SC 6.06.

ARTICLE 13 - PREPARATION OF BID

- 13.01 The Bid form is included with the Bidding Documents. Additional copies may be obtained from Engineer.
- 13.02 All blanks on the Bid form shall be completed in ink and the Bid signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each *{section, Bid item, alternative, adjustment unit price item, and unit price item}* listed therein, or the words “No Bid,” “No Change,” or “Not Applicable” entered.
- 13.03 A Bid by a corporation shall be executed in the corporate name by the president or a vice-president or other corporate officer accompanied by evidence of authority to sign. The corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be provided on the Bid Form.
- 13.04 A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be provided on the Bid Form.
- 13.05 A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of

the firm and the official address of the firm shall be shown.

- 13.06 A Bid by an individual shall show the Bidder's name and business address.
- 13.07 A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid form. The official address of the joint venture must be provided on the Bid Form.
- 13.08 All names shall be printed in ink below the signatures.
- 13.09 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers and dates of which shall be filled in on the Bid form.
- 13.10 The postal and email addresses and telephone number for communication regarding the Bid shall be shown.
- 13.11 The Bid shall contain evidence of Bidder's authority and qualification to do business in the state or locality where the Project is located or Bidder shall covenant in writing to obtain such qualification prior to award of the Contract and attach such covenant to the Bid. Bidder's state contractor license number, if any, shall also be shown on the Bid Form.

ARTICLE 14 - BASIS OF BID; COMPARSION OF BIDS

14.01 Unit Price

- A. Bidders shall submit a Bid on a unit price basis for each item of Work listed in the Bid schedule.
- B. The total of all bid prices will be the sum of the products of the estimated quantity of each item and the corresponding unit price. The final quantities and Contract Price will be determined in accordance with paragraph 11.03 of the General Conditions.

14.02 Allowances

- A. For cash allowances the Bid price shall include such amounts as the Bidder deems proper for Contractor's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 11.02.B of the General Conditions.

ARTICLE 15 - SUBMITTAL OF BID

- 15.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and the Bid bond form. The unbound copy of the Bid Form is to be completed and submitted with all the attachments outlined in Article 7 of the Bid Form.

15.02 A Bid shall be submitted no later than the date and time prescribed and at the place indicated in the Advertisement for Bids and shall be enclosed in an opaque sealed envelope plainly marked with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate envelope plainly marked on the outside with the notation "BID ENCLOSED." When using the mail or other delivery system, the Bidder is totally responsible for the mail or other delivery system delivering the Bid at the place and prior to the time indicated in the Advertisement for Bid. A mailed Bid shall be addressed to Owner at address in Article 1.01 of Bid Form.

ARTICLE 16 - MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be modified or withdrawn by an appropriate document duly executed in the manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids.

16.02 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid or negotiated, that Bidder will be disqualified from further bidding on the Work. This provision to withdraw a Bid without forfeiting the Bid security does not apply to Bidder's errors in judgment in preparing the Bid.

ARTICLE 17 - OPENING OF BIDS

17.01 Bids will be opened at the time and place indicated in the Advertisement for Bids and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 18 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE

18.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, at its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 19 - EVALUATION OF BIDS AND AWARD OF CONTRACT

19.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to be non-responsible. Owner also reserves the right to waive

all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder.

- 19.02 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.
- 19.03 In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested in the Bid Form or prior to the Notice of Award.
- 19.04 In evaluating Bidders, Owner will consider the qualifications of Bidders and may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted as provided in the Supplementary Conditions.
- 19.05 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities to perform the Work in accordance with the contract Documents.
- 19.06 If the Contract is to be awarded, Owner will award the Contract to the responsible Bidder whose Bid, conforming with all the material terms and conditions of the Instructions to Bidders, is lowest, price and other factors considered. If detailed in the bid form, factors such as discounts, transportation costs, and life cycle costs may be used to determine which bidder, if any, is to offered the award.

ARTICLE 20 - CONTRACT SECURITY AND INSURANCE

- 20.01 Article 5 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it shall be accompanied by such bonds.

ARTICLE 21 - SIGNING OF AGREEMENT

- 21.01 When Owner gives a Notice of Award to the Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents which are identified in the Agreement as attached thereto. Within 15 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner. Within ten days thereafter, Owner shall deliver one fully signed counterpart to Successful Bidder with a complete set of the Drawings with appropriate identification.

21.02 This Contract is expected to be funded in part with funds provided by a KIA FADWSRF loan. Please refer to Supplementary General Conditions for requirements.

ARTICLE 22 – WAGE RATE REQUIREMENTS

22.01 The prevailing wage rates of the Commonwealth of Kentucky shall apply to this contract as do any requirements of the Commonwealth of Kentucky associated with the use of these State Prevailing wages.

22.02 The prevailing wage rates of the Department of Labor shall apply to this project. The Labor Standards Provisions found at 29 CFR 5.5(a) apply to this project if the prevailing wage rates of the Department of Labor apply.

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Steven L. Beshear
Governor

KENTUCKY LABOR CABINET
DEPARTMENT OF WORKPLACE STANDARDS
DIVISION OF EMPLOYMENT STANDARDS,
APPRENTICESHIP & MEDIATION
1047 US Hwy 127 S - Suite 4
Frankfort, Kentucky 40601
Phone: (502) 564-3534
Fax (502) 696-1897
www.labor.ky.gov

Larry Roberts
Secretary

Anthony Russell
Commissioner

July 22, 2015

Robert Stigall
Stigall Engineering Assoc.
4117 Hillsboro Pike
Nashville TN 37215

Re: Monroe Co. Water District, Phase IX Contract 1-WTP & Intake

Advertising Date as Shown on Notification: August 13, 2015

Dear Robert Stigall:

This office is in receipt of your written notification on the above project as required by KRS 337.510 (1).

I am enclosing a copy of the current prevailing wage determination number CR 1-009, dated August 5, 2014 for MONROE County. This schedule of wages shall be attached to and made a part of the specifications for the work, printed on the bidding blanks, and made a part of the contract for the construction of the public works between the public authority and the successful bidder or bidders.

The determination number assigned to this project is based upon the advertising date contained in your notification. There may be modifications to this wage determination prior to the advertising date indicated. In addition, if the contract is not awarded within 90 days of this advertising date or if the advertising date is modified, a different set of prevailing rates of wages may be applicable. It will be the responsibility of the public authority to contact this office and verify the correct schedule of the prevailing rates of wages for use on the project. Your project number is as follows: 086-H-00065-14-1, Heavy/Highway

Sincerely,

Anthony Russell
Commissioner



KENTUCKY DEPARTMENT OF LABOR
PREVAILING WAGE DETERMINATION
CURRENT REVISION
LOCALITY NO. 010

ALLEN, BARREN, GREEN, METCALFE, MONROE & SIMPSON COUNTIES

Determination No. CR-1-009

Date of Determination: August 5, 2014

Project No. 086-H-00065-14-1
Type: ___ Bldg ___x___ HH

This schedule of the prevailing rate of wages for Locality No. 009, which includes Allen, Barren, Green, Metcalfe, Monroe and Simpson Counties, has been determined in accordance with the provisions of KRS 337.505 to 337.550. This determination shall be referred to as Prevailing Wage Determination No. CR-1-009.

Apprentices shall be permitted to work as such subject to Administrative Regulations. Copies of these regulations will be furnished upon request to any interested person.

Overtime is to be computed at not less than one and one-half (1 1/2) times the indicated BASE RATE for all hours worked in excess of eight (8) per day, or in excess of forty (40) per week. However, KRS 337.540 permits an employee and employer to agree, in writing, that the employee will be compensated at a straight time base rate for hours worked in excess of eight (8) hours in any one workday, but not more than ten (10) hours worked in any one workday, if such written agreement is prior to the over eight (8) hours in a workday actually being worked, or where provided for in a collective bargaining agreement. The fringe benefit rate is to be paid for each hour worked at a straight time rate for all hours worked.

No laborer, workman or mechanic shall be paid at a rate less than that of the General Laborer except those classified as bona fide apprentices registered with the Kentucky State Apprenticeship Supervisor unless otherwise specified in this schedule of wage rates.

Fringe benefit amounts are applicable for all hours worked except when otherwise noted.

WELDERS - Receive rate for craft in which welding is incidental.

NOTE: The type of construction shall be determined by applying the following definitions.

BUILDING CONSTRUCTION

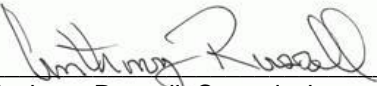
Building construction is the construction of sheltered enclosures with walk-in access for the purpose of housing persons, machinery, equipment, or supplies. It includes all construction of such structures, the installation of utilities and the installation of equipment, both above and below grade level, as well as incidental grading, utilities and paving.

HIGHWAY CONSTRUCTION

Highway construction includes the construction, alteration or repair of roads, streets, highways, runways, taxiways, alleys, trails, paths, parking areas, and other similar projects not incidental to building or heavy construction. It includes all incidental construction in conjunction with the highway construction project.

HEAVY CONSTRUCTION

Heavy projects are those projects that are not properly classified as either "building" or "highway". For example, dredging projects, water and sewer line projects, dams, flood control projects, sewage treatment plants and facilities, and water treatment plants and facilities are considered heavy.



Anthony Russell, Commissioner
Department of Workplace Standards
Kentucky Labor Cabinet

ASBESTOS/INSULATION WORKERS:		BASE RATE	\$24.41
		FRINGE BENEFITS	9.81

BOILERMAKERS:		BASE RATE	\$24.65
		FRINGE BENEFITS	12.94

BRICKLAYERS:		BASE RATE	\$19.00
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CARPENTERS:		BASE RATE	\$22.70
Carpenters	BUILDING	FRINGE BENEFITS	14.14

Piledrivermen	BUILDING	BASE RATE	\$22.95
		FRINGE BENEFITS	14.14

Carpenters	HEAVY & HIGHWAY	BASE RATE	\$26.40
		FRINGE BENEFITS	13.95

Divers	HEAVY & HIGHWAY	BASE RATE	\$39.98
		FRINGE BENEFITS	13.95

Piledrivermen	HEAVY & HIGHWAY	BASE RATE	\$26.65
		FRINGE BENEFITS	13.95

CEMENT MASONS:		BASE RATE	\$12.50
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ELECTRICIANS:	BUILDING	BASE RATE	\$29.88
		FRINGE BENEFITS	14.78

	HEAVY & HIGHWAY	BASE RATE	\$24.75
		FRINGE BENEFITS	7.96

LINEMAN:	HEAVY & HIGHWAY	BASE RATE	\$32.98
		FRINGE BENEFITS	11.60

EQUIPMENT OPERATOR:	HEAVY & HIGHWAY	BASE RATE	\$29.48
		FRINGE BENEFITS	10.90

GROUNDSMEN:	HEAVY & HIGHWAY	BASE RATE	\$19.53
		FRINGE BENEFITS	8.91

ELEVATOR CONSTRUCTORS:		BASE RATE	\$24.72
		FRINGE BENEFITS	8.74

GLAZIERS:		BASE RATE	\$10.90
		FRINGE BENEFITS	1.72

IRONWORKERS: (Including Structural and Reinforcing)	BASE RATE	\$26.97
	FRINGE BENEFITS	20.01

LABORERS / BUILDING:

GROUP 1: General Laborers, watchmen, water boy, wrecking labor on building and structures, clearing of way and building site, carpenter tender, deck hand flagging traffic, truck spotters and dumpers, axe and cross cut saw filer, concrete puddlers and form strippers, asbestos abatement laborers, toxic waste removal laborer, lead abatement laborer, lawnmowing, week control and industrial deep cleaning:

BUILDING	BASE RATE	\$19.85
	FRINGE BENEFITS	10.23

GROUP 2: All power driven tools, hod carriers, mason tenders, finishing tenders, mortar mixers, jack hammer, vibrators, soil compactors, wagon drill, core drill, test drill, well drill, concrete pump machine, tunnel boring machine, men in tunnel and crib ditch work, signal men, riprap rock setters and handlers, asphalt rakers, tampers and smoothers, pipe payers, grout pump man, chain saw, pipe clearing, doping and wrapping, swampers and straight cable hooking, cement guns, grade checkers, machine excavating, tool room checkers, batch plant scale man, sand hog free air, sand hog compressed air, cutting torch man on salvage work, road form setters, brick slingers, hand spikers, power buggy, handling of creosote material, sandblasters, curing of concrete and apply hardener, air and gas tampers, concrete saw, power post hole diggers, forklift for masonry contractors and green cut men on concrete work. Request that two men be used on pavement breakers, multi craft tender. Request that two men be used on 6" vibrator.

BUILDING	BASE RATE	\$20.05
	FRINGE BENEFITS	10.23

POWDERMAN OR BLASTERS WAGES TO BE PAID \$.50 ABOVE THE GROUP #1 CLASSIFICATION

LABORERS / HEAVY HIGHWAY:

GROUP 1: Aging and curing of concrete (any mode or method), asbestos abatement worker, asphalt plant laborers, asphalt laborers, batch truck dumpers, carpenter tenders, cement mason tenders, cleaning of machines, concrete laborers, demolition laborers, dredging laborers, drill helper, environmental laborer - nuclear, radiation, toxic and hazardous waste - Level D, flagmen, grade checkers, all hand digging and hand back filling, highway marker placers, landscaping laborers, mesh handlers and placers, puddler, railroad laborers, rip-rap and grouters, right of way laborers, sign, guard rail and fence installers (all types), signal men, sound barrier installer, storm and sanitary sewer laborers, swampers, truck spotters and dumpers, wrecking of concrete forms and general cleanup:

HEAVY & HIGHWAY	BASE RATE	\$21.51
	FRINGE BENEFITS	10.15

GROUP 2: Batter board men (sanitary and storm sewer), brickmason tenders, mortar mixer operator, scaffold builders, burner and welder, bushhammers, chain saw operator, concrete saw operators, deckhand scow man, dry cement handlers, environmental laborers - nuclear, radiation, toxic and hazardous waste - Level C, forklift operators for masonry, form setters, green concrete cutting, hand operated grouter and grinder machine operator, jack hammers, lead paint abatement, pavement breakers, paving joint machine, pipe layers-laser operators (non-metallic), plastic pipe fusion, power driven Georgia buggy or wheelbarrow, power post hole diggers, precast manhole setters walk-behind tampers, walk-behind trenchers, sand blasters, concrete chippers, surface grinders, vibrator operators, wagon drillers:

HEAVY & HIGHWAY	BASE RATE	\$21.76
	FRINGE BENEFITS	10.15

GROUP 3: Asphalt luteman and rakers, gunnite nozzleman, gunnite operators and mixers, grout pump operator, side rail setters, rail paved ditches, screw operators, tunnel laborers (free air), and water blasters:

HEAVY & HIGHWAY	BASE RATE	\$21.81
	FRINGE BENEFITS	10.15

GROUP 4: Caisson workers (free air), cement finishers, environmental laborer - nuclear, radiation, blasters, and tunnel muckers (free air), directional and horizontal boring, air track drillers (all types), powderman and blasters, troxler and concrete testers:

HEAVY & HIGHWAY	BASE RATE	\$22.41
	FRINGE BENEFITS	10.15

MARBLE, TILE & TERRAZZO SETTERS:	BASE RATE	\$22.64
	FRINGE BENEFITS	6.10

MARBLE, TILE & TERRAZZO FINISHERS:	BASE RATE	\$15.42
	FRINGE BENEFITS	5.42

MILLWRIGHTS:	BASE RATE	\$16.00
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OPERATING ENGINEERS / BUILDING:

BUILDING CLASS A-1: Operating Engineers possessing 3rd party certification NCCCO (National Commission for the Certification of Crane Operators) (or Operating Engineers Certification Program) shall be paid the minimum rate per hour on the following equipment: Crane, dragline, hoist (1 drum when used for stack or chimney construction or repair), hoisting engineer (2 or more drums), orangepeel bucket, overhead crane, piledriver, truck crane, hydraulic crane:

BUILDING	*BASE RATE	\$27.28
	FRINGE BENEFIT	13.40

BUILDING CLASS A: Articulating Dump, Auto Patrol, Batch Plant, Bituminous Paver, Cableway, Central Compressor Plant, Clamshell, Concrete Mixer (21 cu. ft. or over), Concrete Pump, Crane, Crusher Plant, Derrick, Derrick Boat, Directional Boring machine, Ditching and Trenching Machine, Dragline, Dredge Operator, Dredge Engineer, Elevating Grader and all types of Loaders, Forklift (regardless of lift height), GPS systems (on equipment within the classification), Hoe-Type Machine, Hoist (1 drum when used for stack or chimney construction or repair), Hoisting Engineer (2 or more drums), Laser or Remote Controlled Equipment (within the classification), Locomotive, Motor Scraper, Carry-all Scoop, Bulldozer, Heavy Duty Welder, Mechanic, Orangepeel Bucket, Piledriver, Power Blade, Motor Grader, Roller (bituminous), Scarifier, Shovel, Tractor Shovel, Truck Crane, Winch Truck, Push Dozer, Highlift, All types of Boom Cats, Self Contained Core Drill, Hopto, Tow or Push Boat, A-Frame Winch Truck, Concrete Paver, Gradeall, Hoist, Hyster, Pumpcrete, Ross Carrier, Boom, Tail Boom, Rotary Drill, Hydro Hammer, Mucking Machine, Rock Spreader attached to equipment, Scoopmobile, KeCal Loader, Tower Cranes (French, German and other types), Hydrocrane, Backfiller, Gurries, Sub-Grader, Tunnel Mining Machines including Moles, Shields, or Similar Types of Tunnel Mining Equipment:

BUILDING	*BASE RATE	\$26.25
	FRINGE BENEFITS	13.40

***Operators on cranes with boom one-hundred fifty feet (150') and over including jib, shall receive (\$.75) above base rate.**

All cranes with piling leads will receive \$.50 above base rate regardless of boom length. Crane operators who have received CCO Certification shall receive \$.50 above base rate.

BUILDING CLASS B: All Air Compressors over 900 cfm, Bituminous Mixer, Joint Sealing Machine, Concrete Mixer under 21 cu. ft, Form Grader, Roller (rock), tractor (50 HP and over), Bull Float, Finish Machine, Outboard Motor Boat, Flexplane, Fireman, Boom Type Tamping Machine, Greaser on Grease Facilities servicing Heavy Equipment, Switchman or Brakeman, Mechanic Helper, Whirley Oiler, Self Propelled Compactor, Tractair and Road Widening Trencher and Farm Tractor with Attachments (except backhoe, highlift and endloader), Elevator (regardless of ownership when used for hoisting any building materials), Hoisting Engineer (1 drum or buck hoist), Firebrick (masonry excluded), Well Points, Grout Pump, Throttle-Valve Man, Tugger, Electric Vibrator Compactor, and Caisson Drill Helper:

BUILDING	BASE RATE	\$22.67
	FRINGE BENEFITS	13.40

OPERATING ENGINEERS / BUILDING: CONTINUED

BUILDING CLASS C: Bituminous Distributor, Cement Gun, Conveyor, Mud Jack, Paving Joint Machine, Roller (earth), Tamping Machine, Tractors under 50 HP, Vibrator, Oiler, Concrete Saw, Burlap and Curing Machine, Hydro-Seeder, Power Form Handling Equipment, Deckhand Steersman, Hydraulic Post Driver and Drill Helper:

BUILDING	BASE RATE	\$21.11
	FRINGE BENEFITS	13.40

OPERATING ENGINEER / HEAVY HIGHWAY:

CLASS A-1: Operating Engineers possessing 3rd party certification NCCCO (National Commission for the Certification of Crane Operators) (or Operating Engineers Certification Program) shall be paid the minimum rate per hour on the following equipment: Cableway, carry deck crane, cherry picker, clamshell, crane, derrick, derrick boat, dragline, hoist engine (2 or more drums), hydraulic boom truck, hydrocrane, orangepeel bucket, overhead crane, piledriver, rough terrain crane, tower cranes (French, German and other types), truck crane:

HEAVY HIGHWAY	BASE RATE	\$29.95
	FRINGE BENEFIT	14.15

CLASS A: A-Frame Winch Truck, Auto Patrol, Backfiller, Batcher Plant, Bituminous Paver, Bituminous Transfer Machine, all types of Boom Cats, Bulldozer, Cableway, Carry-All Scoop, Carry Deck Crane, Central Compressor Plant Operator, Clamshell, Concrete Mixer (21 cu. ft. or over), Concrete Paver, Truck-Mounted Concrete Pump, Core Drills, Crane, Crusher Plant, Derrick, Derrick Boat, Ditching and Trenching Machine, Dragline, Dredge Operator, Dredge Engineer, Earth Movers, Elevating Grader and all types of Loaders, Grade-All, Gurries, Heavy Equipment Robotics Operator/Mechanic, High lift, Hoe-Type Machine, Hoist (two or more drums), Hoisting Engine (two or more drums), Horizontal Directional Drill Operator, Hydraulic Boom Truck, Hydrocrane, Hyster, KeCal Loader, Letourneau, Locomotive, Mechanic, Mechanically Operated Laser Screed, Mechanic Welder, Mucking Machine, Motor Scraper, Orangepeel Bucket, Piledriver, Power Blade, Pumpcrete, Push Dozer, Rock Spreader attached to equipment, All Rotary Drills, Roller (bituminous), Scarifier, Scoopmobile, Shovel, Side Boom, Subgrader, Tailboom, Telescoping Type Forklift, Tow or Push Boat, Tower Cranes (French, German and other types), Tractor Shovel and Truck Crane, Tunnel Mining Machines including Moles, Shields, or Similar types of Tunnel Mining Equipment

HEAVY & HIGHWAY	**BASE RATE	\$28.85
	FRINGE BENEFITS	14.15

****Operators on cranes with booms one hundred fifty feet (150') and over including jib shall receive \$1.00 above base rate.**

All crane operators operating cranes, where the length of the boom in combination with the length of the piling leads equip or exceeds one hundred fifty (150) feet, shall receive \$1.00 above base rate.

CLASS B: All Air Compressors (over 900 cu. ft. per min.), Bituminous Mixer, Boom Type Tamping Machine, Bull Float, Concrete Mixer (under 21 cu. ft.), Dredge Operator, Electric Vibrator Compactor/Self-Propelled Compactor, Elevator (one drum or buck hoist), Elevator (regardless of ownership when used to hoist building material), Finish Machine, Firemen, Flex-Plane, Forklift (regardless of lift height), Form Grader, Hoist (one drum), Joint Sealing Machine, Mechanic Helper, Outboard Motor Boat, Power Sweeper (riding type), Roller (rock), Ross Carrier, Skid Mounted or Trailer Mounted Concrete Pumps, Skid Steer Machine with all attachments, Switchman or Brakeman, Throttle Valve Man, Tract air and Road Widening Trencher, Tractor (50 HP and over), Truck Crane Oiler, Tugger, Welding Machine, Well Points, and Whirley Oiler.

HEAVY & HIGHWAY	BASE RATE	\$26.24
	FRINGE BENEFITS	14.15

CLASS B2: Greaser on Grease Facilities servicing Heavy Equipment, all off road material handling equipment, including articulating dump trucks.

HEAVY & HIGHWAY	BASE RATE	\$26.65
	FRINGE BENEFITS	14.15

OPERATING ENGINEER / HEAVY HIGHWAY: CONTINUED

CLASS C: Bituminous Distributor, Burlap and Curing Machine, Caisson Drill and Core Drill Helper (track or skid mounted), Cement Gun, Concrete Saw, Conveyor, Deckhand Oiler, Grout Pump, Hydraulic Post Driver, Hydro Seeder, Mud Jack, Oiler, Paving Joint Machine, Power form handling equipment, Pump, Roller (earth), Steermen, Tamping Machine, Tractors (under 50 H.P.) and Vibrator.

HEAVY & HIGHWAY	BASE RATE	\$25.95
	FRINGE BENEFITS	14.15

Employees assigned to work below ground level are to be paid 10% above basic wage rate. This does not apply to open cut work.

PAINTERS:	BUILDING	BASE RATE	\$13.85
		FRINGE BENEFITS	.63

Brush	HEAVY & HIGHWAY	BASE RATE	\$15.93
		FRINGE BENEFITS	4.55

Spray, Sandblast, Boswain Chair or heights over 50 feet.	HEAVY & HIGHWAY	BASE RATE	\$16.43
		FRINGE BENEFITS	4.55

PLASTERERS:		BASE RATE	\$11.81
		FRINGE BENEFITS	1.59

PLUMBERS & PIPEFITTERS:		BASE RATE	\$26.31
		FRINGE BENEFITS	10.61

ROOFERS:		BASE RATE	\$ 9.16
		FRINGE BENEFITS	3.80

SHEETMETAL WORKERS:		BASE RATE	\$13.15
		FRINGE BENEFITS	1.82

SPRINKLER FITTERS:		BASE RATE	\$30.74
		FRINGE BENEFITS	17.72

TEAMSTERS - TRUCK DRIVERS / BUILDING:	BUILDING	BASE RATE	\$12.00
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TEAMSTERS - TRUCK DRIVERS / HEAVY HIGHWAY:		BASE RATE	\$16.34
Greaser, tire changer	HEAVY & HIGHWAY	FRINGE BENEFITS	7.04

Truck mechanic	HEAVY & HIGHWAY	BASE RATE	\$16.57
		FRINGE BENEFITS	7.04

TEAMSTERS - TRUCK DRIVERS / HEAVY HIGHWAY: CONTINUED

Single axle dump and flatbed, terrain vehicle when used to haul materials, semi-trailer or pole trailer when used to pull building materials and equipment, tandem axle dump, distributor and mixer.

HEAVY & HIGHWAY	BASE RATE	\$16.64
	FRINGE BENEFITS	7.04

Euclid and other heavy earthmoving equipment and low-boy, articulator cat truck, 5-axle vehicle, winch and A-Frame when used in transporting materials, Ross Carrier, forklift truck when used to transport building materials, drivers on pavement breaker.

HEAVY & HIGHWAY	BASE RATE	\$16.65
	FRINGE BENEFITS	7.04

END OF DOCUMENT
CR-1-009
August 5, 2014

General Decision Number: KY150133 07/17/2015 KY133

Superseded General Decision Number: KY20140133

State: Kentucky

Construction Type: Heavy

County: Monroe County in Kentucky.

HEAVY CONSTRUCTION PROJECTS (including sewer/water construction).

Note: Executive Order (EO) 13658 establishes an hourly minimum wage of \$10.10 for 2015 that applies to all contracts subject to the Davis-Bacon Act for which the solicitation is issued on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.10 (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract. The EO minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/02/2015
1	05/01/2015
2	05/22/2015
3	07/17/2015

CARP0064-007 05/01/2015

	Rates	Fringes
CARPENTER (Form Work Only).....	\$ 27.50	16.06

ELEC0369-004 09/01/2014

	Rates	Fringes
LINE CONSTRUCTION		
Equipment Operator.....	\$ 30.51	11.25
Groundman.....	\$ 20.21	9.19
Lineman.....	\$ 34.13	13.02

ENGI0181-010 07/01/2014

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
GROUP 1.....	\$ 28.85	14.15
GROUP 2.....	\$ 26.24	14.15
GROUP 4.....	\$ 25.95	14.15

OPERATING ENGINEER CLASSIFICATIONS

GROUP 1 - Crane; Drill; Grader/Blade; Mechanic; Scraper

GROUP 2 - Bobcat/Skid Steer/Skid Loader; Forklift

GROUP 4 - Oiler

Operators on cranes with booms 150 feet and over (including jib) shall receive \$1.00 above Group 1 rate; 250 feet and over including jib shall receive \$1.50 above Class 1 rate. Combination Rate: All crane operators operating cranes, where the length of the boom in combination with the length of the piling leads equal or exceeds 150 feet, shall receive \$1.00 above the Group 1 rate.

Employees assigned to work below ground level are to be paid 10% above basic wage rate. This does not apply to open cut work.

IRON0782-010 05/01/2014

	Rates	Fringes
IRONWORKER (Reinforcing & Structural)		
Projects over \$20,000,000.00.....	\$ 27.09	20.66
Projects under \$20,000,000.00.....	\$ 25.50	19.02

* LABO0189-014 07/01/2015

	Rates	Fringes
LABORER		
Concrete Saw (Hand Held/Walk Behind).....	\$ 22.55	12.46
Concrete Worker.....	\$ 22.30	12.46

SUKY2011-010 06/25/2014

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER...	\$ 21.60	10.35
ELECTRICIAN.....	\$ 32.35	2.18
LABORER: Common or General.....	\$ 20.60	9.39
LABORER: Flagger.....	\$ 18.31	8.89
LABORER: Pipelayer.....	\$ 20.13	8.63
OPERATOR: Backhoe/Excavator/Trackhoe.....	\$ 23.60	12.65
OPERATOR: Bulldozer.....	\$ 20.99	6.33
OPERATOR: Loader.....	\$ 30.35	0.00

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 (29CFR 5.5 (a) (1) (ii)).

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

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than "SU" or "UAVG" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the "SU" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

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

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

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

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

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

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

Wage and Hour Administrator

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

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

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

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

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

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END OF GENERAL DECISION

BID FORM

**Monroe County Water District
Phase IX Water System Improvements
Contract I: Water Treatment Facility
SEA Project No. 0323**

TABLE OF ARTICLES

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Article 7 – Attachments To This Bid.....	3
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Article 9 – Bid Submittal	3

ARTICLE 1 – BID RECIPIENT

1.01 This Bid is submitted to:

Monroe County Water District
205 Capp Harlan Road
Tompkinsville, Kentucky 42167

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – BIDDER’S ACKNOWLEDGEMENTS

2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 – BIDDER’S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, the other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged.

<u>Addendum No.</u>	<u>Addendum Date</u>
_____	_____
_____	_____
_____	_____

B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress and performance of the Work.

D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in SC-4.02, and (2) reports and drawings of Hazardous Environmental Conditions that have been identified in SC-4.06.

E. Bidder has obtained and carefully studied (or accepts the consequences for not doing so) all additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder, and safety precautions and programs incident thereto.

F. Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.

- G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
- H. Bidder has correlated the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents.
- I. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.
- J. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.
- K. Bidder will submit written evidence of its authority to do business in the state where the Project is located not later than the date of its execution of the Agreement.

ARTICLE 4 – FURTHER REPRESENTATIONS

4.01 Bidder further represents that:

- A. this Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation;
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and
- D. Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Owner.

ARTICLE 5 – BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

No.	Description	Bid Amount
01.	LUMP SUM: Raw water intake, raw water line and appurtenances, water treatment facility complete, including sitework, electrical, piping, concrete, buildings, generators, fencing and all work shown on the drawings for complete operational water intake and treatment facility _____ dollars _____ cents	\$ _____
02.	LUMP SUM: Allowance for laboratory desktop equipment and supplies	\$ 30,000.00
03.	LUMP SUM: Allowance for WTP plaque	\$ <u>2,000.00</u>
	TOTAL AMOUNT BID; ITEMS 1 – 3 INCLUSIVE	\$ _____

All specified cash allowances are included in the price(s) set forth above, and have been computed in accordance with Paragraph 11.02 of the General Conditions.

Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Bid items will be based on actual quantities, determined as provided in the Contract Documents.

ARTICLE 6 – TIME OF COMPLETION

- 6.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.
- 6.02 Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work within the Contract Times.

ARTICLE 7 – ATTACHMENTS TO THIS BID

- 7.01 The following documents are attached to and made a condition of this Bid:
 - A. Required Bid security in the form of _____
 - B. List of Proposed Subcontractors
 - C. List of Proposed Suppliers
 - D. List of Project References
 - E. Required Bidder Qualification Statement with Supporting Data
 - F. Affidavit of Non-Collusion

ARTICLE 8 – DEFINED TERMS

- 8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 9 – BID SUBMITTAL

9.01 This Bid submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____ (SEAL)
(Individual's signature)

Doing business as: _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____
(Signature of general partner – attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

Type (General Business, Professional, Service, Limited Liability): _____

By: _____
(Signature – attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____
(CORPORATE SEAL)

Attest: _____
(Signature of Corporate Secretary)

Date of Qualification to do business in _____ [State Where Project is Located] is ____________.

A Joint Venture

Name of Joint Venturer: _____

First Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of first joint venture partner – attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Second Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of second joint venture partner – attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business address: _____

Phone: _____ Facsimile: _____

Submitted on _____, 20____.

State Contractor License No. _____. (If applicable)

BID BOND

Any singular reference to Bidder, Surety, Owner, or other party shall be considered plural where applicable.

BIDDER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

Monroe County Water District
205 Capp Harlan Road
Tompkinsville, Kentucky 42167

BID

Bid Due Date:

Project (Brief Description Including Location):

Monroe County Water District Phase IX Water System Improvements Contract I: Water Treatment Facility

BOND

Bond Number:

Date (Not later than Bid due date):

Penal sum

(Words)

(Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

BIDDER

SURETY

(Seal
)

(Seal)

Bidder's Name and Corporate Seal

Surety's Name and Corporate Seal

By: _____
Signature and Title

By: _____
Signature and Title
(Attach Power of Attorney)

Attest: _____
Signature and Title

Attest: _____
Signature and Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Surety's liability.
2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation shall be null and void if:
 - 3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
 - 3.2. All Bids are rejected by Owner, or
 - 3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.
6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.
7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

**SUGGESTED FORM OF AGREEMENT
BETWEEN OWNER AND CONTRACTOR
FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)
FUNDING AGENCY EDITION**

THIS AGREEMENT is by and between Monroe County Water District (“Owner”) and
_____ (“Contractor”).

Owner and Contractor, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1 – WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

Phase IX Water System Improvements: Contract I: Water Treatment Plant

ARTICLE 2 – THE PROJECT

2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows:

Construction of Water Treatment Facility

ARTICLE 3 – ENGINEER

3.01 The Project has been designed by Stigall Engineering Associates, Inc. (Engineer), who is to act as Owner’s representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

ARTICLE 4 – CONTRACT TIMES

4.01 *Time of the Essence*

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 *Days to Achieve Substantial Completion and Final Payment*

A. The Work will be substantially completed within 540 days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within 600 days after the date when the Contract Times commence to run.

4.03 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense,

and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty), Contractor shall pay Owner \$300 for each day that expires after the time specified in Paragraph 4.02 for Substantial Completion until the Work is substantially complete. After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner \$300 for each day that expires after the time specified in Paragraph 4.02 for completion and readiness for final payment until the Work is completed and ready for final payment.

ARTICLE 5 – CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A, 5.01.B, and 5.01.C below:

A. For all Work other than Unit Price Work, a Lump Sum of:

No.	Description	Bid Amount
01.	LUMP SUM: Raw water intake, raw water line and appurtenances, water treatment facility complete, including sitework, electrical, piping, concrete, buildings, generators, fencing and all work shown on the drawings for complete operational water intake and treatment facility	
	_____ dollars	
	_____ cents	\$ _____
02.	LUMP SUM: Allowance for laboratory desktop equipment and supplies	\$ 30,000.00
03.	LUMP SUM: Allowance for WTP plaque	\$ 2,000.00
TOTAL AMOUNT BID; ITEMS 1 – 3 INCLUSIVE		\$ _____

All specific cash allowances are included in the above price and have been computed in accordance with paragraph 11.02 of the General Conditions.

B. For all Work, at the prices stated in Contractor’s Bid, attached hereto as an exhibit.

ARTICLE 6 – PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor’s Applications for Payment on or about the 15th day of each month during performance of the Work as provided in Paragraphs 6.02.A.1 and 6.02.A.2 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements:

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 14.02 of the General Conditions:
 - a. 95 percent of Work completed (with the balance being retainage); and
 - b. 95 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).
2. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 95 percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions.

6.03 *Final Payment*

- A. Upon receipt of the final Application for Payment accompanied by Engineer's recommendation of payment in accordance with Paragraph 14.07 of the General Conditions, Owner shall pay Contractor as provided in Paragraph 14.07 of the General Conditions the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 14.07, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages.

ARTICLE 7 – INTEREST

- 7.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the maximum legal rate.

ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS

- 8.01 In order to induce Owner to enter into this Agreement Contractor makes the following representations:
 - A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.
 - B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
 - C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.
 - D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions and (2) reports and drawings of a Hazardous Environmental Condition, if any, at the Site which has been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.
 - E. Contractor has obtained and carefully studied (or assumes responsibility for doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto.

- F. Contractor does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.
- G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.
- H. Contractor has correlated the information known to Contractor, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.
- I. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
- J. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
- K. The Contractor acknowledges to and for the benefit of the Monroe County Water District (“Purchaser”) and the Commonwealth of Kentucky (the “State”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as “American Iron and Steel,” that requires all of the iron and steel products used in the project to be produced in the United States (“American Iron and Steel Requirement”) including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

*Municipal castings are cast iron or steel infrastructure products that are melted and cast. They typically provide access, protection, or housing for components incorporated into utility owned drinking water, storm water, wastewater, and surface infrastructure. They are typically made of grey or ductile iron, or steel. Examples of municipal castings are: Access Hatches; Ballast Screen; Benches (Iron or Steel); Bollards; Cast Bases; Cast Iron Hinged Hatches, Square and Rectangular; Cast Iron Riser Rings; Catch Basin Inlet; Cleanout/Monument Boxes; Construction Covers and

Frames; Curb and Corner Guards; Curb Openings; Detectable Warning Plates; Downspout Shoes (Boot, Inlet); Drainage Grates, Frames and Curb Inlets; Inlets; Junction Boxes; Lampposts; Manhole Covers, Rings and Frames, Risers; Meter Boxes; Service Boxes; Steel Hinged Hatches, Square and Rectangular; Steel Riser Rings; Trash receptacles; Tree Grates; Tree Guards; Trench Grates; Valve Boxes, Covers and Risers.

**Structural steel is rolled flanged shapes, having at least one dimension of their cross-section three inches or greater, which are used in the construction of bridges, buildings, ships, railroad rolling stock, and for numerous other constructional purposes. Such shapes are designated as wide-flange shapes, standard I-beams, channels,

angles, tees and zees. Other shapes include H-piles, sheet piling, tie plates, cross ties, and those for other special purposes.

***Construction materials are those articles, materials, or supplies made primarily of iron and steel, that are permanently incorporated into the project, not including mechanical and/or electrical components, equipment and systems. Some of these products may overlap with what is also considered "structural steel". This includes, but is not limited to, the following products: wire rod, bar, angles, concrete reinforcing bar, wire, wire cloth, wire rope and cables, tubing, framing, joists, trusses, fasteners (i.e., nuts and bolts), welding rods, decking, grating, railings, stairs, access ramps, fire escapes, ladders, wall panels, dome structures, roofing, ductwork, surface drains, cable hanging systems, manhole steps, fencing and fence tubing, guardrails, doors, and stationary screens.

NOTE: Mechanical and electrical components, equipment and systems are not considered construction materials. Mechanical equipment is typically that which has motorized parts and/or is powered by a motor. Electrical equipment is typically any machine powered by electricity and includes components that are part of the electrical distribution system.

ARTICLE 9 – CONTRACT DOCUMENTS

9.01 Contents

- A. The Contract Documents consist of the following:
 1. This Agreement (pages 1 to 1, inclusive).
 2. Performance bond (pages ____ to ____, inclusive).
 3. Payment bond (pages ____ to ____, inclusive).
 4. Other bonds (pages ____ to ____, inclusive).
 - a. ____ (pages ____ to ____, inclusive).
 - b. ____ (pages ____ to ____, inclusive).
 - c. ____ (pages ____ to ____, inclusive).
 5. General Conditions (pages ____ to ____, inclusive).
 6. Supplementary Conditions (pages ____ to ____, inclusive).
 7. Specifications as listed in the table of contents of the Project Manual.
 8. Drawings consisting of ____ sheets with each sheet bearing the following general title: ____.
 9. Addenda (numbers ____ to ____, inclusive).
 10. Exhibits to this Agreement (enumerated as follows):
 - a. Contractor's Bid (pages ____ to ____, inclusive).
 - b. Documentation submitted by Contractor prior to Notice of Award (pages ____ to ____, inclusive).
 - c. ____.

11. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
- a. Notice to Proceed (pages _____ to _____, inclusive).
 - b. Work Change Directives.
 - c. Change Order(s).
- B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).
- C. There are no Contract Documents other than those listed above in this Article 9.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

ARTICLE 10 – MISCELLANEOUS

10.01 *Terms*

- A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

10.02 *Assignment of Contract*

- A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.03 *Successors and Assigns*

- A. Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.04 *Severability*

- A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in four copies. One counterpart each has been delivered to Owner, Contractor, Engineer, and Agency. All portions of the Contract Documents have been signed, initialed, or identified by Owner and Contractor or identified by Engineer on their behalf.

This Agreement is dated _____. This Agreement shall not be effective unless and until Agency's designated representative concurs.

OWNER:

CONTRACTOR

MONROE COUNTY WATER DISTRICT

By: _____

By: _____

Title: Mark Williams, Chairman

Title: _____

[CORPORATE SEAL]

[CORPORATE SEAL]

Attest: _____

Attest: _____

Title: _____

Title: _____

Address for giving notices:

Address for giving notices:

Monroe County Water District

205 Capp Harlan Road

Tompkinsville, Kentucky 42167

Agent for service of process:

(If Contractor is a corporation or a partnership, attach evidence of authority to sign.)

Agency Concurrence:

As lender or insurer of funds to defray the costs of this Contract, and without liability for any payments thereunder, the Agency hereby concurs in the form, content, and execution of this Agreement.

Agency: _____

By: _____

Date: _____

Title: _____

PERFORMANCE BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):
Monroe County Water District
205 Capp Harlan Road
Tompkinsville, Kentucky 42167

CONTRACT

Date:

Amount:

Description (Name and Location): Phase IX Water System Improvements – Contract I: Water Treatment Facility

BOND

Bond Number:

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____ (Seal)

Name and Title:

SURETY

(Seal)

Surety's Name and Corporate Seal

By:

Signature and Title

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest:

Signature and Title

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____ (Seal)

Name and Title:

SURETY

(Seal)

Surety's Name and Corporate Seal

By:

Signature and Title

(Attach Power of Attorney)

Attest:

Signature and Title:

EJCDC No. C-610 (2002 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, and the American Institute of Architects.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner for the performance of the Contract, which is incorporated herein by reference.

2. If Contractor performs the Contract, Surety and Contractor have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no Owner Default, Surety's obligation under this Bond shall arise after:

3.1. Owner has notified Contractor and Surety, at the addresses described in Paragraph 10 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and

3.2. Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 3.1; and

3.3. Owner has agreed to pay the Balance of the Contract Price to:

1. Surety in accordance with the terms of the Contract;
2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

4. When Owner has satisfied the conditions of Paragraph 3, Surety shall promptly and at Surety's expense take one of the following actions:

4.1. Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or

4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to Owner for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Owner and Contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Contract, and pay to Owner the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by Owner resulting from Contractor Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or
2. Deny liability in whole or in part and notify Owner citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 4.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

6. After Owner has terminated Contractor's right to complete the Contract, and if Surety elects to act under Paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of Surety to Owner shall not be greater than those of Contractor under the Contract, and the responsibilities of Owner to Surety shall not be greater than those of Owner under the Contract. To a limit of the amount of this Bond, but subject to commitment by Owner of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

6.1. The responsibilities of Contractor for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional, and delay costs resulting from Contractor's Default, and resulting from the actions or failure to act of Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Contractor.

7. Surety shall not be liable to Owner or others for obligations of Contractor that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.

8. Surety hereby waives notice of any change, including changes of time, to Contract or to related subcontracts, purchase orders, and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and shall be instituted within two years after Contractor Default or within two years after Contractor ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1. Balance of the Contract Price: The total amount payable by Owner to Contractor under the Contract after all proper adjustments have been made, including allowance to Contractor of any amounts received or to be received by Owner in settlement of insurance or other Claims for damages to which Contractor is entitled, reduced by all valid and proper payments made to or on behalf of Contractor under the Contract.

12.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

12.3. Contractor Default: Failure of Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

**FOR INFORMATION ONLY – Name, Address and Telephone
Surety Agency or Broker**

Owner's Representative (engineer or other party) Stigall Engineering Associates, Inc.; 4117 Hillsboro Pike, Suite 206; Nashville, Tennessee 37215

PAYMENT BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):
Monroe County Water District
205 Capp Harlan Road
Tompkinsville, Kentucky 42167

CONTRACT

Date:
Amount:
Description (Name and Location): Phase IX Water System Improvements – Contract I: Water Treatment Facility

BOND

Bond Number:
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____ (Seal)
Name and Title:

SURETY

Surety's Name and Corporate Seal (Seal)

By: _____
Signature and Title
(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest: _____
Signature and Title

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____ (Seal)
Name and Title:

SURETY

Surety's Name and Corporate Seal (Seal)

By: _____
Signature and Title
(Attach Power of Attorney)

Attest: _____
Signature and Title:

EJCDC No. C-615 (2002 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, the American Institute of Architects, the American Subcontractors Association, and the Associated Specialty Contractors.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to Owner, this obligation shall be null and void if Contractor:

2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2. Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with Contractor:

1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and

2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and

3. Not having been paid within the above 30 days, have sent a written notice to Surety and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.

5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.

6. When a Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at Surety's expense take the following actions:

6.1. Send an answer to that Claimant, with a copy to Owner, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.

6.2. Pay or arrange for payment of any undisputed amounts.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. DEFINITIONS

15.1. Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

15.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone

Surety Agency or Broker:

Owner's Representative (engineer or other party): Stigall Engineering Associates, Inc.; 4117 Hillsboro Pike, Suite 206; Nashville, Tennessee 37215

Notice of Award

Dated _____

Project: Phase IX Water System Improvements	Owner: Monroe County Water District	Owner's Contract No.:
Contract:I: Water Treatment Facility		Engineer's Project No.: 0323
Bidder:		
Bidder's Address: (send Certified Mail, Return Receipt Requested)		

You are notified that your Bid dated _____ for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for _____

(Indicate total Work, alternates or sections or Work awarded.)

The Contract Price of your Contract is _____
_____ Dollars (\$_____).

(Insert appropriate data if Unit Prices are used. Change language for Cost-Plus contracts.)

_____ copies of each of the proposed Contract Documents (except Drawings) accompany this Notice of Award.
_____ sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within [15] days of the date you receive this Notice of Award.

1. Deliver to the Owner [_____] fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract security [Bonds] as specified in the Instructions to Bidders (Article 20), [and] General Conditions (Paragraph 5.01) [and Supplementary Conditions (Paragraph SC-5.01).]
3. Other conditions precedent:

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

Monroe County Water District
Owner

By: _____
Authorized Signature

Mark Williams, Chairman
Title

Copy to Engineer

Notice to Proceed

Dated _____

Project: Phase IX Water System Improvements	Owner: Monroe County Water District	Owner's Contract No.:
Contract: I: Water Treatment Facility		Engineer's Project No.: 0323-01

Contractor:

Contractor's Address: [send Certified Mail, Return Receipt Requested]

You are notified that the Contract Times under the above contract will commence to run on _____. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 4 of the Agreement, the number of days to achieve Substantial Completion is 540, and the number of days to achieve readiness for final payment is 600.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you and Owner must each deliver to the other (with copies to Engineer and other identified additional insureds) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must [add other requirements]:

_____	MONROE COUNTY WATER DISTRICT
_____	Owner
_____	Given by:
_____	Authorized Signature
_____	Mark Williams, Chairman
_____	Title
_____	Date

Copy to Engineer

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the Controlling Law.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT FUNDING AGENCY EDITION

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly By



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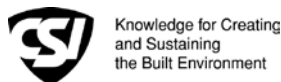
This document has been approved and endorsed by

The Associated General Contractors of America



and the

Construction Specification Institute



These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor Funding Agency Edition No. C-521 (2002 Edition). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the EJCDC Construction Documents, General and Instructions (No. C-001, 2002 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (No. C-800, 2002 Edition).

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1420 King Street, Alexandria, VA 22314-2794
(703) 684-2882

American Council of Engineering Companies
1015 15th Street N.W., Washington, DC 20005
(202) 347-7474

American Society of Civil Engineers
1801 Alexander Bell Drive, Reston, VA 20191-4400
(800) 548-2723

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GENERAL CONDITIONS

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda* – Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agency* – The Federal or state agency named as such in the Agreement.
 3. *Agreement* – The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.
 4. *Application for Payment* – The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 5. *Asbestos* – Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.
 6. *Bid* – The offer or proposal of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 7. *Bidder* – The individual or entity who submits a Bid directly to Owner.
 8. *Bidding Documents* – The Bidding Requirements and the proposed Contract Documents (including all Addenda).
 9. *Bidding Requirements* – The Advertisement or Invitation to Bid, Instructions to Bidders, bid security of acceptable form, if any, and the Bid Form with any supplements.
 10. *Change Order* – A document recommended by Engineer which is signed by Contractor and Owner and Agency and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.
 11. *Claim* – A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.
 12. *Contract* – The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.
 13. *Contract Documents* – Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor's submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

14. *Contract Price* – The moneys payable by Owner to Contractor for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.03 in the case of Unit Price Work).
15. *Contract Times* – The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any, (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.
16. *Contractor* – The individual or entity with whom Owner has entered into the Agreement.
17. *Cost of the Work* – See Paragraph 11.01.A for definition.
18. *Drawings* – That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.
19. *Effective Date of the Agreement* – The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.
20. *Engineer* – The individual or entity named as such in the Agreement.
21. *Field Order* – A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.
22. *General Requirements* – Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.
23. *Hazardous Environmental Condition* – The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.
24. *Hazardous Waste* – The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.
25. *Laws and Regulations; Laws or Regulations* – Any and all applicable laws, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
26. *Liens* – Charges, security interests, or encumbrances upon Project funds, real property, or personal property.
27. *Milestone* – A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.
28. *Notice of Award* – The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.
29. *Notice to Proceed* – A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.
30. *Owner* – The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.
31. *PCBs* – Polychlorinated biphenyls.

32. *Petroleum* – Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.
33. *Progress Schedule* – A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor’s plan to accomplish the Work within the Contract Times.
34. *Project* – The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.
35. *Project Manual* – The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.
36. *Radioactive Material* – Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.
37. *Related Entity* – An officer, director, partner, employee, agent, consultant, or subcontractor.
38. *Resident Project Representative* – The authorized representative of Engineer who may be assigned to the Site or any part thereof.
39. *Samples* – Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.
40. *Schedule of Submittals* – A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.
41. *Schedule of Values* – A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
42. *Shop Drawings* – All drawings, diagrams, illustrations, schedules, and other data or information which are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.
43. *Site* – Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.
44. *Specifications* – That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.
45. *Subcontractor* – An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.
46. *Substantial Completion* – The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.
47. *Successful Bidder* – The Bidder submitting a responsive Bid to whom Owner makes an award.

48. *Supplementary Conditions* – That part of the Contract Documents which amends or supplements these General Conditions.
49. *Supplier* – A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or any Subcontractor.
50. *Underground Facilities* – All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
51. *Unit Price Work* – Work to be paid for on the basis of unit prices.
52. *Work* – The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.
53. *Work Change Directive* – A written statement to Contractor issued on or after the Effective Date of the Agreement and signed by Owner and Agency upon recommendation of the Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

- A. The following words or terms are not defined but, when used in the Bidding Requirements or Contract Documents, have the following meaning.
- B. *Intent of Certain Terms or Adjectives*
 1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action or determination will be solely to evaluate, in general, the Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.
- C. *Day*
 1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents, or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents, or
 - c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

E. *Furnish, Install, Perform, Provide*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.
- F. Unless stated otherwise in the Contract Documents, words or phrases which have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

- A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.
- B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which Contractor and Owner respectively are required to purchase and maintain in accordance with Article 5.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

- A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Agreement.

2.04 *Starting the Work*

- A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

2.05 *Before Starting Construction*

- A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:
 - 1. a preliminary Progress Schedule;
 - 2. a preliminary Schedule of Submittals; and
 - 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.06 *Preconstruction Conference*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, Agency, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

2.07 *Initial Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.
 - 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
 - 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
 - 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage

as being required to produce the intended result will be provided whether or not specifically called for at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

3.02 *Reference Standards*

A. *Standards, Specifications, Codes, Laws, and Regulations*

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
2. No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, or Engineer, or any of their Related Entities, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. Reporting Discrepancies

1. *Contractor's Review of Contract Documents Before Starting Work:* Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor may discover and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.
2. *Contractor's Review of Contract Documents During Performance of Work:* If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor knew or reasonably should have known thereof.

B. Resolving Discrepancies

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between the provisions of the Contract Documents and:
 - a. the provisions of any standard, specification, manual, code, or instruction (whether or not specifically incorporated by reference in the Contract Documents); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.
- B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:
 - 1. A Field Order;
 - 2. Engineer's approval of a Shop Drawing or Sample; (Subject to the provisions of Paragraph 6.17.D.3) or
 - 3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

- A. Contractor and any Subcontractor or Supplier shall not:
 - 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or Engineer's consultants, including electronic media editions; or
 - 2. reuse any of such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.
- B. The prohibition of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

- A. Copies of data furnished by Owner or Engineer to Contractor or Contractor to Owner or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.
- B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.
- C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

4.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any,

of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which the Work is to be performed and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.02 *Subsurface and Physical Conditions*

- A. *Reports and Drawings:* The Supplementary Conditions identify:
 - 1. those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Contract Documents; and
 - 2. those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Contract Documents.
- B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:
 - 1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
 - 2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
 - 3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

- A. *Notice:* If Contractor believes that any subsurface or physical condition at or contiguous to the Site that is uncovered or revealed either:
 - 1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or
 - 2. is of such a nature as to require a change in the Contract Documents; or
 - 3. differs materially from that shown or indicated in the Contract Documents; or
 - 4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb

such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer's Review:* After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner's obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer's findings and conclusions.

C. *Possible Price and Times Adjustments*

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and
- b. with respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

- a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or
- b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment; or
- c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, Owner and Engineer, and any of their Related Entities shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

A. *Shown or Indicated:* The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and
2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. reviewing and checking all such information and data,
 - b. locating all Underground Facilities shown or indicated in the Contract Documents,

- c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction, and
- d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

B. *Not Shown or Indicated*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

4.05 *Reference Points*

- A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.06 *Hazardous Environmental Condition at Site*

- A. *Reports and Drawings:* Reference is made to the Supplementary Conditions for the identification of those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that have been utilized by the Engineer in the preparation of the Contract Documents.
- B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the general accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their Related Entities with respect to:
 1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or
 2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any “technical data” or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.
 - D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any.
 - E. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered to Contractor written notice: (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work; or (ii) specifying any special conditions under which such Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.
 - F. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a Claim therefor as provided in Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner’s own forces or others in accordance with Article 7.
 - G. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual’s or entity’s own negligence.
 - H. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06. H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual’s or entity’s own negligence.
 - I. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.
- B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.
- C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

- A. All bonds and insurance required by the Contract Documents to be purchased and maintained by Owner or Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.03 *Certificates of Insurance*

- A. Contractor shall deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.
- B. Owner shall deliver to Contractor, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

5.04 *Contractor's Liability Insurance*

- A. Contractor shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and as will provide protection from claims set forth below which may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable:
 - 1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;
 - 2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

3. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees;
 4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:
 - a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or
 - b. by any other person for any other reason;
 5. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and
 6. claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.
- B. The policies of insurance required by this Paragraph 5.04 shall:
1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;
 2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;
 3. include completed operations insurance;
 4. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;
 5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);
 6. remain in effect at least until final payment and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work in accordance with Paragraph 13.07; and
 7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment.
 - a. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Owner's Liability Insurance*

- A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

5.06 *Property Insurance*

- A. Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (Contractor shall be responsible for any deductible or self-insured retention.). This insurance shall:
1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;
 2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions;
 3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);
 4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;
 5. allow for partial utilization of the Work by Owner;
 6. include testing and startup; and
 7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.
- B. Contractor shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.
- C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.
- D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 to protect the interests of Contractor, Subcontractors, or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by Contractor, Subcontractors, or others suffering any such loss, and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

5.07 *Waiver of Rights*

- A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or additional insureds thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insured or additional insured (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Contractor as trustee or otherwise payable under any policy so issued.
- B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for:
 - 1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
 - 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.
- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them.

5.08 *Receipt and Application of Insurance Proceeds*

- A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Contractor and made payable to Contractor as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph 5.08.B. Contractor shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof.
- B. Contractor as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within 15 days after the occurrence of loss to Contractor's exercise of this power. If such objection be made, Contractor as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, Contractor as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Contractor as fiduciary shall give bond for the proper performance of such duties.

5.09 *Acceptance of Bonds and Insurance; Option to Replace*

- A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of

non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

- A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy.

ARTICLE 6 – CONTRACTOR’S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction. Contractor shall not be responsible for the negligence of Owner or Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances. The superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All communications given to or received from the superintendent shall be binding on Contractor.

6.02 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.
- B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

6.03 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

- B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

6.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.
 - 1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.
 - 2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

6.05 *Substitutes and "Or-Equals"*

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.
 - 1. *"Or-Equal" Items:* If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that:
 - 1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
 - 3) it has a proven record of performance and availability of responsive service; and
 - b. Contractor certifies that, if approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times, and
 - 2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

2. Substitute Items

- a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.
 - b. Contractor shall submit sufficient information as provided below to allow Engineer to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.
 - c. The procedure requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented in the General Requirements and as Engineer may decide is appropriate under the circumstances.
 - d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
 - 1) shall certify that the proposed substitute item will:
 - a) will perform adequately the functions and achieve the results called for by the general design,
 - b) be similar in substance to that specified, and
 - c) be suited to the same use as that specified;
 - 2) will state:
 - a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;
 - b) whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
 - c) whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;
 - 3) will identify:
 - a) all variations of the proposed substitute item from that specified , and
 - b) available engineering, sales, maintenance, repair, and replacement services;
 - 4) and shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.
- B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

- C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.
- D. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- E. *Engineer's Cost Reimbursement:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute item so proposed or submitted by Contractor, Contractor shall reimburse Owner for the charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.
- F. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

6.06 *Concerning Subcontractors, Suppliers, and Others*

- A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.
- B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.
- C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:
 - 1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity, nor
 - 2. shall anything in the Contract Documents create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.
- D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

- E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.
- F. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.
- G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of Owner or Engineer its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

6.08 *Permits*

- A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's primary responsibility to make certain

that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

- C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

6.10 *Taxes*

- A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

6.11 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.
2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.
3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning:* Prior to Substantial Completion of the Work, Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

6.12 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show changes made during construction. These record documents together with all approved

Samples and a counterpart of all approved Shop Drawings will be available to Engineer for reference. Upon completion of the Work, these record documents, Samples, and Shop Drawings will be delivered to Engineer for Owner.

6.13 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
 - 1. all persons on the Site or who may be affected by the Work;
 - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.
- C. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or , or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- D. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

- A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.15 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

6.16 *Emergencies*

- A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract

Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

6.17 *Shop Drawings and Samples*

- A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the acceptable Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.
 1. *Shop Drawings*
 - a. Submit number of copies specified in the General Requirements.
 - b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.
 2. *Samples*
 - a. Submit number of Samples specified in the Specifications.
 - b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.
- B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Submittal Procedures*
 1. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:
 - a. all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
 - b. the suitability of all materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work;
 - c. all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto; and
 - d. shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.
 2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.
 3. With each submittal, Contractor shall give Engineer specific written notice of any variations, that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular means, method, technique, sequence, or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.

6.18 *Continuing the Work*

- A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

6.19 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its Related Entities shall be entitled to rely on representation of Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 2. normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
 1. observations by Engineer;
 2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
4. use or occupancy of the Work or any part thereof by Owner;
5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;
6. any inspection, test, or approval by others; or
7. any correction of defective Work by Owner.

6.20 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer or any of their respective consultants, agents, officers, directors, partners, or employees by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.
- C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, consultants and subcontractors arising out of:
 1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
 2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

6.21 *Delegation of Professional Design Services*

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.
- B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.
- D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.
- E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 Related Work at Site

- A. Owner may perform other work related to the Project at the Site with Owner's employees, or via other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:
 - 1. written notice thereof will be given to Contractor prior to starting any such other work; and
 - 2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.
- B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of Engineer and the others whose work will be affected. The duties and responsibilities of Contractor under this Paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor in said direct contracts between Owner and such utility owners and other contractors.
- C. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 7, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

7.02 Coordination

- A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:
 - 1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;
 - 2. the specific matters to be covered by such authority and responsibility will be itemized; and
 - 3. the extent of such authority and responsibilities will be provided.

- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

7.03 *Legal Relationships*

- A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.
- B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's actions or inactions.
- C. Contractor shall be liable to Owner and any other contractor for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's action or inactions.

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

- A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

8.02 *Replacement of Engineer*

- A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

8.03 *Furnish Data*

- A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

8.04 *Pay When Due*

- A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

- A. Owner's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been utilized by Engineer in preparing the Contract Documents.

8.06 *Insurance*

- A. Owner's responsibilities, if any, in respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

8.07 *Change Orders*

- A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

8.08 *Inspections, Tests, and Approvals*

- A. Owner's responsibility in respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

8.09 *Limitations on Owner's Responsibilities*

- A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

8.10 *Undisclosed Hazardous Environmental Condition*

- A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

8.11 *Evidence of Financial Arrangements*

- A. If and to the extent Owner has agreed to furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents, Owner's responsibility in respect thereof will be as set forth in the Supplementary Conditions.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

- A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents and will not be changed without written consent of Owner and Engineer.

9.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

- A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

- A. Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on Owner and also on Contractor, who shall perform the Work involved promptly. If Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

- A. Engineer will have authority to reject Work which Engineer believes to be defective, or that Engineer believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer will also have authority to require special inspection or testing of the Work as provided in Paragraph 13.04, whether or not the Work is fabricated, installed, or completed.

9.06 *Shop Drawings, Change Orders and Payments*

- A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.
- B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.
- C. In connection with Engineer's authority as to Change Orders, see Articles 10, 11, and 12.
- D. In connection with Engineer's authority as to Applications for Payment, see Article 14.

9.07 *Determinations for Unit Price Work*

- A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

- A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.
- B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believe that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.
- C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

- D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *Limitations on Engineer's Authority and Responsibilities*

- A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.
- B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with the Contract Documents.
- E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, subject to written approval by Agency at any time or from time to time, order additions, deletions, or revisions in the Work by a Change Order, or a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).
- B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

10.02 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

10.03 *Execution of Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:
1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;
 2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and
 3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; provided that, in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, Contractor shall carry on the Work and adhere to the Progress Schedule as provided in Paragraph 6.18.A.

10.04 *Notification to Surety*

- A. If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any bond to be given to a surety, the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

- A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.
- B. *Notice:* Written notice stating the general nature of each Claim shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Time shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).
- C. *Engineer's Action:* Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:
1. deny the Claim in whole or in part,
 2. approve the Claim, or
 3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.
- D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

- E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.
- F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

- A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Except as otherwise may be agreed to in writing by Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items, and shall not include any of the costs itemized in Paragraph 11.01.B.
 - 1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time at the Site. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.
 - 2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.
 - 3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.
 - 4. Costs of special consultants (including but not limited to Engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
 - 5. Supplemental costs including the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are

consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

- c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
 - d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, imposed by Laws and Regulations.
 - e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
 - f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.
 - g. The cost of utilities, fuel, and sanitary facilities at the Site.
 - h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expressages, and similar petty cash items in connection with the Work.
 - i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.
- B. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:
1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.
 2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
 3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
 4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
 5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A and 11.01.B.

- C. **Contractor's Fee:** When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.
- D. **Documentation:** Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

11.02 Allowances

- A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.
- B. **Cash Allowances**
 - 1. Contractor agrees that:
 - a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 - b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.
- C. **Contingency Allowance**
 - 1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

11.03 Unit Price Work

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

- D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:
1. the Bid price of a particular item of Unit Price Work amounts to more than 5 percent of the Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Agreement; and
 2. there is no corresponding adjustment with respect to any other item of Work; and
 3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

12.01 Change of Contract Price

- A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. The value of any Work covered by a Change Order or of any Claim for an adjustment in the Contract Price will be determined as follows:
1. where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 11.03); or
 2. where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 12.01.C.2); or
 3. where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).
- C. Contractor's Fee: The Contractor's fee for overhead and profit shall be determined as follows:
1. a mutually acceptable fixed fee; or
 2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;
 - b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;
 - c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraph 12.01.C.2.a is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;
 - d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

- e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
- f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.
- B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

- A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.
- B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.B.
 - 1. delays caused by or within the control of Contractor; or
- D. Owner, Engineer and the Related Entities of each of them shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of Engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.
- E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

13.01 *Notice of Defects*

- A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. All defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspecting, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's Site safety procedures and programs so that they may comply therewith as applicable.

13.03 *Tests and Inspections*

- A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:
 - 1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;
 - 2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in said Paragraph 13.04.C; and
 - 3. as otherwise specifically provided in the Contract Documents.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.
- E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, it must, if requested by Engineer, be uncovered for observation.
- F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

- A. If any Work is covered contrary to the written request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

- B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.
- C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.
- D. If, the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

13.06 *Correction or Removal of Defective Work*

- A. Promptly after receipt of notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).
- B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. repair such defective land or areas; or
 - 2. correct such defective Work; or
 - 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.
- C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
- E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

- C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

- A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. *Applications for Payments*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to Owner or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations on the Site of the executed Work as an experienced and qualified design professional and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
 - a. the Work has progressed to the point indicated;

- b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and to any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
 3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
 - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or
 - b. that there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
 4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - a. to supervise, direct, or control the Work, or
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
 5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:
 - a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or
 - d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. Payment Becomes Due

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. *Reduction in Payment*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:
 - a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;
 - b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
 - c. the Contractor's performance or furnishing of the Work is inconsistent with funding Agency requirements;
 - d. there are other items entitling Owner to a set-off against the amount recommended; or
 - e. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.
2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.
3. If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

14.03 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.
- B. Promptly after Contractor's notification, Owner, Agency, Contractor, and Engineer shall make a prefinal inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will within 14 days after submission of the tentative certificate to Owner notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will within said 14 days execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

- D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.
- E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to complete or correct items on the tentative list.

14.05 *Partial Utilization*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions.
 - 1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor will certify to Owner and Engineer that such part of the Work is substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
 - 2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
 - 3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
 - 4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

- A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner, Agency, and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

14.07 *Final Payment*

- A. *Application for Payment*
 - 1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.7;
 - b. consent of the surety, if any, to final payment;
 - c. a list of all Claims against Owner that Contractor believes are unsettled; and
 - d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner or Owner's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. Engineer's Review of Application and Acceptance

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. Payment Becomes Due

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

- A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims. The remaining balance of any sum included in the final Application for Payment but held by OWNER for Work not fully completed and accepted will become due when the Work is fully completed and accepted.

14.09 *Waiver of Claims*

- A. The making and acceptance of final payment will constitute:
1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and
 2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will justify termination for cause:
1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);
 2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;
 3. Contractor's disregard of the authority of Engineer; or
 4. Contractor's violation in any substantial way of any provisions of the Contract Documents.
- B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:
1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion),
 2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and
 3. complete the Work as Owner may deem expedient.
- C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by

Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph Owner shall not be required to obtain the lowest price for the Work performed.

- D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.
- E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.
- F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B, and 15.02.C.

15.03 *Owner May Terminate For Convenience*

- A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;
 - 3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and
 - 4. reasonable expenses directly attributable to termination.
- B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

- A. Owner and Contractor may mutually request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association. Timely submission of the request shall stay the effect of Paragraph 10.05.E.
- B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.
- C. If the claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:
 - 1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or
 - 2. agrees with the other party to submit the Claim to another dispute resolution process, or
 - 3. gives written notice to the other party of their intent to submit the Claim to a court of competent jurisdiction.

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

- A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:
 - 1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or
 - 2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

- A. When any period of time is referred to in the Contract Documents by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

17.03 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract Documents. The provisions of this Paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

17.04 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

- A. This Contract is to be governed by the law of the state in which the Project is located.

17.06 *Headings*

- A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

ARTICLE 18 – FEDERAL REQUIREMENTS

18.01 *Agency Not a Party*

- A. This Contract is expected to be funded in part with funds provided by Agency. Neither Agency, nor any of its departments, entities, or employees is a party to this Contract.

18.02 *Contract Approval*

- A. Owner and Contractor will furnish Owner's attorney such evidence as required so that Owner's attorney can complete and execute the following "Certificate of Owner's Attorney" (Exhibit GC-A) before Owner submits the executed Contract Documents to Agency for approval.
- B. Concurrence by Agency in the award of the Contract is required before the Contract is effective.

18.03 *Conflict of Interest*

- A. Contractor may not knowingly contract with a supplier or manufacturer if the individual or entity who prepared the plans and specifications has a corporate or financial affiliation with the supplier or manufacturer.
- B. Owner's officers, employees, or agents shall not engage in the award or administration of this Contract if a conflict of interest, real or apparent, would be involved. Such a conflict would arise when: (i) the employee, officer or agent; (ii) any member of their immediate family; (iii) their partner or (iv) an organization that employs, or is about to employ, any of the above, has a financial interest in Contractor. Owner's officers, employees, or agents shall neither solicit nor accept gratuities, favors or anything of monetary value from Contractor or subcontractors.

18.04 *Gratuities*

- A. If Owner finds after a notice and hearing that Contractor, or any of Contractor's agents or representatives, offered or gave gratuities (in the form of entertainment, gifts, or otherwise) to any official, employee, or agent of Owner or Agency in an attempt to secure this Contract or favorable treatment in awarding, amending, or making any determinations related to the performance of this Contract, Owner may, by written notice to Contractor, terminate this Contract. Owner may also pursue other rights and remedies that the law or this Contract provides. However, the existence of the facts on which Owner bases such findings shall be an issue and may be reviewed in proceedings under the dispute resolution provisions of this Contract.
- B. In the event this Contract is terminated as provided in paragraph 18.04.A, Owner may pursue the same remedies against Contractor as it could pursue in the event of a breach of this Contract by Contractor. As a penalty, in addition to any other damages to which it may be entitled by law, Owner may pursue exemplary damages in an

amount (as determined by Owner) which shall not be less than three nor more than ten times the costs Contractor incurs in providing any such gratuities to any such officer or employee.

18.05 *Audit and Access to Records*

- A. For all negotiated contracts and negotiated modifications (except those of \$10,000 or less), Owner, Agency, the Comptroller General, or any of their duly authorized representatives, shall have access to any books, documents, papers, and records of the Contractor, which are pertinent to the Contract, for the purpose of making audits, examinations, excerpts and transcriptions. Contractor shall maintain all required records for three years after final payment is made and all other pending matters are closed.

18.06 *Small, Minority and Women's Businesses*

- A. If Contractor intends to let any subcontracts for a portion of the work, Contractor shall take affirmative steps to assure that small, minority and women's businesses are used when possible as sources of supplies, equipment, construction, and services. Affirmative steps shall consist of: (1) including qualified small, minority and women's businesses on solicitation lists; (2) assuring that small, minority and women's businesses are solicited whenever they are potential sources; (3) dividing total requirements when economically feasible, into small tasks or quantities to permit maximum participation of small, minority, and women's businesses; (4) establishing delivery schedules, where the requirements of the work permit, which will encourage participation by small, minority and women's businesses; (5) using the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce; (6) requiring each party to a subcontract to take the affirmative steps of this section; and (7) Contractor is encouraged to procure goods and services from labor surplus area firms.

18.07 *Anti-Kickback*

- A. Contractor shall comply with the Copeland Anti-Kickback Act (18 USC 874 and 40 USC 276c) as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Buildings or Public Works Financed in Whole or in Part by Loans or Grants of the United States"). The Act provides that Contractor or subcontractor shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public facilities, to give up any part of the compensation to which they are otherwise entitled. Owner shall report all suspected or reported violations to Agency.

18.08 *Clean Air and Pollution Control Acts*

- A. If this Contract exceeds \$100,000, Contractor shall comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 USC 7401 *et seq.*) and the Federal Water Pollution Control Act as amended (33 USC 1251 *et seq.*). Contractor will report violations to the Agency and the Regional Office of the EPA.

18.09 *State Energy Policy*

- A. Contractor shall comply with the Energy Policy and Conservation Act (P.L. 94-163). Mandatory standards and policies relating to energy efficiency, contained in any applicable State Energy Conservation Plan, shall be utilized.

18.10 *Equal Opportunity Requirements*

- A. If this Contract exceeds \$10,000, Contractor shall comply with Executive Order 11246, "Equal Employment Opportunity," as amended by Executive Order 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," and as supplemented by regulations at 41 CFR part 60, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor."
- B. Contractor's compliance with Executive Order 11246 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative active obligations required by the Standard Federal Equal Employment

Opportunity Construction Contract Specifications, as set forth in 41 CFR Part 60-4 and its efforts to meet the goals established for the geographical area where the Contract is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the Contract, and in each trade, and 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 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.

- C. Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 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; estimated dollar amount of subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the Contract is to be performed.

18.11 *Restrictions on Lobbying*

- A. Contractor and each subcontractor shall comply with Restrictions on Lobbying (Public Law 101-121, Section 319) as supplemented by applicable Agency regulations. This Law applies to the recipients of contracts and subcontracts that exceed \$100,000 at any tier under a Federal loan that exceeds \$150,000 or a Federal grant that exceeds \$100,000. If applicable, Contractor must complete a certification form on lobbying activities related to a specific Federal loan or grant that is a funding source for this Contract. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 USC 1352. Each tier shall disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Certifications and disclosures are forwarded from tier to tier up to the Owner. Necessary certification and disclosure forms shall be provided by Owner.

18.12 *Environmental Requirements*

- A. When constructing a project involving trenching and/or other related earth excavations, Contractor shall comply with the following environmental constraints:
 - 1. Wetlands – When disposing of excess, spoil, or other construction materials on public or private property, Contractor shall not fill in or otherwise convert wetlands.
 - 2. Floodplains – When disposing of excess, spoil, or other construction materials on public or private property, Contractor shall not fill in or otherwise convert 100 year floodplain areas delineated on the latest Federal Emergency Management Agency Floodplain Maps, or other appropriate maps, i.e., alluvial soils on NRCS Soil Survey Maps.
 - 3. Historic Preservation – Any excavation by Contractor that uncovers an historical or archaeological artifact shall be immediately reported to Owner and a representative of Agency. Construction shall be temporarily halted pending the notification process and further directions issued by Agency after consultation with the State Historic Preservation Officer (SHPO).
 - 4. Endangered Species – Contractor shall comply with the Endangered Species Act, which provides for the protection of endangered and/or threatened species and critical habitat. Should any evidence of the presence of endangered and/or threatened species or their critical habitat be brought to the attention of Contractor, Contractor will immediately report this evidence to Owner and a representative of Agency. Construction shall be temporarily halted pending the notification process and further directions issued by Agency after consultation with the U.S. Fish and Wildlife Service.

EXHIBIT GC-A

Certificate of Owner's Attorney

I, the undersigned, _____, the duly authorized and acting legal representative of _____, do hereby certify as follows:

I have examined the attached Contract(s) and performance and payment bond(s) and the manner of execution thereof, and I am of the opinion that each of the aforesaid agreements is adequate and has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with the terms, conditions, and provisions thereof.

Date: _____

Supplementary Conditions

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (No. C-700, 2007 Edition) and other provisions of the Contract Documents as indicated below. All provisions that are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

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SC-1.01.A.2. Add the following new Paragraph after Paragraph 1.01.A.1:

The Project is financed in whole or in part by USDA Rural Utilities Service pursuant to the Consolidated Farm and Rural Development Act (7 USC Section 1921 et seq.). The Rural Utilities Service programs are administered through the USDA Rural Development offices; therefore, the Agency for these documents is USDA Rural Development.

SC-1.01.A.3. Add the following language to the end of Paragraph 1.01.A.3:

The Application for Payment form to be used on this Project is EJCDC No. C-620. The Agency must approve all Applications for Payment before payment is made.

SC-1.01.A.9. Add the following language to the end of Paragraph 1.01.A.9:

The Change Order form to be used on this Project is EJCDC No. C-941. Agency approval is required before Change Orders are effective.

SC-1.01.A.19. Add the following language to the end of Paragraph 1.01.A.19:

The Engineer's Consultants on this project are: N/A

SC-5.04. Add the following new paragraph immediately after Paragraph 5.04.B:

C. The limits of liability for insurance required by Paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation, and related coverages under Paragraphs 5.04.A.1 and A.2 of the General Conditions:

- | | |
|---|------------|
| a. State: | Statutory |
| b. Applicable Federal
(e.g., Longshoremen's) | Statutory |
| c. Employer's Liability | \$ 500,000 |

2. Contractor's General Liability under Paragraphs 5.04.A.3 through A.6 of the General Conditions which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody, and control of the Contractor:

- | | |
|--|--------------|
| a. General Aggregate | \$ 2,000,000 |
| b. Products - Completed
Operations Aggregate | \$ 1,000,000 |
| c. Personal and Advertising
Injury | \$ 1,000,000 |
| d. Each Occurrence
(Bodily Injury and
Property Damage) | \$ 1,000,000 |
| e. Property Damage liability
insurance will provide
Explosion, Collapse, and
Underground coverages where
applicable. | |
| f. Excess or Umbrella Liability | |
| 1) General Aggregate | \$ 5,000,000 |
| 2) Each Occurrence | \$ 5,000,000 |

3. Automobile Liability under Paragraph 5.04.A.6 of the General Conditions:

- | | |
|-----------------------------|--------------|
| a. Bodily Injury: | |
| Each Person | \$ 1,000,000 |
| Each Accident | \$ 1,000,000 |
| b. Property Damage: | |
| Each Accident | \$ 1,000,000 |
| c. Combined Single Limit of | \$ 1,000,000 |

4. The Contractual Liability coverage required by paragraph 5.04.B.4 of the General Conditions shall provide coverage for not less than the following amounts:
 - a. Bodily Injury:

Each Person	\$ 2,000,000
Each Accident	\$ 2,000,000
 - b. Property Damage:

Each Accident	\$ 2,000,000
Annual Aggregate	\$ 2,000,000

5. Other persons or entities to be included on policy as additional insured's:
 - Town of Linden

SC-6.05.C. Amend the paragraph by making two subparagraphs under the title C. Engineer's Evaluation. The paragraph text is retitled, 6.05.C.2 After Effective Date of Agreement. A new paragraph is added before this paragraph to read as follows:

1. During Bidding. The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, or "or-equal" materials and equipment as defined in paragraph 6.05 of the General Conditions, or those substitute materials and equipment approved by the Engineer and identified by Addendum. The materials and equipment described in the Bidding Documents establish a standard of required type, function, and quality to be met by any proposed substitute or "or-equal" item. Request for Engineer's clarification of materials and equipment considered "or-equal" prior to the Effective Date of the Agreement must be received by the Engineer at least 5 days prior to the date for receipt of Bids. No item of material or equipment will be considered by Engineer as a substitute unless written request for approval has been submitted by Bidder
and
has been received by Engineer at least 15 days prior to the date for receipt of Bids. Each request shall conform to the requirements of Paragraph 6.05 of the General Conditions. The burden of proof of the merit of the proposed item is upon the Bidder. Engineer's decision of approval or disapproval of a proposed item will be final. If Engineer approves any proposed substitute item, such approval will be set forth in an Addendum issued to all prospective Bidders. Bidders shall not rely upon approvals made in any other manner.

SC-6.06 Add a new paragraph immediately after Paragraph 6.06.G:

The Contractor shall not award work valued at more than fifty (50%) percent of the Contract Price to Subcontractor(s), without prior written approval of the Owner.

SC-14.02.A.3. Add the following language at the end of paragraph 14.02.A.3:

No payments will be made that would deplete the retainage, place in escrow any funds that are required for retainage, or invest the retainage for the benefit of the Contractor.

SC-14.02.A.4. Add the following new Paragraph after Paragraph 14.02.A.3:

The Application for Payment form to be used on this Project is EJCDC No. C-620. The Agency must approve all Applications for Payment before payment is made.

SC-14.02.C.1. Delete Paragraph 14.02.C.1 in its entirety and insert the following in its place:

1. The Application for Payment with Engineer's recommendations will be presented to the Owner and Agency for consideration. If both the Owner and Agency find the Application for Payment acceptable, the recommended amount less any reduction under the provisions of Paragraph 14.02.D will become due ten days after the Application for Payment is presented to the Owner, and the Owner will make payment to the Contractor.

SC-18 Add a new Article 18, "Federal Requirements," after Article 17.

SC-18.01 Add the following language at the beginning of Article 18 with the title "Agency Not a Party."

- A. This Contract is expected to be funded in part with funds provided by Agency. Neither Agency, nor any of its departments, entities, or employees is a party to this Contract.

SC-18.02 Add the following language after Article 18.01.A with the title "Contract Approval."

- A. Owner and Contractor will furnish Owner's attorney such evidence as required so that Owner's attorney can complete and execute the following "Certificate of Owner's Attorney" (Exhibit GC-A) before Owner submits the executed Contract Documents to Agency for approval.
- B. Concurrence by Agency in the award of the Contract is required before the Contract is effective.

SC 18.03 Add the following language after Article 18.02.B with the title "Conflict of Interest."

- A. Contractor may not knowingly contract with a supplier or manufacturer if the individual or entity who prepared the plans and specifications has a corporate or financial affiliation with the supplier or manufacturer. Owner's officers, employees, or agents shall not engage in the award or administration of this Contract if a conflict of interest, real or apparent, would be involved. Such a conflict would arise when: (i) the employee, officer or agent; (ii) any member of their immediate family; (iii) their partner or (iv) an organization that employs, or is about to employ, any of the above, has a financial interest

in Contractor. Owner's officers, employees, or agents shall neither solicit nor accept gratuities, favors or anything of monetary value from Contractor or subcontractors.

SC-18.04 Add the following language after Article 18.03.A with the title "Gratuities."

- A. If Owner finds after a notice and hearing that Contractor, or any of Contractor's agents or representatives, offered or gave gratuities (in the form of entertainment, gifts, or otherwise) to any official, employee, or agent of Owner or Agency in an attempt to secure this Contract or favorable treatment in awarding, amending, or making any determinations related to the performance of this Contract, Owner may, by written notice to Contractor, terminate this Contract. Owner may also pursue other rights and remedies that the law or this Contract provides. However, the existence of the facts on which Owner bases such findings shall be an issue and may be reviewed in proceedings under the dispute resolution provisions of this Contract.
- B. In the event this Contract is terminated as provided in paragraph 18.04.A, Owner may pursue the same remedies against Contractor as it could pursue in the event of a breach of this Contract by Contractor. As a penalty, in addition to any other damages to which it may be entitled by law, Owner may pursue exemplary damages in an amount (as determined by Owner) which shall not be less than three nor more than ten times the costs Contractor incurs in providing any such gratuities to any such officer or employee.

SC-18.05 Add the following language after Article 18.04.B with the title "Audit and Access to Records."

- A. Owner, Agency, the Comptroller General of the United States, or any of their duly authorized representatives, shall have access to any books, documents, papers, and records of the Engineer which are pertinent to the Agreement, for the purpose of making audits, examinations, excerpts, and transcriptions. Engineer shall maintain all required records for three years after final payment is made and all other pending matters are closed.

SC-18.06 Add the following language after Article 18.05.A with the title "Small, Minority and Women's Businesses."

- A. If Contractor intends to let any subcontracts for a portion of the work, Contractor shall take affirmative steps to assure that small, minority and women's businesses are used when possible as sources of supplies, equipment, construction, and services. Affirmative steps shall consist of: (1) including qualified small, minority and women's businesses on solicitation lists; (2) assuring that small, minority and women's businesses are solicited whenever they are potential sources; (3) dividing total requirements when economically feasible, into small tasks or quantities to permit maximum participation of small, minority, and women's businesses; (4) establishing delivery schedules, where the requirements of the work permit, which will encourage participation by small, minority and women's businesses; (5) using the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce; (6) requiring each party to a subcontract to take the affirmative steps of this section; and (7) Contractor is encouraged to procure goods and services from labor surplus area firms.

SC-18.07 Add the following after Article 18.06.A with the title “Anti-Kickback.”

- A. Contractor shall comply with the Copeland Anti-Kickback Act (18 USC 874 and 40 USC 276c) as supplemented by Department of Labor regulations (29 CFR Part 3, “Contractors and Subcontractors on Public Buildings or Public Works Financed in Whole or in Part by Loans or Grants of the United States”). The Act provides that Contractor or subcontractor shall be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public facilities, to give up any part of the compensation to which they are otherwise entitled. Owner shall report all suspected or reported violations to Agency.

SC-18.08 Add the following after Article 18.07.A with the title “Clean Air and Pollution Control Acts.”

- A. If this Contract exceeds \$100,000, Compliance with all applicable standards, orders, or requirements issued under section 306 of the Clean Air Act (42 U.S.C. 1857(h) and 42 USC 7401et. seq.), section 508 of the Clean Water Act (33 U.S.C. 1368) and Federal Water Pollution Control Act (33 USC 1251 et seq.), Executive Order 11738, and Environmental Protection Agency regulations (40 CFR part 15) is required. Contractor will report violations to the Agency and the Regional Office of the EPA.

SC-18.09 Add the following after Article 18.08 with the title “State Energy Policy.”

- A. Contractor shall comply with the Energy Policy and Conservation Act (P.L. 94-163). Mandatory standards and policies relating to energy efficiency, contained in any applicable State Energy Conservation Plan, shall be utilized.

SC-18.10 Add the following after Article 18.09 with the title “Equal Opportunity Requirements.”

- A. If this Contract exceeds \$10,000, Contractor shall comply with Executive Order 11246, “Equal Employment Opportunity,” as amended by Executive Order 11375, “Amending Executive Order 11246 Relating to Equal Employment Opportunity,” and as supplemented by regulations at 41 CFR part 60, “Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor.”
- B. Contractor’s compliance with Executive Order 11246 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative active obligations required by the Standard Federal Equal Employment Opportunity Construction Contract Specifications, as set forth in 41 CFR Part 60-4 and its efforts to meet the goals established for the geographical area where the Contract is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the Contract, and in each trade, and 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 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.

- C. Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 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; estimated dollar amount of subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the Contract is to be performed.

SC-18.11 Add the following after Article 18.10.C with the title “Restrictions on Lobbying.”

- A. Contractor and each subcontractor shall comply with Restrictions on Lobbying (Public Law 101-121, Section 319) as supplemented by applicable Agency regulations. This Law applies to the recipients of contracts and subcontracts that exceed \$100,000 at any tier under a Federal loan that exceeds \$150,000 or a Federal grant that exceeds \$100,000. If applicable, Contractor must complete a certification form on lobbying activities related to a specific Federal loan or grant that is a funding source for this Contract. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 USC 1352. Each tier shall disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Certifications and disclosures are forwarded from tier to tier up to the Owner. Necessary certification and disclosure forms shall be provided by Owner.

SC-18.12 Add the following after Article 18.11.A with the title “Environmental Requirements.”

When constructing a project involving trenching and/or other related earth excavations, Contractor shall comply with the following environmental constraints:

- A. Wetlands – When disposing of excess, spoil, or other construction materials on public or private property, Contractor shall not fill in or otherwise convert wetlands.
- B. Floodplains – When disposing of excess, spoil, or other construction materials on public or private property, Contractor shall not fill in or otherwise convert 100 year floodplain areas delineated on the latest Federal Emergency Management Agency Floodplain Maps, or other appropriate maps, i.e., alluvial soils on NRCS Soil Survey Maps.
- C. Historic Preservation – Any excavation by Contractor that uncovers an historical or archaeological artifact shall be immediately reported to Owner and a representative of Agency. Construction shall be temporarily halted pending the notification process and

further directions issued by Agency after consultation with the State Historic Preservation Officer (SHPO).

- D. Endangered Species – Contractor shall comply with the Endangered Species Act, which provides for the protection of endangered and/or threatened species and critical habitat. Should any evidence of the presence of endangered and/or threatened species or their critical habitat be brought to the attention of Contractor, Contractor will immediately report this evidence to Owner and a representative of Agency. Construction shall be temporarily halted pending the notification process and further directions issued by Agency after consultation with the U.S. Fish and Wildlife Service.

- E. Mitigation Measures – If the project had an Environmental Report, Environmental Assessment, or Environmental Impact Statement to meet the requirements of the National Environmental Policy Act, compliance with the mitigation measures, if any, in that document are hereby included as a condition of this contract. {These mitigation measures are as follows: Insert mitigation measures if any. }

EXHIBIT GC-A

Certificate of Owner's Attorney

I, the undersigned, _____, the duly authorized and acting legal representative _____, do hereby certify as follows:

I have examined the attached Contract(s) and performance and payment bond(s) and the manner of execution thereof, and I am of the opinion that each of the aforesaid agreements is adequate and has been duly executed by the proper parties thereto acting through their duly authorized representatives; that said representatives have full power and authority to execute said agreements on behalf of the respective parties named thereon; and that the foregoing agreements constitute valid and legally binding obligations upon the parties executing the same in accordance with the terms, conditions, and provisions thereof.

Date: _____

AGENCY CONCURRENCE

As lender or insurer of funds to defray the costs of this Contract, and without liability for any payments thereunder, the Agency hereby concurs in the form, content, and execution of this Agreement.

By: _____ Date _____

Type Name: _____

SUPPLEMENTAL GENERAL CONDITIONS
FOR
CLEAN WATER STATE REVOLVING FUND
DRINKING WATER STATE REVOLVING FUND
(Drinking Water and Wastewater)

Project Name: Monroe County Water District Phase IX Water System Improvements – Contract I: Water Treatment Facility

Project Number: 0323-I

The attached instructions and regulations as listed below shall be incorporated into the Specifications and comprise Special Conditions.

	<u>Attachment No.</u>
SRF Special Provisions	1
Buy American Memo	2
KRS Chapter 45A-Kentucky Model Procurement Code	3
Equal Employment Opportunity (EEO) Documents:	
Notice of Requirement for Affirmative Action	4
Contract Specifications (Executive Order 11246)	5
EEO Goals for Region 4 Economic Areas	6
Special Notice #1 - Check List of EEO Documentation	7
Employer Information Report EEO-1 (SF 100)	8
Labor Standards Provisions for Federally Assisted Construction, EPA Form 5720-4	9
Certifications	
Debarment, Suspension and Other Responsibility Matters	10
Anti-lobbying	11
Region 4 Disadvantaged Business Enterprise (DBE)	12
Bonds and Insurance	13
Storm Water General Permit	14
Davis-Bacon Wage Rate Requirements under FY 2013 Continuing Resolution	15

SRF SPECIAL PROVISIONS

- (a) **Line crossings of all roads and streets shall be done in accordance with the Kentucky Transportation Cabinet requirements as may be set forth in the Special Conditions.**
- (b) **Construction is to be carried out so as to prevent by-passing of flows during construction unless a schedule has been approved by the State or EPA, whichever is applicable. Siltation and soil erosion must be minimized during construction. All construction projects with surface disturbance of more than 1 acre during the period of construction must have a KPDES Storm Water General Permit. The permit can be found at the following web address: <https://dep.gateway.ky.gov/eForms/default.aspx?FormID=7>.**

If you have any questions regarding the completion of this form call the Surface Water Permits Branch at (502) 564-3410.

- (c) **Restore disturbed areas to original or better condition.**
- (d) **Use of Chemicals: All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either DOW or EPA. Use of all such chemicals and disposal of residues shall be in conformance with instructions on the manufacturer's label.**
- (e) **The construction of the project, including the letting of contracts in connection therewith, shall conform to the applicable requirements of state, territorial, and local laws and ordinances to the extent that such requirements do not conflict with Federal laws and this subchapter.**
- (f) **The owner shall provide and maintain competent and adequate supervision and inspection.**
- (g) **The Kentucky Infrastructure Authority and Kentucky Division of Water shall have access to the site and the project work at all times.**
- (h) **In the event Archaeological materials (arrowheads, stone tools, stone axes, prehistoric and historic pottery, bottles, foundations, Civil War artifacts, and other types of artifacts) are uncovered during the construction of this project, work is to immediately cease at the location and the Kentucky Heritage Council shall be contacted. The telephone number is (502) 564-7005. Construction shall commence at this location until a written release is received from the Kentucky Heritage Council. Failure to report a find could result in legal action.**
- (i) **This procurement will be subject to DOW Procurement Guidance including the Davis-Bacon Act.**
- (j) **Reasonable care shall be taken during construction to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.**
- (k) **No wastewater bypassing will occur during construction unless a schedule has been approved by the Kentucky Division of Water.**
- (l) **Change orders to the construction contract (if required) must be negotiated pursuant to DOW/KIA Procurement Guidance for Construction and Equipment Contracts.**



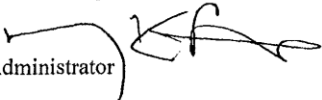
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 24 2014

OFFICE OF WATER

MEMORANDUM

SUBJECT: Application of Buy American Requirements to Fiscal Year 2014 Clean Water State Revolving Fund and Drinking Water State Revolving Fund Assistance Agreements

FROM: Nancy K. Stoner 
Acting Assistant Administrator

TO: Water Management Division Directors
Regions I- X

On January 17, 2014, H.R. 3547, "Consolidated Appropriations Act, 2014," (Appropriations Act) was enacted. This law provides appropriations for both the Clean Water State Revolving Fund (CWSRF) and the Drinking Water State Revolving Fund (DWSRF) for Fiscal Year 2014, while adding a Buy American requirement to these already existing programs. Application of this new requirement is the focus of this memorandum.

H.R. 3547 includes the following language in Division G, Title IV, under the heading, "Use of American Iron and Steel,"

Sec. 436. (a)(1) None of the funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12) shall be used for a project for the construction, alteration, maintenance, or repair of a public water system or treatment works unless all of the iron and steel products used in the project are produced in the United States.

(2) In this section, the term "iron and steel products" means the following products made primarily of iron or steel: lined or unlined pipes and fittings, manhole covers and other municipal castings, hydrants, tanks, flanges, pipe clamps and restraints, valves, structural steel, reinforced precast concrete, and construction materials.

(b) Subsection (a) shall not apply in any case or category of cases in which the Administrator of the Environmental Protection Agency (in this section referred to as the "Administrator") finds that—

- (1) applying subsection (a) would be inconsistent with the public interest;
- (2) iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or

(3) inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

(d) This section shall be applied in a manner consistent with United States obligations under international agreements.

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

(f) This section does not apply with respect to a project if a State agency approves the engineering plans and specifications for the project, in that agency's capacity to approve such plans and specifications prior to a project requesting bids, prior to the date of the enactment of this Act.

In order to comply with this provision, States must include in all assistance agreements, whether in the form of a loan, bond purchase, grant, or any other vehicle to provide financing for a project, executed on or after January 17, 2014 (date of enactment of H.R. 3547), and prior to October 1, 2014, for the construction, alteration, maintenance, or repair of treatment works under the CWSRF or for construction, alteration, maintenance, or repair of a public water system under the DWSRF, a provision requiring the application of Buy American requirements for the entirety of the construction activities financed by the assistance agreement through completion of construction, no matter when construction commences. The one exception to this requirement is if a project has approved engineering plans and specifications, by a State agency, prior to enactment of the Appropriations Act.

Application of the Buy American requirements extend not only to assistance agreements funded with Fiscal Year 2014 appropriations, but to all assistance agreements executed on or after January 17, 2014 and prior to October 1, 2014, whether the source of the funding is prior year's appropriations, state match, bond proceeds, interest earnings, principal repayments, or any other source of funding so long as the project is financed by an SRF assistance agreement. If a project began construction prior to January 17, 2014, but is financed or refinanced through an assistance agreement executed on or after January 17, 2014 and prior to October 1, 2014, Buy American requirements will apply to all construction that occurs on or after January 17, 2014, through completion of construction, unless, as is likely, engineering plans and specifications were approved by a State agency prior to enactment of the Appropriations Act.

Notably, there is no application of the Buy American requirements where such a refinancing occurs for a project that has completed construction prior to January 17, 2014. This provision does not apply to any project for which an assistance agreement was executed prior to January 17, 2014, no matter when construction occurs.

Further information will be provided in the form of guidance as soon as possible.

We understand the complexity of this provision and the challenges involved in its application. If you have any questions, please contact Peter Grevatt or Andrew Sawyers, or have your staff contact Jordan Dorfman, Attorney-Advisor, State Revolving Fund Branch, Municipal Support Division, at dorfman.jordan@epa.gov or (202) 564-0614 and Kiri Anderer, Environmental Engineer, Infrastructure Branch, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134

KRS Chapter 45A
Kentucky Model Procurement Code

45A.075 Methods of awarding state contracts.

Except as otherwise authorized by law, all state contracts shall be awarded by:

- (1) Competitive sealed bidding, pursuant to KRS 45A.080; or
- (2) Competitive negotiation, pursuant to KRS 45A.085 and 45A.090 or 45A.180; or
- (3) Noncompetitive negotiation, pursuant to KRS 45A.095; or
- (4) Small purchase procedures, pursuant to KRS 45A.100.

Effective: June 24, 2003

History: Amended 2003 Ky. Acts ch. 98, sec. 4, effective June 24, 2003. -- Created 1978 Ky. Acts ch. 110, sec. 16, effective January 1, 1979.

45A.080 Competitive sealed bidding.

(1) Contracts exceeding the amount provided by KRS 45A.100 shall be awarded by competitive sealed bidding, which may include the use of a reverse auction, unless it is determined in writing that this method is not practicable. Factors to be considered in determining whether competitive sealed bidding is not practicable shall include:

- (a) Whether specifications can be prepared that permit award on the basis of best value; and
- (b) The available sources, the time and place of performance, and other relevant circumstances as are appropriate for the use of competitive sealed bidding.

(2) The invitation for bids shall state that awards shall be made on the basis of best value. In any contract which is awarded under an invitation to bid which requires delivery by a specified date and imposes a penalty for late delivery, if the delivery is late, the contractor shall be given the opportunity to present evidence that the cause of the delay was beyond his control. If it is the opinion of the purchasing officer that there is sufficient justification for delayed delivery, the purchasing officer may adjust or waive any penalty that is provided for in the contract.

(3) Adequate public notice of the invitation for bids and any reverse auction shall be given a sufficient time prior to the date set forth for the opening of bids or beginning of the reverse auction. The notice may include posting on the Internet or publication in a newspaper or newspapers of general circulation in the state as determined by the secretary of the Finance and Administration Cabinet not less than seven (7) days before the date set for the opening of the bids and any reverse auction. The provisions of this subsection shall also apply to price contracts and purchase contracts of state institutions of higher education.

(4) Bids shall be opened publicly or entered through a reverse auction at the time and place designated in the invitation for bids. At the time the bids are opened, or the reverse auction has ended, the purchasing agency shall announce the agency's engineer's estimate, if applicable, and make it a part of the agency records pertaining to the letting of any contract for which bids were received. Each written or reverse auction bid, together with the name of the bidder and the agency's engineer's estimate, shall be recorded and be open to public inspection. Electronic bid opening and posting of the required information for public viewing shall satisfy the requirements of this subsection.

(5) The contract shall be awarded by written notice to the responsive and responsible bidder whose bid offers the best value.

(6) Correction or withdrawal of written or reverse auction bids shall be allowed only to the extent permitted by regulations issued by the secretary.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 63, sec. 3, effective July 15, 2010. -- Amended 2000 Ky. Acts ch. 509, sec. 1, effective July 14, 2000. -- Amended 1998 Ky. Acts ch. 120, sec. 10, effective July 15, 1998. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 27, effective May 30, 1997. -- Amended 1996 Ky. Acts ch. 60, sec. 2, effective July 15, 1996. -- Amended 1994 Ky. Acts ch. 278, sec. 1, effective July 15, 1994. -- Amended 1982 Ky. Acts ch. 282, sec. 1, effective July 15, 1982. -- Amended 1979 (1st Extra. Sess.) Ky. Acts ch. 9, sec. 1, effective February 10, 1979. -- Created 1978 Ky. Acts ch. 110, sec. 17, effective January 1, 1979.

45A.085 Competitive negotiation.

(1) When, under administrative regulations promulgated by the secretary or under KRS 45A.180, the purchasing officer determines in writing that the use of competitive sealed bidding is not practicable, and except as provided in KRS 45A.095 and 45A.100, a contract may be awarded by competitive negotiation, which may include the use of a reverse auction.

(2) Adequate public notice of the request for proposals and any reverse auction shall be given in the same manner and circumstances as provided in KRS 45A.080(3).

(3) Contracts other than contracts for projects utilizing an alternative project delivery method under KRS 45A.180 may be competitively negotiated when it is determined in writing by the purchasing officer that the bids received by competitive sealed bidding either are unreasonable as to all or part of the requirements, or were not independently reached in open competition, and for which each competitive bidder has been notified of the intention to negotiate and is given reasonable opportunity to negotiate.

(4) Contracts for projects utilizing an alternative project delivery method shall be processed in accordance with KRS 45A.180.

(5) The request for proposals shall indicate the relative importance of price and other evaluation factors, and any reverse auction procedures.

(6) Award shall be made to the responsible and responsive offeror whose proposal is determined in writing to be the most advantageous to the Commonwealth, taking into consideration price and the evaluation factors set forth in the request for proposals and the reciprocal preference for resident bidders required under KRS 45A.494.

(7) Written or oral discussions shall be conducted with all responsible offerors who submit proposals determined in writing to be reasonably susceptible of being selected for award. Discussions shall not disclose any information derived from proposals submitted by competing offerors. Discussions need not be conducted:

(a) With respect to prices, where the prices are fixed by law, reverse auction, or administrative regulation, except that consideration shall be given to competitive terms and conditions;

(b) Where time of delivery or performance will not permit discussions; or

(c) Where it can be clearly demonstrated and documented from the existence of adequate competition or prior experience with the particular supply, service, or construction item, that acceptance of an initial offer without discussion would result in fair and reasonable best value procurement, and the request for proposals notifies all offerors of the possibility that award may be made on the basis of the initial offers.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 63, sec. 4, effective July 15, 2010; and ch. 162, sec. 8, effective July 15, 2010. -- Amended 2003 Ky. Acts ch. 98, sec. 5, effective June 24, 2003. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 28, effective May 30, 1997. -- Amended 1979 (1st Extra. Sess.) Ky. Acts ch. 9, sec. 2, effective February 10, 1979. -- Created 1978 Ky. Acts ch. 110, sec. 18, effective January 1, 1979.

45A.090 Negotiation after competitive sealed bidding when all bids exceed available funds.

(1) In the event that all bids submitted pursuant to competitive sealed bidding under KRS 45A.080 result in bid prices in excess of the funds available for the purchase, and the chief purchasing officer determines in writing:

- (a) That there are no additional funds available from any source so as to permit an award to the responsive and responsible bidder whose bid offers the best value; and
- (b) The best interest of the state will not permit the delay attendant to a resolicitation under revised specifications, or for revised quantities, under competitive sealed bidding as provided in KRS 45A.080, then a negotiated award may be made as set forth in subsections (2) or (3) of this section.

(2) Where there is more than one (1) bidder, competitive negotiations pursuant to KRS 45A.085(3) shall be conducted with the three (3) (two (2) if there are only two (2)) bidders determined in writing to be the most responsive and responsible bidders, based on criteria contained in the bid invitation and the reciprocal preference for resident bidders under KRS 45A.494. Such competitive negotiations shall be conducted under the following restrictions:

- (a) If discussions pertaining to the revision of the specifications or quantities are held with any potential offeror, all other potential offerors shall be afforded an opportunity to take part in such discussions; and
- (b) A request for proposals, based upon revised specifications or quantities, shall be issued as promptly as possible, shall provide for an expeditious response to the revised requirements, and shall be awarded upon the basis of best value.

(3) Where, after competitive sealed bidding, it is determined in writing that there is only one (1) responsive and responsible bidder, a noncompetitive negotiated award may be made with such bidder in accordance with KRS 45A.095.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 162, sec. 9, effective July 15, 2010. -- Amended 2003 Ky. Acts ch. 98, sec. 6, effective June 24, 2003. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 29, effective May 30, 1997. -- Created 1978 Ky. Acts ch. 110, sec. 19, effective January 1, 1979.

45A.095 Noncompetitive negotiation.

(1) A contract may be made by noncompetitive negotiation only for sole source purchases, or when competition is not feasible, as determined by the purchasing officer in writing prior to award, under administrative regulations promulgated by the secretary of the Finance and Administration Cabinet or the governing boards of universities operating under KRS Chapter 164A, or when emergency conditions exist. Sole source is a situation in which there is only one (1) known capable supplier of a commodity or service, occasioned by the unique nature of the requirement, the supplier, or market conditions. Insofar as it is practical, no less than three (3) suppliers shall be solicited to submit written or oral quotations whenever it is determined that competitive sealed bidding is not feasible. Award shall be made to the supplier offering the best value. The names of the suppliers submitting quotations and the date and amount of each quotation shall be placed in the procurement file and maintained as a public record. Competitive bids may not be required:

- (a) For contractual services where no competition exists, such as telephone service, electrical energy, and other public utility services;
- (b) Where rates are fixed by law or ordinance;
- (c) For library books;
- (d) For commercial items that are purchased for resale;
- (e) For interests in real property;

- (f) For visiting speakers, professors, expert witnesses, and performing artists;
 - (g) For personal service contracts executed pursuant to KRS 45A.690 to 45A.725; and
 - (h) For agricultural products in accordance with KRS 45A.645.
- (2) The chief procurement officer, the head of a using agency, or a person authorized in writing as the designee of either officer may make or authorize others to make emergency procurements when an emergency condition exists.
- (3) An emergency condition is a situation which creates a threat or impending threat to public health, welfare, or safety such as may arise by reason of fires, floods, tornadoes, other natural or man-caused disasters, epidemics, riots, enemy attack, sabotage, explosion, power failure, energy shortages, transportation emergencies, equipment failures, state or federal legislative mandates, or similar events. The existence of the emergency condition creates an immediate and serious need for services, construction, or items of tangible personal property that cannot be met through normal procurement methods and the lack of which would seriously threaten the functioning of government, the preservation or protection of property, or the health or safety of any person.
- (4) The Finance and Administration Cabinet may negotiate directly for the purchase of contractual services, supplies, materials, or equipment in bona fide emergencies regardless of estimated costs. The existence of the emergency shall be fully explained, in writing, by the head of the agency for which the purchase is to be made. The explanation shall be approved by the secretary of the Finance and Administration Cabinet and shall include the name of the vendor receiving the contract along with any other price quotations and a written determination for selection of the vendor receiving the contract. This information shall be filed with the record of all such purchases and made available to the public. Where practical, standard specifications shall be followed in making emergency purchases. In any event, every effort should be made to effect a competitively established price for purchases made by the state.

Effective: July 15, 2002

History: Amended 2002 Ky. Acts ch. 344, sec. 9, effective July 15, 2002. -- Amended 1997 (1st Extra. Sess.) Ky. Acts ch. 4, sec. 30, effective May 30, 1997. -- Amended 1990 Ky. Acts ch. 496, sec. 4, effective July 13, 1990. -- Created 1978 Ky. Acts ch. 110, sec. 20, effective January 1, 1979

45A.100 Small purchases by state governmental bodies.

- (1) Procurements may be made in accordance with small purchase administrative regulations promulgated by the secretary of the Finance and Administration Cabinet, pursuant to KRS Chapter 13A, as follows:
- (a) Up to ten thousand dollars (\$10,000) per project for construction and one thousand dollars (\$1,000) for purchases by any state governmental body, except for those state administrative bodies specified in paragraph (b) of this subsection; and
 - (b) Up to forty thousand dollars (\$40,000) per project for construction or purchases by the Finance and Administration Cabinet, state institutions of higher education, and the legislative branch of government.
- (2) Procurement requirements shall not be artificially divided so as to constitute a small purchase under this section. Reverse auctions may be used for small purchase procurements. At least every two (2) years, the secretary shall review the prevailing costs of labor and materials and may make recommendations to the next regular session of the General Assembly for the revision of the then current maximum small purchase amount as justified by intervening changes in the cost of labor and materials.
- (3) The secretary of the Finance and Administration Cabinet may grant to any state agency with a justifiable need a delegation of small purchasing authority which exceeds the agency's small purchase limit provided in subsection (1) of this section. Delegations of small purchasing authority shall be granted or revoked by the secretary of the Finance and Administration Cabinet,

in accordance with administrative regulations promulgated by the cabinet pursuant to KRS Chapter 13A. These administrative regulations shall establish, at a minimum, the criteria for granting and revoking delegations of small purchasing authority, including the requesting agency's past compliance with purchasing regulations, the level of training of the agency's purchasing staff, and the extent to which the agency utilizes the Kentucky Automated Purchasing System. The administrative regulations may permit the secretary of the Finance and Administration Cabinet to delegate small purchase procurements up to the maximum amount specified in subsection (1)(b) of this section.

Effective: July 15, 2010

History: Amended 2010 Ky. Acts ch. 63, sec. 5, effective July 15, 2010. -- Amended 2002 Ky. Acts ch. 320, sec. 2, effective July 15, 2002. -- Amended 2000 Ky. Acts ch. 225, sec. 1, effective July 14, 2000. -- Amended 1996 Ky. Acts ch. 60, sec. 1, effective July 15, 1996. -- Amended 1994 Ky. Acts ch. 323, sec. 1, effective July 15, 1994. -- Amended 1990 Ky. Acts ch. 496, sec. 5, effective July 13, 1990. -- Amended 1986 Ky. Acts ch. 384, sec. 1, effective July 15, 1986. -- Amended 1984 Ky. Acts ch. 384, sec. 1, effective July 13, 1984. -- Amended 1982 Ky. Acts ch. 282, sec. 2, effective July 15, 1982. -- Amended 1980 Ky. Acts ch. 242, sec. 1, effective July 15, 1980; and ch. 250, sec. 19, effective April 9, 1980. -- Created 1978 Ky. Acts ch. 110, sec. 21, effective January 1, 1979.

**NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE
EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE ORDER 11246)**

The following excerpts are from 45 FR 65984 (October 3, 1980):

The minority and female goals apply to Federal and federally assisted construction contractors and subcontractors which have covered contracts. The goals are expressed as a percentage of the total hours worked by such a covered or subcontractor's entire onsite construction workforce, which is working on any construction site within a relevant area. The goal applies to each construction craft and trade in the contractor's entire workforce in the relevant area including those employees working on private non-federally involved projects.

Until further notice, the following goals for minority utilization in each construction craft and trade shall be included in all Federal or federally assisted construction contracts and subcontracts in excess of \$10,000 to be performed in the respective geographic area. The goals are applicable to each nonexempt contractor's total onsite construction workforce, regardless of whether or not part of that workforce is performing work on a Federal, federally assisted or non-federally related project, contract or subcontract.

Construction contractors which are participating in an approved Hometown Plan (see 41 CFR 60-4.5) are required to comply with the goals of the Hometown Plan with regard to construction work they perform in the area covered by the Hometown Plan. With regard to all their other covered construction work, such contractors are required to comply as follows:

- Goals for female participation in each trade.....6.9%
- Goals for minority participation in each trade.....Insert goals for each year
(see Attachment Number 6)

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.

The following excerpts are from 45 FR 65977 (October 3, 1980):

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 established for the geographical area where the contract resulting from this solicitation is to be performed. 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 10 working days of award of any construction subcontract in excess of \$10,000 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; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed.

4. As used in this Notice, and in the contract resulting from this solicitation, the covered area is (insert description of the geographical areas where the contract is to be performed giving the state, country, and city, if any).

**STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION
CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246)**

EEO Specifications

Following is the standard language, which must be incorporated into all solicitations for offers and bids on all Federal and Federally assisted construction contracts or subcontracts in excess of \$10,000 to be performed in designated geographical areas:

1. As used in these specifications:
 - (a) Covered Area means the geographical area described in the solicitation from which this contract resulted.
 - (b) Director means Director, Office of Federal Contract Compliance Program, United States Department of Labor, or any person to whom the Director delegates authority;
 - (c) Employer identification number means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
 - (d) Minority includes:
 - (i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
 - (ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
 - (iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
 - (iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).
2. Whenever the Contractor or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.
3. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take a good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7-a through p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. The Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7. The Contractor shall take specific affirmative action to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative actions steps at least as extensively as the following:

a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the contractor or its unions have employment opportunities available, and maintain a record of the organizations responses.

c. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the contractor, this shall be documented in the file with the reason therefore, along with whatever additional actions the contractor may have taken.

d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligation.

e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources complied under 7-b above.

f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, lay-off, termination or other employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foreman, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

i. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's workforce.

k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

l. Conduct, at least annually, an inventory and evaluation of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that EEO policy and the Contractor's obligations under these specifications are being carried out.

n. Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative actions obligations (7 a through p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant may be asserted as fulfilling any one or more of its obligations under 7 a through p of these specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example: even though the Contractor has achieved its goal for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10. The Contractor shall not use the goals and timetables for affirmative action standards to discriminate against any person because of race, color, religion, sex or national origin.

11. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and executive Order 11246, as amended.

13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation, if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local

or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

EEO Goals for Economic Areas in Region 4

Source: Appendix B-80 in 45 FR 65984 (October 3, 1980)

Kentucky:

053 Knoxville, TN
 SMSA Counties:
 3840 Knoxville, TN6.6
 TN Anderson; TN Blount; TN Knox; TN Union.
 Non-SMSA Counties4.5
 KY Bell; KY Harlan; KY Knox; KY Laurel; KY McCreary; KY Wayne; KY Whitley; TN
 Campbell; TN Claiborne; TN Cocke; TN Cumberland; TN Fentress; TN Grainger, TN Hamblen;
 TN Jefferson; TN Loudon; TN Morgan; TN Roane; TN Scott;
 TN Sevier.

054 Nashville, TN:
 SMSA Counties:
 1660 Clarksville - Hopkinsville, TN - KY18.2
 KY Christian; TN Montgomery.
 5360 Nashville - Davidson, TN15.8
 TN Cheatham, TN Davidson; TN Dickson; TN Robertson; TN Rutherford; TN Sumner; TN
 Williamson; TN Wilson.
 Non-SMSA Counties12.0
 KY Allen; KY Barren; KY Butler; KY Clinton; KY Cumberland; KY Edmonson; KY Logan; KY
 Metcalfe; KY Monroe; KY Simpson; KY Todd; KY Trigg; KY Warren; TN Bedford; TN Cannon;
 TN Clay; TN Coffee; TN DeKalb; TN Franklin; TN Giles; TN Hickman; TN Houston; TN
 Humphreys; TN Jackson; TN Lawrence; TN Lewis; TN Macon; TN Marshall; TN Maury; TN
 Moore; TN Overton; TN Perry; TN Pickett; TN Putnam; TN Smith; TN Stewart; TN Trousdale;
 TN Van Buren; TN Warren; TN Wayne; TN White.

056 Paducah, KY:
 Non-SMSA Counties5.2
 IL Hardin; IL Massac; IL Pope; KY Ballard; KY Caldwell; KY Calloway. KY Carlisle; KY
 Crittenden; KY Fulton; KY Graves; KY Hickman; KY Livingston; KY Lyon. KY McCracken; KY
 Marshall.

057 Louisville, KY:
 SMSA Counties:
 4520 Louisville, KY-IN11.2
 IN Clark; IN Floyd; KY Bullitt; KY Jefferson; KY Oldham.
 Non-SMSA Counties9.6
 IN Crawford; IN Harrison; IN Jefferson; IN Orange; IN Scott; IN Washington; KY Breckinridge;
 KY Grayson; KY Hardin; KY Hart; KY Henry; KY Larue; KY Marion;
 KY Meade; KY Nelson; KY Shelby; KY Spencer; KY Trimble; KY Washington.

058 Lexington, KY
 SMSA Counties
 4280 Lexington-Fayette, KY10.8
 KY Bourbon; KY Clark; KY Fayette; KY Jessamine; KY Scott; KY Woodford.
 Non-SMSA Counties7.0
 KY Adair KY Anderson; KY Bath; KY Boyle; KY Breathitt; KY Casey; KY Clay; KY Estill; KY
 Franklin; KY Garrard; KY Green; KY Harrison; KY Jackson; KY Knott; KY Lee; KY Leslie; KY
 Letcher; KY Lincoln; KY Madison; KY Magoffin; KY Menifee; KY Mercer; KY Montgomery;
 KY Morgan. KY Nicholas; KY Owsley; KY Perry; KY Powell; KY Pulaski; KY Rockcastle; KY
 Russell; KY Taylor; KY Wolfe.

059 Huntington, WV:
 SMSA Counties:
 3400 Huntington – Ashland, WV-KY-OH2.9
 KY Boyd; KY Greenup; OH Lawrence; WV Cabell; WV Wayne.
 Non-SMSA Counties2.5
 KY Carter; KY Elliott; KY Floyd; KY Johnson; KY Lawrence; KY Martin; KY Pike; KY Rowan;
 OH Gallia; WV Lincoln; WV Logan; WV Mason; WV Mingo.

067 Cincinnati, OH:
 SMSA Counties:
 1640 Cincinnati, OH-KY-IN11.0
 IN Dearborn; KY Boone; KY Campbell; KY Kenton; OH Clermont;
 OH Hamilton; OH Warren.

3200 Hamilton-Middletown, OH	5.0
OH Butler.	
Non-SMSA Counties	9.2
IN Franklin; IN Ohio; IN Ripley; IN Switzerland; KY Bracken; KY Carroll; KY Fleming; KY Gallatin; KY Grant; KY Lewis; KY Mason; KY Owen; KY Pendleton; KY Robertson; OH Adams; OH Brown; OH Clinton; OH Highland.	
080 Evansville, IN:	
SMSA Counties	
2440 Evansville, IN-KY	4.8
IN Gibson; IN Posey; IN Vanderburgh; IN Warrick; KY Henderson.	
5990 Owensboro, KY	4.7
KY Daviess.	
Non-SMSA Counties	3.5
IL Edwards; IL Gallatin; IL Hamilton; IL Lawrence; IL Saline; IL Wabash; IL White; IN Dubois; IN Knox; IN Perry; IN Pike; IN Spencer; KY Hancock; KY Hopkins; KY McLean; KY Muhlenberg; KY Ohio; KY Union; KY Webster.	

**CHECK LIST OF EEO DOCUMENTATION FOR BIDDERS
ON GRANT/LOAN CONSTRUCTION
(Required by Executive Order 11246 as amended)**

The low, responsive responsible bidder must forward the following items, in duplicate, to the owner no later than ten (10) days after bid opening. The owner shall have one (1) copy available for inspection by the Office of Federal Contracts Compliance within 14 days after the bid opening. The web site for the OFCC is <http://www.dol.gov/esa/ofcp.org.htm>.

1. Project Number. Project Location. Type of Construction.
2. Proof of registration with the Joint Reporting Commission. (See Attachment Number 8.)
3. Copy of Affirmative Action Plan of contractor. Indicate company official responsible for EEO.
4. List of current construction contracts, with dollar amount. List contracting Federal Agency, if applicable.
5. Statistics concerning company percent workforce, permanent and temporary, by sex, race, trade, handicapped, and age. 40 CFR Part 7.
6. List of employment sources for project in question. If union sources are utilized, indicate percentage of minority membership within the union crafts.
7. Anticipated employment needs for this project, by sex, race and trade, with estimate of minority participation in specific trades.
8. List of subcontractors (name, address and telephone) with dollar amount and duration of subcontract. Subcontractor contracts over \$10,000 must submit items 1- 8. The following information must be provided for all supplier contracts regardless of contract size: name of company, contact person, address, telephone number, dollar value of the contract, and a list of the materials to be supplied to the prime contractor.
9. List of any subcontract work yet to be committed with estimate of dollar amount and duration of contract.
10. Contract Price. Duration of prime contract.
11. DBE Documents - See special instructions regarding use of Minority, and Women Owned, and Small Businesses.

Employer Information Report EEO-1

Under the direction of the US Equal Employment Opportunity Commission, the Joint Reporting Committee is responsible for the full-length, multi-phase processing of employment statistics collected on the Employer Information Report EEO-1. This report, also termed Standard Form 100, details the sex and race/ethnic composition of an employer's work force by job category.

The Employer Information EEO-1 survey is conducted annually under the authority of Public Law 88-352, Title VII of the Civil Rights Act of 1964, as amended by the Equal Employment Opportunity Act of 1972. All employers with 15 or more employees are covered by Public Law 88-352 and are required to keep employment records as specified by Commission regulations. Based on the number of employees and federal contract activities, certain large employers are required to file an EEO-1 Report on an annual basis.

The EEO-1 Report must be filed by:

(A) All private employers who are: (1) subject to Title VII of the Civil Rights Act of 1964 (as amended by the Equal Employment Opportunity Act of 1972) with 100 or more employees EXCLUDING State and local governments, primary and secondary school systems, institutions of higher education, Indian tribes and tax-exempt private memberships clubs other than labor organizations; OR (2) subject to Title VII who have fewer than 100 employees if the company is owned or affiliated with another company, or there is centralized ownership, control or management (such as central control of personnel policies and labor relations) so that the group legally constitutes a single enterprise and the entire enterprise employs a total of 100 or more employees.

(B) All federal contractors (private employers), who: (1) are not exempt as provided for by 41 CFR 60-1.5, (2) have 50 or more employees, and (a) are prime contractors or first-tier subcontractors, and have a contract, subcontract, or purchase order amounting to \$50,000 or more; or (b) serve as depository of Government funds in any amount, or (c) is a financial institution which is an issuing or paying agent for U.S. Savings Bonds and Notes.

Only those establishments located in the District of Columbia and the 50 states are required to submit the EEO-1 Report. No Reports should be filed for establishments in Puerto Rico, the Virgin Islands or other American Protectorates.

When filing for the EEO-1 Report for the first time, go to the web site at: <http://www.mimdms.com/jrc.html> and select "Filing for the first time" from the box labeled INFORMATION. File out the electronic questionnaire to enter your company into Joint Reporting Committee (JRC) system. Once you have completed the registration process, you will be contacted on how to proceed with the EEO-1 Report. If you have previously registered with the JRC, follow their instructions to update your information.

Labor Standards Provisions for Federally Assisted Construction

Labor standards provisions applicable to contracts covering federally financed and assisted construction (29 CFR 5.5, Contract Provisions and Related Matters) that apply to EPA Special Appropriations Projects grants are:

(a)(4)(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

(a)(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

(a)(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5 (a) (1) through (10) and such other clauses as the U.S. Environmental Protection Agency may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(a)(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(b) Contractor Work Hours and Safety Standards Act. The Administrator, EPA shall cause or require the contracting officer to insert the following clauses set forth in paragraph (b)(1),(2),(3), and (4) of this section in full in any contract subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by *Section 5.5(a) of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any work week in which he or she is employed on such work to in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b) (1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for unliquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The U.S. Environmental Protection Agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other Federally- assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such liabilities of such contractor or

subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b) (2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in section 5.1, the Administrator of EPA shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly worked, deductions made, and actual wages paid. Further, the Administrator of EPA shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the U.S. Environmental Protection Agency and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job. (Approved by the Office of Management and Budget under OMB control numbers 1215-0140 and 1215-0017.)

CERTIFICATIONS

Debarred Firms

All prime Construction Contractors shall certify that Subcontractors have not and will not be awarded to any firm that is currently on the EPA Master List of Debarred, Suspended and Voluntarily Excluded Persons in accordance with the provisions of 40 CFR 32.500(c). Debarment action is taken against a firm for noncompliance with Federal Law.

All bidders shall complete the attached certification (Attachment Number 10) and submit to the owner with the bid proposal.

Anti-lobbying Certification

All prime Construction Contractors must certify (Attachment Number 11) that no appropriated funds were or will be expended for the purpose of lobbying the Executive or Legislative Branches of the Federal Government or Federal Agency concerning this contract (contract in excess of \$100,000). If the Contractor has made or agreed to make payment to influence any member of Congress in regard to award of this contract, a Disclosure Form must be completed and submitted to the owner with the bid proposal.

All prime Contractors must require all Subcontractors to submit the certification, which must also be submitted to the owner.

**CERTIFICATION REGARDING DEBARMENT,
SUSPENSION AND OTHER RESPONSIBILITY MATTERS**

The prospective 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 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 government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
- (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

I understand that a false statement on this certification may be grounds for rejection of this proposal or termination of the award. In addition, under 18 USC Sec. 1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to 5 years, or both.

Typed Name & Title of Authorized Representative

Signature of Authorized Representative

Date

_____ I am unable to certify to the above statements. My explanation is attached.

CERTIFICATION REGARDING LOBBYING
Certification for Contracts, Grants,
Loans, and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) 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 an 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.

(2) 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 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.

(3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub-grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

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 section 1352, title 31, U.S. Code. 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.

Typed Name & Title of Authorized Representative

Signature of Authorized Representative

Date

_____ I am unable to certify to the above statements. My explanation is attached.

EPA DISADVANTAGED BUSINESS ENTERPRISE PROGRAM

EPA's Disadvantaged Business Enterprise Program rule applies to contract procurement actions funded in part by EPA assistance agreements awarded after May 27, 2008. The rule is found at Federal regulation Title 40, Part 33. Specific responsibilities are highlighted below.

Grant recipient responsibilities:

- Conduct an Availability Analysis and negotiate fair share objectives with EPA (§33.411), or adopt the fair share objectives of the oversight state agency revolving loan fund for comparable infrastructure. (§33.405(b)(3)).
- Include the Appendix A term and condition in each contract with a primary contractor (§3.106). The term and condition is included in the EPA Region 4 contract specifications insert *FEDERAL REQUIREMENTS AND CONTRACT PROVISIONS FOR SPECIAL APPROPRIATION ACT PROJECTS US ENVIRONMENTAL PROTECTION AGENCY, Region III, June 2008*.
- Employ the six Good Faith Efforts during prime contractor procurement (§33.301).
- Require prime contractor to comply with the following prime contractor requirements of Title 40 Part 33:
 - To employ the six Good Faith Efforts steps in paragraphs (a) through (e) of §33.301 if the prime contractor awards subcontracts (§33.301(f)).
 - To provide EPA form 6100-2 – *DBE Subcontractor Participation Form* to all DBE subcontractors (§33.302(e)).
 - To submit EPA forms 6100-3 – *DBE Program Subcontractor Performance Form* and 6100-4 – *DBE Program Subcontractor Utilization Form* with bid package or proposal. (§33.302 (f) and (g)).
 - To pay its subcontractor for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the recipient (§33.302(a)).
 - To notify recipient in writing by its prime contractor prior to any termination of a DBE subcontractor for convenience by the prime contractor (§33.302(b)).
 - To employ the six good faith efforts described in §33.301 if soliciting a replacement subcontractor after a DBE subcontractor fails to complete work under the subcontract for any reason. (§33.302(c)).
 - To employ the six good faith efforts described in §33.301 even if the prime contractor has achieved its fair share objectives under subpart D of Part 33. (§33.302(d)).

- Semiannually complete and submit to Charles Hayes, EPA Region 4 DBE Coordinator EPA form 5700-52A summarizing DBE participation achieved during the previous six months (§33.502).
- Maintain records documenting its compliance with the requirements of Title 40 Part 33, including documentation of its, and its prime contractors', good faith efforts (§33.501(a)).

Prime Contractor Responsibilities:

- Employ the six Good Faith Efforts steps in paragraphs (a) through (e) of §33.301 if the prime contractor awards subcontracts (§33.301(f)).
- Provide EPA form number 6100-2 – *DBE Program Subcontractor Participation Form* and form number 6100-3 – *DBE Program Subcontractor Performance Form* to each DBE subcontractor prior to opening of the contractor's bid or proposal (§33.302(e) and (f)).
- Complete EPA form number 6100-4 – *DBE Program Subcontractor Utilization Form* (§33.302(g)).
- Submit to recipient with its bid package or proposal the completed EPA form number 6100-4, plus an EPA form number 6100-3 for each DBE subcontractor used in the contractor's bid or proposal (§33.302(f) and (g)).
- Pay subcontractors for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the recipient (§33.302(a)).
- Notify the recipient in writing prior to prime contractor termination of a DBE subcontractor for convenience (§33.302(b)).
- Employ the six good faith efforts described in §33.301 if soliciting a replacement subcontractor after a DBE subcontractor fails to complete work under the subcontract for any reason. (§33.302(c)).
- Employ the six good faith efforts described in §33.301 even if the prime contractor has achieved its fair share objectives under subpart D of Part 33. (§33.302(d)).
- Semiannually inform recipient of DBE participation achieved (§33.502).
- Maintain records documenting its compliance with the requirements of Title 40 Part 33, including documentation of its, and its prime contractors', good faith efforts (§33.501(a)).

Subcontractor Responsibilities:

- May submit EPA form 6100-2 – *DBE Subcontractor Participation Form* to Charles Hayes, EPA Region 4 DBE Coordinator (§33.302(e)).
- Must complete EPA form 6100-3 – *DBE Program Subcontractor Performance Form*, and submit it to the prime contractor soliciting services from the subcontractor prior to the opening of bids for the prime contract.

SPAP Requirements:

Form	Requirement	Provided By:	Completed By:	Submitted To:
EPA Form 6100-2	Grant Recipients required to have prime contractors provide form to Subcontractors	Prime Contractors	DBE Subcontractors	EPA Region 4 DBE Coordinator Charles Hayes
EPA Form 6100-3	Grant Recipients required to have prime contractors provide form to Subcontractors	Prime Contractors	DBE Subcontractors	Grant Recipients as part of a bid or proposal package
EPA Form 6100-4	Grant Recipients required to have prime contractors complete the form	Grant Recipients	Prime Contractors	Grant Recipients as part of a bid or proposal package

SRF Requirements:

Form	Requirement	Provided By:	Completed By:	Submitted To:
EPA Form 6100-2	Recipients required to have prime contractors provide form to Subcontractors	Prime Contractors	DBE Subcontractors	DOW Project Administrator
EPA Form 6100-3	Recipients required to have prime contractors provide form to Subcontractors	Prime Contractors	DBE Subcontractors	Dow Project Administrator w/ATA Package

EPA Form 6100-4	Recipients required to have prime contractors complete the form	Recipients	Prime Contractors	DOW Project Administrator w/ATA Package
Pay Request DBE Form	Recipients required to have prime contractors complete the form	Recipients	Prime Contractors	DOW Project Administrator w/EACH PAYMENT

DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION POLICY

PROJECT NAME: _____

BID DATE: _____

1. Name, address and telephone number of contact person on all DBE matters:

Prime Contractor's Name: _____

Contact Person: _____

Address: _____

Phone: _____

Cell Phone: _____

Email: _____

Total Contract Amount: _____

2. Total dollar amount/percent of contract of MBE participation: _____

3. Total dollar amount/percent of contract of WBE participation: _____

4. Are certifications* for each MBE/WBE/DBE subcontractor enclosed; if no, please explain: Yes No

5. Are MBE/WBE/DBE subcontracts or letters of intent signed by both parties enclosed; if no, please explain: Yes No

6. List of MBE Subcontractors:

Name: _____

Contact Person: _____

Address: _____

Phone: _____

Cell Phone: _____

Email: _____

Type of Contract: _____

Work to be Done: _____

Amount: _____

7. List of WBE Subcontractors:

Name: _____

Contact Person: _____

Address: _____

Phone: _____

Cell Phone: _____

Email: _____

Type of Contract: _____

Work to be Done: _____

Amount: _____

Attach Additional Sheets, If Necessary

*Self-certification: Self certification of MBE/WBE/DBE firms will NOT be accepted as a valid form of certification of MBE/WBE/DBE status.

8. Information and documentation concerning efforts taken to comply with EPA’s “six good faith efforts”

(i). Ensure DBE construction firms or material suppliers are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities; including placing DBEs on solicitation lists and soliciting them whenever they are potential sources. A good source for a list of DBEs is the Kentucky Transportation’s website: <http://transportation.ky.gov/Civil-Rights-and-Small-Business-Development/Pages/Certified-DBE-Directory.aspx>.

The prime contractor certifies that a bidders list (see example sheet below) of qualified vendors, including DBEs, was developed for current and future solicitations and that the list will be maintained. *Submit a copy of the list as documentation.*

(ii). Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process; including, whenever possible, posting solicitation for bids or proposals for a sufficient amount of time as to receive a competitive bid or proposal pool.

The prime contractor certifies that every opportunity was provided to a number of DBEs to encourage their participation in the competitive process and that an adequate amount of time was provided for response.

a. List each DBE construction firm or material supplier to which a solicitation was attempted. *Submit copies of letters, emails, faxes, telecommunication logs, certified mail receipts, returned envelopes, certified mail return receipts, etc. as documentation.*

Company name and phone number: _____

Area of work expertise: _____

Date of any follow-ups and person spoke to: _____

b. Advertisements, if applicable: List each publication in which an announcement or notification was placed. *Submit a tear sheet of each announcement from each publication as documentation.*

Name of publication: _____

Date(s) of advertisement: _____

Specific subcontract areas announced: _____

c. Other, if applicable: List each notification method in which an announcement or outreach was used; list serve, public meeting, etc. *Submit applicable information to document effort.*

Method of notification: _____

Date(s) of notification: _____

(iii). Consider in the contracting process whether firms competing for large contracts could subcontract with DBEs; including dividing total requirements, when economically feasible, into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.

The prime contractor certifies that the project was broken into its basic elements (i.e., dirt hauling, landscaping, painting, pipe installation, material supplies, etc.) and that a determination was made whether it’s economically feasible to bid the elements separately and that the analysis of this effort was documented with a short memo to the project file.

- (iv). Establishing delivery schedules, where the requirement permits, which encourage participation by small and minority business, and women’s business enterprises.
 - The prime contractor certifies that they established delivery schedules which would allow DBEs to participate in the projects.
- (v). Use the services and assistance of the Small Business Administration (SBA) and the Minority Business Development Agency (MBDA) of the U.S. Department of Commerce. The easiest way to utilize the services of SBA and MBDA is to visit their websites: www.sba.gov and www.mbda.gov and use the electronic tools available there or you may send the nearest SBA and MBDA office a certified letter that generally describes the solicitation, the dates it will be open, the types of vendors you are seeking and applicable SIC or NAIC codes if known. You may also use the services and assistance of the Kentucky Procurement Assistance Program (KPAP). The easiest way to utilize the services of KPAP is to send an email: ced.kpap@ky.gov and provide information on forthcoming opportunities available to DBEs.
 - The prime contractor certifies that the assistance of the SBA, MBDA, and/or KPAP was utilized. *Submit pages printed off the SBA and MBDA websites which evidence efforts to register a solicitation on those sites or submit copies of the letter sent and certified mail receipt as documentation; submit copies of emails with KPAP as documentation.*
- (vi). If a subcontractor awards any subcontracts, require the subcontractor to take the steps in numbers (i) through (v) above.
 - The prime contractor certifies that subcontractors used for this project will be required to follow the steps of the “six good faith efforts” as listed above.

9. Signature and date:

To the best of my knowledge and belief, all “six good faith efforts” have been met and the information contained in this document is true and correct; the document has been duly authorized by the legal representative.

Signature

Print name and title

Date

BIDDER'S LIST FORM

OWNER: _____

LOAN NO: _____

PROJECT TITLE: _____

BID DATE: _____

Instructions:

1. This list must include all firms that were solicited for participation, bid on, or quoted for a prime contract or subcontracts under EPA assisted projects, included both DBE's and non DBE's.
2. SRF loan participants must keep the Bidder's List until the project period for the identified loan has ended and no funds are remaining.
3. This list must be submitted to DOW in the ATA Package. Contract Award Approval cannot be given until this form has been received by DOW.
4. The following information must be obtained from all prime and subcontractors. Please complete the form below:

ENTITY'S NAME	MAILING ADDRESS	CONTACT PERSON	PHONE#	E-MAIL ADDRESS	M/WBE?

BONDS AND INSURANCE

The minimum requirements shall be as follows:

Bonding requirements for contracts of \$100,000 or less are contained in 40 CFR 31.36(h).

Bond requirements for contracts in excess of \$100,000 are:

- Bid guarantee equivalent to five percent of the bid price. The bid guarantee shall consist of a firm commitment such as a certified check or bid bond submitted with the bid;
- Performance bond equal to 100 percent of the contract price, and
- Payment bond equal to 100 percent of the contract price. Bonds must be obtained from companies holding Certificates of Authority as acceptable sureties, issued by the U.S. Treasury.

Insurance requirements are contained in the General Conditions of the contract. In addition to the other required insurance, the owner or the contractor, as appropriate, must acquire any flood insurance made available by the Federal Emergency Management Agency as required by 44 CFR Parts 59-79, if construction will take place in a flood hazard area identified by the Federal Emergency Management Agency. The owner's requirements on Flood Insurance are contained in the Special Conditions Section of the Contracts Documents.

NOTICE OF INTENT

All construction projects with surface disturbance of more than 1 acre during the period of construction must have a KPDES Storm Water General Permit. The permit can be found at the following web address:
<https://dep.gateway.ky.gov/eForms/default.aspx?FormID=7>.

If you have any questions regarding the completion of this form call the Surface Water Permits Branch, at (502) 564-3410.

Davis-Bacon Wage Rate Requirements

CWSRF: The recipient agrees to include in all agreements to provide assistance for the construction of treatment works carried out in whole or in part with such assistance made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.), or with such assistance made available under section 205(m) of that Act (33 U.S.C. 1285(m)), or both, a term and condition requiring compliance with the requirements of section 513 of that Act (33 U.S.C. 1372) in all procurement contracts and sub-grants, and require that loan recipients, procurement contractors and sub-grantees include such a term and condition in subcontracts and other lower tiered transactions. All contracts and subcontracts for the construction of treatment works carried out in whole or in part with assistance made available as stated herein shall insert in full in any contract in excess of \$2,000 the contract clauses as set forth below titled “Wage Rate Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6)”. This term and condition applies to all agreements to provide assistance under the authorities referenced herein, whether in the form of a loan, bond purchase, grant, or any other vehicle to provide financing for a project, where such agreements are executed on or after October 30, 2009.

DWSRF: The recipient agrees to include in all agreements to provide assistance for any construction project carried out in whole or in part with such assistance made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12), a term and condition requiring compliance with the requirements of section 1450(e) of the Safe Drinking Water Act (42 U.S.C.300j-9(e)) in all procurement contracts and sub-grants, and require that loan recipients, procurement contractors and sub-grantees include such a term and condition in subcontracts and other lower tiered transactions All contracts and subcontracts for any construction project carried out in whole or in part with assistance made available as stated herein shall insert in full in any contract in excess of \$2,000 the contract clauses as set forth below entitled “Wage Rate Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6)”. This term and condition applies to all agreements to provide assistance under the authorities referenced herein, whether in the form of a loan, bond purchase, grant, or any other vehicle to provide financing for a project, where such agreements are executed on or after October 30, 2009.

Wage Rate Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6)

Preamble

With respect to the Clean Water and Safe Drinking Water State Revolving Funds, EPA provides capitalization grants to each State which in turn provides subgrants or loans to eligible entities within the State. Typically, the subrecipients are municipal or other local governmental entities that manage the funds. For these types of recipients, the provisions set forth under Roman Numeral I, below, shall apply. Although EPA and the State remain responsible for ensuring subrecipients’ compliance with the wage rate requirements set forth herein, those subrecipients shall have the primary responsibility to maintain payroll records as described in Section 3(ii)(A), below and for compliance as described in Section I-5.

Occasionally, the subrecipient may be a private for profit or not for profit entity. For these types of recipients, the provisions set forth in Roman Numeral II, below, shall apply. Although EPA and the State remain responsible for ensuring subrecipients' compliance with the wage rate requirements set forth herein, those subrecipients shall have the primary responsibility to maintain payroll records as described in Section II-3(ii)(A), below and for compliance as described in Section II-5.

I. Requirements Under The Consolidated and Further Continuing Appropriations Act, 2013 (P.L. 113-6) For Subrecipients That Are Governmental Entities:

The following terms and conditions specify how recipients will assist EPA in meeting its Davis-Bacon (DB) responsibilities when DB applies to EPA awards of financial assistance under the FY 2013 Continuing Resolution with respect to State recipients and subrecipients that are governmental entities. If a subrecipient has questions regarding when DB applies, obtaining the correct DB wage determinations, DB provisions, or compliance monitoring, it may contact the State recipient. The recipient or subrecipient may also obtain additional guidance from DOL's website at <http://www.dol.gov/whd/>

1. Applicability of the Davis- Bacon (DB) prevailing wage requirements.

Under the FY 2013 Continuing Resolution, DB prevailing wage requirements apply to the construction, alteration, and repair of treatment works carried out in whole or in part with assistance made available by a State water pollution control revolving fund and to any construction project carried out in whole or in part by assistance made available by a drinking water treatment revolving loan fund. If a subrecipient encounters a unique situation at a site that presents uncertainties regarding DB applicability, the subrecipient must discuss the situation with the recipient State before authorizing work on that site.

2. Obtaining Wage Determinations.

(a) Subrecipients shall obtain the wage determination for the locality in which a covered activity subject to DB will take place prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. These wage determinations shall be incorporated into solicitations and any subsequent contracts. Prime contracts must contain a provision requiring that subcontractors follow the wage determination incorporated into the prime contract.

(i) While the solicitation remains open, the subrecipient shall monitor www.wdol.gov weekly to ensure that the wage determination contained in the solicitation remains current. The subrecipients shall amend the solicitation if DOL issues a modification more than 10 days prior to the closing date (i.e. bid opening) for the solicitation. If DOL modifies or supersedes the applicable wage determination less than 10 days prior to the closing date, the subrecipients may request a finding from the State recipient that there is not a reasonable time to notify interested contractors of the modification of the wage determination. The State recipient will provide a report of its findings to the subrecipient.

(ii) If the subrecipient does not award the contract within 90 days of the closure of the solicitation, any modifications or supersedes DOL makes to the wage determination contained in the solicitation shall be effective unless the State recipient, at the request of the subrecipient, obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv). The subrecipient shall monitor www.wdol.gov on a weekly basis if it does not award the contract within 90 days of closure of the solicitation to ensure that wage determinations contained in the solicitation remain current.

(b) If the subrecipient carries out activity subject to DB by issuing a task order, work assignment or similar instrument to an existing contractor (ordering instrument) rather than by publishing a solicitation, the subrecipient shall insert the appropriate DOL wage determination from www.wdol.gov into the ordering instrument.

(c) Subrecipients shall review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

(d) As provided in 29 CFR 1.6(f), DOL may issue a revised wage determination applicable to a subrecipient's contract after the award of a contract or the issuance of an ordering instrument if DOL determines that the subrecipient has failed to incorporate a wage determination or has used a wage determination that clearly does not apply to the contract or ordering instrument. If this occurs, the subrecipient shall either terminate the contract or ordering instrument and issue a revised solicitation or ordering instrument or incorporate DOL's wage determination retroactive to the beginning of the contract or ordering instrument by change order. The subrecipient's contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

3. Contract and Subcontract provisions.

(a) The Recipient shall insure that the subrecipient(s) shall insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a treatment work under the CWSRF or a construction project under the DWSRF financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1 or the FY 2013 Continuing Resolution, the following clauses:

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's website, www.dol.gov.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient (s) to the State award official. The State award official will transmit the request, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request and the local wage determination, including the views of all

interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that

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the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) 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 (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will

no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination; debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 DOW– February 2014

CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

4. Contract Provision for Contracts in Excess of \$100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (a)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (a)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may

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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 (b)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (a)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (a)(1) through (4) of this section.

(b) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

5. Compliance Verification.

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence.

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable, the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract. Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. In addition, during DOW– February 2014

the examinations the subrecipient shall verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractor's use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB contact listed above and to the appropriate DOL Wage and Hour District Office listed at <http://www.dol.gov/contacts/whd/america2.htm>.

II. Requirements Under The Consolidated and further Continuing Appropriations Act, 2013 (P.L. 113-6) For Subrecipients That Are Not Governmental Agencies

The following terms and conditions specify how recipients will assist EPA in meeting its DB responsibilities when DB applies to EPA awards of financial assistance under the FY2013 Continuing Resolution with respect to subrecipients that are not governmental entities. If a subrecipient has questions regarding when DB applies, obtaining the correct DB wage determinations, DB provisions, or compliance monitoring, it may contact the State recipient for guidance. The recipient or subrecipient may also obtain additional guidance from DOL's web site at <http://www.dol.gov/whd/>.

Under these terms and conditions, the subrecipient must submit its proposed DB wage determinations to the State recipient for approval prior to including the wage determination in any solicitation, contract task orders, work assignments, or similar instruments to existing contractors.

1. Applicability of the Davis- Bacon (DB) prevailing wage requirements.

Under the FY 2013 Continuing Resolution, Davis-Bacon prevailing wage requirements apply to the construction, alteration, and repair of treatment works carried out in whole or in part with assistance made available by a State water pollution control revolving fund and to any construction project carried out in whole or in part by assistance made available by a drinking water treatment revolving loan fund. If a subrecipient encounters a unique situation at a site that presents uncertainties regarding DB applicability, the subrecipient must discuss the situation with the recipient State before authorizing work on that site.

2. Obtaining Wage Determinations.

(a) Subrecipients must obtain proposed wage determinations for specific localities at www.wdol.gov. After the Subrecipient obtains its proposed wage determination, it must submit the wage determination to (insert contact information for State recipient DB point of contact for wage determination) for approval prior to inserting the wage determination into a solicitation, contract or issuing task orders, work assignments or similar instruments to existing contractors

(ordering instruments unless subsequently directed otherwise by the State recipient Award Official).

(b) Subrecipients shall obtain the wage determination for the locality in which a covered activity subject to DB will take place prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. These wage determinations shall be incorporated into solicitations and any subsequent contracts. Prime contracts must contain a provision requiring that subcontractors follow the wage determination incorporated into the prime contract.

(i) While the solicitation remains open, the subrecipient shall monitor www.wdol.gov on a weekly basis to ensure that the wage determination contained in the solicitation remains current. The subrecipients shall amend the solicitation if DOL issues a modification more than 10 days prior to the closing date (i.e. bid opening) for the solicitation. If DOL modifies or supersedes the applicable wage determination less than 10 days prior to the closing date, the subrecipients may request a finding from the State recipient that there is not a reasonable time to notify interested contractors of the modification of the wage determination. The State recipient will provide a report of its findings to the subrecipient.

(ii) If the subrecipient does not award the contract within 90 days of the closure of the solicitation, any modifications or supersedes DOL makes to the wage determination contained in the solicitation shall be effective unless the State recipient, at the request of the subrecipient, obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv). The subrecipient shall monitor www.wdol.gov on a weekly basis if it does not award the contract within 90 days of closure of the solicitation to ensure that wage determinations contained in the solicitation remain current.

(c) If the subrecipient carries out activity subject to DB by issuing a task order, work assignment or similar instrument to an existing contractor (ordering instrument) rather than by publishing a solicitation, the subrecipient shall insert the appropriate DOL wage determination from www.wdol.gov into the ordering instrument.

(c) Subrecipients shall review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

(d) As provided in 29 CFR 1.6(f), DOL may issue a revised wage determination applicable to a subrecipient's contract after the award of a contract or the issuance of an ordering instrument if DOL determines that the subrecipient has failed to incorporate a wage determination or has used a wage determination that clearly does not apply to the contract or ordering instrument. If this occurs, the subrecipient shall either terminate the contract or ordering instrument and issue a revised solicitation or ordering instrument or incorporate DOL's wage determination retroactive to the beginning of the contract or ordering instrument by change order. The subrecipient's contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

3. Contract and Subcontract provisions.

(a) The Recipient shall insure that the subrecipient(s) shall insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including
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painting and decorating, of a treatment work under the CWSRF or a construction project under the DWSRF financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1 or the FY 2013 Continuing Resolution, the following clauses:

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's web site, www.dol.gov.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient(s) to the State award official. The State award official will transmit the report, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request, and the local wage determination, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding. The subrecipient(s) shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by
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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 (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA, the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a “Statement of Compliance,” signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) 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 (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered
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program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may be appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

4. Contract Provision for Contracts in Excess of \$100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages. The subrecipient shall upon the request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (a)(2) of this section.

(4) Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

5. Compliance Verification.

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence.

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract. Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB . In addition, during the examinations the subrecipient shall verify evidence of fringe benefit plans and payments thereunder by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractors use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB contact listed above and to the appropriate DOL Wage and Hour District Office listed at <http://www.dol.gov/whd/america2.htm> or its successor site.

Section 02465 RAMMED AGGREGATE PIER SOIL REINFORCEMENT

PART 1: GENERAL REQUIREMENTS

1.01 Description

Work shall consist of designing, furnishing and installing Rammed Aggregate Pier elements to the lines and grades designated on the project foundation plan and as specified herein. The aggregate pier elements shall be constructed by compacting aggregate in an excavated hole using special high-energy impact densification equipment. The aggregate pier elements shall be in a columnar-type configuration and shall be used to reinforce soils for the support of high bearing pressure spread footings.

1.02 Work Included

- A. Provision of all equipment, material, labor, and supervision to design and install rammed aggregate pier elements. Design shall rely on subsurface information presented in the project geotechnical report (Rammed Aggregate Pier Designer/Contractor is responsible for obtaining a copy of the project's geotechnical report). Layout of aggregate pier elements, removal of spoils from the site (which result from aggregate pier construction), removal of spoils off the working pad, footing excavation, and subgrade preparation following aggregate pier installation is not included.
- B. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.

1.03 Approved Installers

- A. Installers of Rammed Aggregate Pier Foundation Systems shall have a minimum of 5 years of experience with the installation of aggregate piers and shall have completed installations for at least 50 buildings or structures.
- B. Installers shall be licensed by Geopier Foundation Company, Inc. and shall have demonstrated experience in the construction of similar size and types of projects. The rammed aggregate pier Installer shall be approved by the Owner's Engineer and must be approved two weeks prior to bid opening. The Installer shall adhere to all methods and standards described in this Specification.
- C. Information regarding contractors licensed to install Rammed Aggregate piers can be obtained by contacting Geopier Foundation Company. (901-309-3363 or 800-371-7470)

1.05 Reference Standards

A. Design

1. Lawton, E.C., N.S. Fox, and R.L. Handy. "Control of Settlement and Uplift of Structures Using Short Aggregate Piers." ASCE. Proceedings of In-Situ Deep Soil Improvement. ASCE National Convention, Atlanta, Georgia. October 9-13, 1994.
2. Lawton, E.C. and N.S. Fox. "*Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers.*" ASCE. Geotechnical Special Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments, ASCE 2, 962-974.
3. Fox, N.S. and M. Cowell. 1998. Geopier Reference Manual. Published by Geopier Foundation Company, Inc., Scottsdale, AZ.
4. Wissmann, K.J., E.C. Lawton, and T.M. Farrell. 1999. "Behavior of Geopier-Supported Foundation Systems During Seismic Events." Technical Bulletin No. 1. Geopier Foundation Company, Inc., Scottsdale, AZ.
5. Wissmann, K.J. 1999. "Bearing Capacity of Geopier-Supported Foundation Systems." Technical Bulletin No. 2. Geopier® Foundation Company, Inc., Scottsdale, AZ.
6. Wissmann, K.J., J.M. Caskey, and B.T. Fitzpatrick. 2001. "Geopier® Uplift Resistance." Technical Bulletin No. 3. Geopier® Foundation Company, Inc., Scottsdale, AZ.
7. Wissmann, K.J., B.T. Fitzpatrick, and E.C. Lawton. 2001. "Geopier® Lateral Resistance." Technical Bulletin No. 4. Geopier® Foundation Company, Inc., Scottsdale, AZ.
8. Fitzpatrick, B.T. and K.J. Wissmann. 2002. "Geopier® Shear Reinforcement for Global Stability and Slope Stability." Technical Bulletin No. 5. Geopier® Foundation Company, Inc., Scottsdale, AZ.

- B. Modulus and Uplift Testing
 - 1. ASTM D-1143 – Pile Load Test Procedures
 - 2. ASTM D-1194 – Spread Footing Load Test
 - 3. ASTM-D-3689 – Uplift Load Test

- C. Materials and Inspection
 - 1. ASTM D-1241 – Aggregate Quality
 - 2. ASTM STP 399 – Dynamic Penetrometer Testing
 - 3. ASTM D-422 – Gradation Soils

1.06 Conflicts in Specifications/References

Where specifications and reference documents conflict, the Architect/Engineer shall make the final determination of the applicable document.

1.07 Certifications and Submittals

- A. The installer shall submit detailed design calculations and construction drawings prepared by the Rammed Aggregate Pier Designer (the Designer) to the Owner or Owner's Engineer for approval at least 2 weeks prior to the start of construction. All plans shall be sealed by a Professional Engineer in the State in which the project is constructed.
- B. The Rammed Aggregate Pier Designer shall have Errors and Omissions design insurance for the work. The insurance policy should provide a minimum coverage of \$2 million per occurrence.
- C. Modulus and uplift test data - The Installer shall furnish the General Contractor a description of the installation equipment, installation records, complete test data, analysis of the test data and recommended design parameter values based on the modulus test results. The report shall be prepared under supervision of a registered professional engineer.
- D. Daily Rammed Aggregate Pier Progress Reports – The Installer shall furnish a complete and accurate record of aggregate pier installation to the General Contractor. The record shall indicate the pier location, length, average lift thickness and final elevations of the base and top of piers. The record shall also indicate the type and size of the densification equipment used. The Installer shall immediately report any unusual conditions encountered during installation to the General Contractor, to the Designer and to the Testing Agency.

1.08 Method of Measurement

- A. Measurement of the aggregate pier elements is on a per-pier basis.
- B. Payment shall cover design and installation of the aggregate pier foundation system. Excavation of unsuitable materials, drilling

obstructions, delays, and remobilization as documented and approved by the Owner or Owner's Engineer shall be paid for under separate pay items.

- C. Quantities of piers, as shown on Rammed Aggregate Pier Designer's plans, may be increased or decreased at the direction of the Owner or Owner's Engineer, based on construction procedures and actual site conditions.

1.09 Basis of Payment

- A. The accepted quantities of piers will be paid per approval, in-place aggregate-pier.

- B. Additional unit prices below shall be written on the Bid Tab:

Additional Installed Piers (w/o remobilization)	\$____ Each
Add for Casing Holes	\$____/Linear Foot
Additional Mobilizations	\$____ Each
Additional Modulus or Uplift Load Tests	\$____ Each

PART 2: PRODUCTS

2.01 Materials

- A. Aggregate used for piers constructed above the water table shall be Type I Grade B in accordance with ASTM D-1241-68, or shall be other graded aggregate selected by the Installer and successfully used in the modulus test. It shall be compacted to a densification and strength, which provides resistance to the dynamic penetration test (ASTM STP 399) of a minimum average of 15 blows per 1.75-inch vertical movement.
- B. For aggregate used for piers constructed below the water table, the gradation shall be the same as Type I Gradation B, except that particles passing the No. 40 sieve shall be eliminated. Alternatively, No.57 stone or other stone selected by the Aggregate Pier Installer may be used. Dynamic penetration resistance testing is inappropriate for this material.
- C. Potable water or other suitable source shall be used to increase aggregate moisture content where required. The General Contractor shall provide such water to the Installer.
- D. The General Contractor will provide adequate and suitable marshalling areas on the project site for the use of the Installer for the storage of aggregate and equipment.

PART 3: DESIGN REQUIREMENTS

3.01 Rammed Aggregate Pier Design

- A. The Rammed Aggregate Pier elements shall be designed for an Aggregate Pier stiffness modulus of 175 pci. The stiffness modulus value shall be verified by the results of the Rammed Aggregate Pier modulus test, described in this specification.
- B. Aggregate piers shall be designed in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design shall meet the following criteria.

Maximum Allowable Bearing Pressure for Aggregate Pier Reinforced Soils	5,000 psf
Estimated Total Long-Term Settlement for Footings:	≤1-inch
Estimated Long-Term Differential Settlement of Adjacent Footings:	≤ ½-inch

- C. The design submitted by the Installer shall consider the bearing capacity and settlement of all footings supported by aggregate piers, and shall be in accordance with acceptable engineering practice and these specifications. Total and differential settlement shall be considered. The design life of the structure shall be 50 years.
- D. The Rammed Aggregate Pier system shall be designed to preclude plastic bulging deformations at the top-of-pier design stress and to preclude significant tip stresses as determined from the shape of the telltale test curve from telltales installed in modulus test piers.

3.02 Design Submittal

The Installer shall submit 4 sets of detailed design calculations, construction drawings, and shop drawings, (the Design Submittal), for approval at least 2 weeks prior to the beginning of construction. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. Additionally, the quality control test program for aggregate piers, meeting these design requirements, shall be submitted. All calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the State or Province where the piers are to be built.

3.03 Building Code Acceptance

The Rammed Aggregate Pier Installer shall demonstrate that the Aggregate Pier system has been ICBO certified.

PART 4: CONSTRUCTION

4.01 Excavation

- A. All Rammed Aggregate Pier elements shall be pre-augered using mechanical drilling or excavation equipment. Installation of piers without pre-augering shall not be allowed because this technique results in significant disturbance and remolding of the matrix soils surrounding the piers.
- B. If cave-ins occur during excavation such that the sidewalls of the hole are deemed to be unstable, steel casing or a drilling slurry shall be used to stabilize the excavation.
- C. If cave-ins occur on top of a lift of aggregate such that the volume of the caved soils is greater than 10 percent of the volume of the aggregate in the lift, then the aggregate shall be considered contaminated and shall be removed and replaced with uncontaminated aggregate.

4.02 Densification

- A. Special high-energy impact densification apparatus shall be employed to densify the Rammed Aggregate Pier elements during installation. The apparatus shall apply direct downward impact energy to each lift of aggregate.
- B. The bottom of the excavation shall be densified prior to the placement of the aggregate. If wet, soft or sensitive soils are present, open-graded aggregate, such as ASTM No.57 stone or other, shall be placed at the bottom of the excavation and compacted to stabilize the element bottom and may serve as the initial lift.
- C. Densification shall be performed using a beveled tamper. The beveled tamper foot is required to adequately increase the lateral earth pressure in the matrix soil during installation.
- D. Downward pressure shall be applied to the tamper shaft during tamping.
- E. Each lift of aggregate shall be tamped for a minimum of 10 seconds.

4.03 Plan Location and Elevation of Rammed Aggregate Pier Elements

The center of each pier shall be within six inches of the plan locations indicated. The final measurement of the top of piers shall be the lowest point on the aggregate in the last compacted lift. Piers installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

4.04 Rejected Rammed Aggregate Pier Elements

Rammed Aggregate pier elements improperly located or installed beyond the maximum allowable tolerances shall be abandoned and replaced with new piers, unless the Designer approves other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of the rejection is due to an obstruction or mislocation.

PART 5: QUALITY CONTROL

5.01 Quality Control Representative

The Installer shall have a full-time Quality Control (QC) representative to verify and report all QC installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Design Engineer, the General Contractor, and to the Testing Agency. The QC procedures shall include the preparation of Aggregate Pier Progress Reports completed during each day of installation and containing the following information:

- A. Footing and Rammed Aggregate Pier location.
- B. Rammed Aggregate Pier length and drilled diameter.
- C. Planned and actual Rammed Aggregate Pier elevations at the top and bottom of the element.
- D. Average lift thickness for each Rammed Aggregate Pier.
- E. Soil types encountered at the bottom of the Rammed Aggregate Pier and along the length of the element.
- F. Depth to groundwater, if encountered.
- G. Documentation of any unusual conditions encountered.
- H. Type and size of densification equipment used.

5.02 Modulus Test

A modulus test shall be performed to verify the parameter values selected for design. The modulus tests shall be of the type and installed in a manner specified herein.

- A. A telltale shall be installed at the bottom of the test pier so that bottom-of-pier deflections may be determined. Acceptable performance is indicated when the bottom of the pier deflection is no more than 20% of the top of pier deflection at the design stress level.
- B. ASTM D-1143 general test procedures shall be used as a guide to establishing load increments, load increment duration, and load decrements.

- C. With the exception of the load increment representing approximately 115% of the design maximum top of Aggregate Pier stress, all load increments shall be held for a minimum of 15 minutes, a maximum of 1 hour, and until the rate of deflection reduces to 0.01 inch per hour, or less.
- D. The load increment that represents approximately 115% of the design maximum stress on the Aggregate Pier shall be held for a minimum of 15 minutes, a maximum of 4 hours and until the rate of deflection reduces to 0.01 inches per hour or less.
- E. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
- F. Rammed Aggregate Pier modulus testing shall be performed in accordance with the requirements outlined in the Design Submittal.
- G. The location of the aggregate pier modulus test should be coordinated with the project Geotechnical Engineer of record.

5.04 Bottom Stabilization Verification Test

- A. After completion of the bottom pier bulb, or at anytime during the process of constructing the pier, the energy source may be turned off, and bottom stabilization verification test may be performed. These tests shall be performed when a new soil formation is encountered, or at the beginning of a project to provide quantitative information on pier stabilization.
- B. Bottom Stabilization Tests are performed by placing a reference bar over the cavity, marking the tamper shaft, applying energy to the tamper for an additional 15 seconds, and observing the downward deflection of the tamper shaft by observing the deflection of the mark on the tamper shaft.
- C. Acceptable performance is indicated if the vertical movement of the shaft is less than 150% of the vertical movement measured for the modulus test pier.
- D. If the measured vertical movement exceeds 150% of the value achieved during the modulus test, added energy is applied to re-densify the bulb. The procedure for measure is then repeated. If there is still movement greater than 150% of that achieved during the modulus test and greater than ½ inch, a lift of loose aggregate may be placed on top of the compacted aggregate, and the verification test may be performed on this next lift after it is densified. If there is excessive movement on this lift, another lift may be placed and tested. Movement must be limited to below 150% of the values achieved for the modulus test before completion of 2/3 of the pier depth.

5.05 Dynamic Cone Petrometer Test

- A. The Rammed Aggregate Pier elements shall be tested by the Dynamic Cone Penetrometer method (ASTM STP 399) at locations within the upper 1/3 of the pier shaft length.
- B. The minimum acceptable criteria as an indicator of acceptable densification shall be at least 15 blows per 1-3/4 inch penetration.
- C. Dynamic Cone Penetrometer testing shall be performed in each Aggregate Pier until such time as five consecutive tests indicate that the minimum criterion is met. Thereafter, such tests need not be performed on every pier, provided that the aggregate used in the elements is representative of that previously tested. If average penetration resistances measured exceed 15 blows, and less than 10% of tests fall below 15 blows, then testing may be reduced to spot checks. A pattern of successful tests is sufficient to reduce testing to several tests per day.
- D. Observation of questionable aggregate moisture content or questionable aggregate gradation appearance may determine the need for additional dynamic penetration testing to verify that the proper densification is being achieved.
- E. Use of Dynamic Cone Penetrometer is not appropriate for use on open-graded aggregate such as No. 57 stone.

PART 6: QUALITY ASSURANCE

6.01 Independent Engineering Testing Agency

The General Contractor is responsible for retaining an independent engineering testing firm to provide Quality Assurance services. The Testing Agency should be the Geotechnical Engineer of Record.

6.02 Responsibilities of Independent Engineering Testing Agency

- A. The Testing Agency shall monitor the modulus and uplift test(s) when modulus or uplift test(s) are to be performed. The Installer shall provide and install all dial indicators and other measuring devices.
- B. The Testing Agency shall monitor the installation of aggregate pier elements to verify that the production installation practices are similar to those used during the installation of the modulus test elements.
- C. The Testing Agency shall perform Dynamic Cone Penetrometer tests as described herein.
- D. The Testing Agency shall report any discrepancies to the Installer and General Contractor immediately.

PART 7: RESPONSIBILITIES OF GENERAL CONTRACTOR

7.01 Preparation

- A. The General Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the Aggregate Pier elements.
- B. The General Contractor will provide the site to the Installer, after earthwork in the area has been completed.
- C. Site subgrade shall be established by the General Contractor within 6 inches of final design subgrade, as approved by the Design Engineer.
- D. A working surface will be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the Aggregate Pier installation.

7.02 Layout of the Rammed Aggregate Pier Elements

The General Contractor shall provide layout (construction staking) of the Aggregate Piers. The General Contractor shall provide ground elevations in sufficient detail to estimate drilling depth elevations to within 2 inches.

7.03 Rammed Aggregate Pier Excavation

Should any obstruction be encountered during drilling or excavation for aggregate piers, the General Contractor shall be responsible for removing such obstruction, or the pier shall be relocated or abandoned. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., that prevent installing the aggregate piers to the required depth, or cause the aggregate pier to drift from the required locations. Dense natural rock or weathered rock shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials. If the General Contractor cannot or does not remove such obstructions within one hour from the time the Installer reports the obstruction to the General Contractor, the Installer may remove such obstructions with his own means. Should this occur, the Installer shall receive an extra to the contract to account for their additional expenses, including delay time involved to crew and equipment.

7.04 Excavations

The General Contractor shall coordinate all excavations made subsequent to Aggregate Pier installations so that at least five feet of horizontal distance remains between the edge of any installed Rammed Aggregate Pier and the excavation. Protection of completed Aggregate Pier elements is the responsibility of the General Contractor. In the event that utility excavations are required at horizontal distances of less than five feet from installed Aggregate Piers, the General Contractor shall contact the Aggregate Pier Designer to develop construction solutions to minimize impacts on the installed Aggregate Piers.

Recommended procedures may include:

- A. Using cement-treated base to construct portions of the Aggregate Piers subject to future excavations.

- B. Replacing excavated soil with compacted crushed stone in the portions of excavations where Aggregate Piers have been disturbed. The placement and compaction of the crushed stone shall meet the following requirements.
1. The crushed stone shall meet the gradation specified by the Designer.
 2. The crushed stone shall be placed in a controlled manner using motorized impact compaction equipment.
 3. The aggregate should be compacted to 95% of the maximum dry density as determined by the modified Proctor method (ASTM D-1557).
 4. The Testing Agency shall be on site to observe placement, compaction, and provide density testing. The test results shall be submitted to the Designer and the General Contractor. The General Contractor shall provide notification to the Testing Agency and the Designer when excavation, placement, and compaction will occur and arrange for construction observation and testing.

7.05 Protection of the Work

Upon completion of rammed aggregate pier installations, the General Contractor is responsible for protection of the work. This includes, but is not limited to, proper site drainage to prevent the collection or ponding of water on or near completed rammed aggregate piers and appropriate control and coordination of earthwork activities and/or subsequent drilling activities in order to prevent damage to completed rammed aggregate piers.

7.06 Footing Bottoms

The provisions in this section should be referenced in the appropriate section of the Concrete Division. Typically this section is referenced in the "RELATED WORK" section of the concrete section.

- A. Excavation and surface compaction of all footings shall be the responsibility of the General Contractor.
- B. Foundation excavations to expose the tops of Aggregate Pier elements shall be made in a workmanlike manner, and shall be protected until concrete placement, with procedures and equipment best suited to (1) prevent softening of the matrix soil between and around the Aggregate Pier elements before pouring structural concrete, and (2) achieving direct and firm contact between the dense, undisturbed Aggregate Pier elements and the concrete footing.
- C. Recommended procedures for achieving these goals are to:
 1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment,
 2. Compaction of surface soil and top of Aggregate Pier elements shall be prepared using a motorized impact compactor ("Wacker

Packer," "Jumping Jack," or similar). Sled-type tamping devices shall not be used. Compaction shall be performed over the entire footing bottom to compact any loose surface soil and loose surface pier aggregate.

3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on expansive or sensitive soils.
 4. If same day placement of footing concrete is not possible, place a minimum 3-inch thick lean concrete seal ("mud mat") immediately after the footing is excavated and approved.
- D. The following criteria shall apply, and a written inspection report sealed by the project Geotechnical Engineer shall be furnished to the Installer to confirm:
1. That water (which may soften the unconfined matrix soil between and around the Aggregate Pier elements, and may have detrimental effects on the supporting capability of the Aggregate Pier reinforced subgrade) has not been allowed to pond in the footing excavation at any time.
 2. That all Aggregate Pier elements designed for each footing have been exposed in the footing excavation.
 3. That immediately before footing construction, the tops of all the Aggregate Pier elements exposed in each footing excavation have been inspected and recompacted as necessary with mechanical compaction equipment, and that the tops of any Aggregate Pier elements which may have been disturbed by footing excavation and related activity have been recompacted to a dry density equivalent to at least 95% of the maximum dry density obtainable by the modified Proctor method (ASTM D-1557).
 4. That no excavations or drilled shafts have been made after installation of Aggregate Pier elements within horizontal distance of five feet from the edge of any pier, without the written approval of the Installer or Designer.
- E. Failure to provide the above inspection and certification by the project Geotechnical Engineer, which are beyond the responsibility of the Aggregate Pier Installer, may void any written or implied warranty on the performance of the Aggregate Pier system.

SECTION 03010 - CONCRETE WORK

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 specification sections, apply to work of this section.

DESCRIPTION OF WORK:

The extents of concrete work as shown on drawings.

QUALITY ASSURANCE:

Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:

ACI 301 "Specifications for Structural Concrete for Buildings."

ACI 318 "Building Code Requirements for Reinforced Concrete."

Concrete Reinforcing Steel Institute, "Manual of Standard Practice."

ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."

Concrete Testing Service: Employ, at Contractor's expense a testing laboratory acceptable to Architect to perform material evaluation tests and to design concrete mixes.

Materials and installed work may require testing and retesting, as directed by Architect, at anytime during progress of work. Allow free access to material stockpiles and facilities. Tests, not specifically indicated to be done at Owner's expense, including retesting of rejected materials and installed work, shall be done at Contractor's expense.

SUBMITTALS:

Product Data: Submit manufacturer's product data with application and installation instructions for proprietary materials and items, including reinforcement (including fibrous reinforcement) and forming accessories, admixtures, patching compounds, water stops, joint systems, curing compounds, and others as requested by Architect.

Samples: Submit samples of materials as specified and as otherwise requested by Architect, including names, sources and descriptions.

Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test as specified.

PART 2 - PRODUCTS

FORM MATERIALS:

Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

REINFORCING MATERIALS:

Reinforcing Bars (ReBar): ANSI/ASTM A 615, Grade 60, deformed (detailed and fabricated in accordance with latest edition of ACI 318 & 315).

Welded Wire Fabric (WWF): ANSI/ASTM A 185, welded steel wire fabric.

Fibrous Reinforcement: 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Reinforcement shall be equal to Fibermesh Inforce E3 as manufactured by SI Concrete Systems. Refer S1.0 for additional information.

Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Support spacing shall be in accordance with CRSI recommendations and shall be adequate to maintain clearance for reinforcing as indicated or recommended by ACI 318 and CRSI prior to, during and after concrete placement Use wire bar type supports complying with CRSI recommendations, unless otherwise acceptable.

For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

CONCRETE MATERIALS:

Portland Cement: ANSI/ASTM C 150, Type I, unless otherwise acceptable to Architect.

Normal Weight Aggregates: ANSI/ASTM C 33, and as herein specified. Maximum aggregate size 1-1/2".

Light Weight Aggregates: ASTM C330, and as herein specified. Maximum aggregate size 1".

Limestone Aggregates: Approved aggregate shall be used in all exterior exposed concrete.

Water: Potable.

Air-Entraining Admixture: ANSI/ASTM C 260.

Water-Reducing Admixture: ANSI/ASTM C 494, Type A, and contain not more than 1% chloride ions.

Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

- "Eucon WR-75"; Euclid Chemical Co.
- "Pozzolith 322N"; Master Builders.
- "Plastocrete 160"; Sika Chemical Corp.
- "Chemtard"; Chem-Masters Corp.

Water-Reducing, Accelerator Admixture: ASTM C 494, Type C or E.

Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

"Accelguard HE"; Euclid Chemical Co.
"Pozzolith 122-HE"; Master Builders.
"Darex"; W.R. Grace.
"Sikacrete"; Sika Chemical Co.

Calcium chloride: not permitted.

Fly ash: not permitted.

RELATED MATERIALS:

Waterstops: Provide flat, dumbbell type or centerbulb type waterstops at construction joints and other joints as shown. Size to suit joints.

Polyvinyl chloride (PVC) waterstops: Corps of Engineers CRD-C 572.

Moisture Barrier: Provide moisture barrier cover over prepared base material where indicated. Use only materials which are resistant to decay when tested in accordance with ANSI/ASTM E 154, as follows:

Polyethylene sheet not less than 6 mils thick.

Non-Shrink Grout Type D, Non-metallic, Non-shrink: CRD-C 621, ASTM C1107 and tested in accordance with ASTM C-827, factory premixed grout.

Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

"Masterflow 713"; Master Builders.
"Sonogrout"; Sonneborn-Contech.
"Euco-NS"; Euclid Chemical Co.
"Five Star Grout"; U.S. Grout Co.
"Duragrout"; L & M Const. Chemical Co.

Chemical Hardener (ChHd-Fn): Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gal.

Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

Moisture-Retaining Cover: One of the following, complying with ANSI/ASTM C 171.

Waterproof paper.
Polyethylene film.
Polyethylene-coated burlap.

PROPORTIONING AND DESIGN OF MIXES:

Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Architect for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to Architect.

Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Architect.

Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:

3000 psi 28-day compressive strength; 480 lbs. cement per cu. yd. minimum; W/C ratio, 0.62 maximum (non-air entrained), 0.57 maximum (air entrained).

3500 psi 28 day compressive strength 520 lbs cement per cu. yd. minimum; w/c ratio .58 maximum (non-air entrained) .52 maximum (air entrained).

4000 psi 28-day compressive strength; 560 lbs. cement per cu. yd. minimum; W/C ratio, 0.54 maximum (non-air entrained), 0.48 maximum (air entrained).

CONCRETE SCHEDULE:

Footings:	3000 psi Non-Air Entrained
Block Cores Below Grade:	3000 psi Non-Air Entrained
Exterior Exposed Piers and Walls:	4000 psi Air Entrained
Interior Piers and Walls:	4000 psi Non-Air Entrained
Slabs on Grade Interior:	3000 psi Non-Air Entrained
Slabs On Grade Exterior:	4000 psi Air Entrained
Mezzanines and Elevated Floor Slabs:	4000 psi, Non-Air Entrained

ADJUSTMENT TO CONCRETE MIXES: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to Owner and as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in work.

ADMIXTURES:

Use water-reducing admixture in all concrete.

Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F (10 degrees C).

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 air content within following limits:

Concrete structures and slabs exposed to freezing and thawing or subjected to hydraulic pressure:

- 3% to 5% for maximum 2" aggregate.
- 3% to 7% for maximum 3/4" aggregate.
- 6% to 8% for maximum 1/2" aggregate.
- Other Concrete: 2% to 4% air.

Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions, and architect's approval.

Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

- Ramps and sloping surfaces: Not more than 3".
- Reinforced foundation systems: Not more than 4".

Other concrete: Not more than 4".

CONCRETE MIXES:

Job-Site Mixing: Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of one cu. yd., or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd., or fraction thereof.

Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

Ready-Mix Concrete: Comply with requirements of ANSI/ASTM C 94, and as herein specified. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ANSI/ASTM C 94 may be required.

When air temperature is between 85° F (30° C) and 90° F (32° C), reduce mixing, delivery, and beginning placing operation time from 1-1/2 hours to 75 minutes, and when air temperature is above 90° F (32° C), reduce mixing, delivery, and beginning placing operation time to 60 minutes.

Tempering and Control of Mixing Water: Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be re-tempered, but shall be discarded.

When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. An addition of water above that permitted by the limitation on water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio. Such addition shall be authorized by the Architect/Engineer or his representative.

PART 3 - EXECUTION

FORMS:

Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.

Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.

Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

Chamfer, exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

Form Ties: Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

Unless otherwise indicated, provide ties so portion remaining within concrete after removal is at least 1-1/2" inside concrete.

Unless otherwise shown, provide form ties which will not leave holes larger than 1" diameter in concrete surface.

Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retighten forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

PLACING REINFORCEMENT:

Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

Accurately position, support and secure reinforcement against displacement by formwork construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required to maintain proper clearances.

Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Corner bars shall be furnished at all insertions or walls and bond beams where continuous reinforcing is required.

Corner bars shall be furnished at all intersections of footings, walls and bond beams where continuous reinforcing is required.

Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

JOINTS:

Construction Joints: Locate and install construction joints, which are not shown on drawings, so as not to impair strength and appearance of the structure, as acceptable to Architect.

Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.

Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.

Water-stops: Provide water-stops in construction joints as indicated. Install water-stops to form continuous diaphragm in each joint. Make provisions to support and protect exposed water-stops during progress of work. Fabricate field joints in water-stops in accordance with manufacturer's printed instructions.

Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams and elsewhere as indicated.

Joint filler and sealant materials are specified in Division-7 sections of these specifications.

Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/3 of slab depth, unless otherwise indicated.

Contraction joints may be formed by saw cuts of 1/3 the slab thickness as soon after slab finishing without dislodging aggregate, maximum time of 8 hours after concrete placement.

Joint sealant material is specified in Division-7 sections of these specifications.

INSTALLATION OF EMBEDDED ITEMS:

General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.

Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

PREPARATION OF FORM SURFACES:

Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

CONCRETE PLACEMENT:

Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

General: Comply with ACI 304, and as herein specified.

Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation, maximum free fall of 4' 0". Concrete to be placed with chutes, hoppers, baffles drop pipes or flexible drop chute to avoid segregation as recommended by ACI 304.

Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

Placing Concrete Slabs: Deposit and consolidate concrete slabs by mechanical vibrating equipment in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

Maintain reinforcing in proper position during concrete placement operations.

Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

When air temperature has fallen to or is expected to fall below 40° F (4° C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50° F (10° C), and not more than 80° F (27° C) at point of placement.

Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen sub-grade or on sub-grade containing frozen materials.

Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.

Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

Cool ingredients before mixing to maintain concrete temperature at time of placement below 90° F (32°C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing.

Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

Wet forms thoroughly before placing concrete.

Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

FINISH OF FORMED SURFACES:

Rough Form Finish (RfFm-Fn): For formed concrete surfaces not exposed-to-view in the finish work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and other projections exceeding 1/4" in height rubbed down or chipped off.

Smooth Form Finish (SmFm-Fn): For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp-proofing, painting or other similar system. This is as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

MONOLITHIC SLAB FINISHES:

Scratch Finish (Scr-Fn): Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.

After placing slabs, plane surface to a tolerance not exceeding 1/2" in 10' when tested with a 10' straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms or rakes.

Float Finish (Flt-Fn): Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.

After screening, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding 1/4" in 10' when tested with a 10' straightedge. Cut down high spots and fill low spots. Uniformly slope surface to drains. Immediately after leveling, re-float surface to a uniform, smooth, granular texture.

Trowel Finish (Tr-Fn): Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, paint or other thin film finish coating system.

After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface

plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

Non-Slip Broom Finish (NSBrm-Fn): Apply non-slip broom finish to all exterior concrete, including platforms, steps and ramps, and elsewhere as indicated.

Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

Chemical-Hardener Finish (ChHd-Fn): Apply chemical-hardener finish to interior concrete floors where indicated. Apply liquid chemical-hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water, and apply in 3 coats; first coat, 1/3 strength; second coat, 1/2 strength; third coat, 2/3 strength. Evenly apply each coat, and allow 24 hours for drying between coats.

Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions.

After final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

Finishing of Concrete Containing Fibrous Reinforcement: In addition to finishing methods described above, contractor shall remove all traces of fibrous reinforcement at slab surface as directed by engineer/architect.

CONCRETE CURING AND PROTECTION:

General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

Curing Methods: Perform curing of concrete by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified.

Provide moisture curing by following methods.

Keep concrete surface continuously wet by covering with water.

Continuous water-fog spray.

Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.

Curing, Sealing and Dustproofing Compounds: The compound shall be a clear liquid acrylate-based polymer that contains no oils, saponifiable resins, waxes, or chlorinated rubbers. It shall have a minimum of 30% solids content and have test data from an independent laboratory indicating a maximum moisture loss of 0.030 grams per sq. cm. when applied at a coverage rate of 300 sq. ft. per gallon and tested in accordance with federal specification TT-C-800A. Compound shall be applied in two coats to guarantee sealing and dust-proofing. Coverage rate shall be as per manufacturer's recommendation but no more than 300 square feet per gallon, each coat. The compound shall be equal to Sonneborn Kure-N-Seal 30. Contractor to verify compatibility with floor finish specified.

Provide moisture-cover curing as follows:

Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

Curing Formed Surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

SHORES AND SUPPORTS:

Comply with ACI 347 for shoring and re-shoring in multistory construction, and as herein specified.

Extend shoring from ground to roof of structure, unless otherwise permitted.

REMOVAL OF FORMS:

Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28-days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

Form-facing material may be removed 4 days after placement, only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

RE-USE OF FORMS:

Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to Architect.

MISCELLANEOUS CONCRETE ITEMS:

Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections and terminations slightly rounded.

Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

Reinforced Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

CONCRETE SURFACE REPAIRS:

Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Architect.

Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having required slope.

Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.

Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.

Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

Use epoxy-based mortar for structural repairs, where directed by Architect.

Repair methods not specified above may be used, subject to acceptance of Architect.

QUALITY CONTROL TESTING DURING CONSTRUCTION:

The Contractor will employ a testing laboratory to perform all tests and to submit test reports.

Sampling and testing for quality control during placement of concrete shall include the following, unless otherwise directed by Architect.

Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

Slump: ASTM C 143; one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.

Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete, ASTM C 231 pressure for normal weight concrete; one for each set of compressive strength test specimens.

Concrete Temperature: Test hourly when air temperature is 40° F (4°C) and below, and when 80°F (27°C) and above; and each time a set of compression test specimens made.

Compression Test Specimen: ASTM C 31; one set of 6 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field- cure test specimens are required.

Compressive Strength Tests: ASTM C 39; one set for each 100 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 5,000 sq. ft. of surface area placed; 2 specimens tested at 7 days, 3 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.

Test results will be reported in writing to Architect and Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7- day tests and 28-day tests.

Chemical-Hardener Finish (ChHd-Fn): Apply chemical-hardener finish to interior concrete floors where characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

Batch Ticket Submittal: Contractor shall provide architect/engineer with batch tickets for concrete with fibrous reinforcement showing the amount of reinforcement used in mixes for each pour. Concrete that does not meet specification requirements shall be removed and replaced at the direction of the engineer of record at the contractor's expense.

END OF SECTION 03010

SECTION 04200 – UNIT MASONRY

CMU with Brick

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-I Specifications sections, apply to work of this section.

Related sections:

Section 01020 - Allowances.

DESCRIPTION OF WORK:

Extent of each type of masonry work is indicated on drawings and schedule.

QUALITY ASSURANCE:

Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:

ACI 530-92 "Building Code Requirements for Masonry Structures."

ACI 530.1-92 "Specifications for Masonry Structures."

ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."

ACI 117-90 "Standard Specifications for Tolerances for Concrete Construction and Materials."

Concrete Reinforcing Steel Institute, "Manual of Standard Practice."

Concrete Testing Service: Employ, at Contractor's expense a testing laboratory acceptable to Architect to perform material evaluation tests and to design concrete grout or mortar mixes.

System Performance Requirements: Provide unit masonry and mortar that develops the following minimum installed net area compressive strength $f'_m = 1500$ psi

Materials and installed work may require testing and retesting, as directed by the Architect/Engineer, at anytime during progress of work. Allow free access to material stockpiles and facilities. Tests required to document submittals, certify product compliance with these Specifications prior to use in construction, establish mix designs, provide acceptability of changes requested by the Contractor shall be performed by accepted independent laboratories under Contractor's responsibility. Tests, not specifically indicated to be done at Owner's expense, including retesting of rejected materials and installed work, shall be done at Contractor's expense.

Clay unit masonry tests: For each different clay masonry unit indicated, units shall be tested per ASTM C 67.

Concrete Masonry Unit Tests: For each different concrete masonry unit indicated, units shall be tested for strength, absorption, and moisture content per ASTM C 140.

Prism tests: for each type of wall construction indicated, masonry prisms will be tested per ASTM E-447, Method B.

Mortar properties: shall be tested per property specification of ASTM C 270.

Mortar composition and properties: will be evaluated per ASTM C 780.

Grout compressive strength: will be tested per ASTM C -1019.

Fire Performance Characteristics: Where fire-resistance ratings are indicated for unit masonry work, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E 119 by a recognized testing and inspecting organization or by another means, as acceptable to authority having jurisdiction.

Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

Field Constructed Mock-Ups: Prior to installation of masonry work, erect sample wall panels representative of completed masonry work required for project with respect to qualities of appearance, materials and construction. Locate mock-ups on site in locations indicated or, if not indicated, as directed by Architect/Engineer. Retain mock-ups during construction as standard for judging completed masonry work. For the following types of masonry, build mock-ups which are approximately 4' long by 4' high by full thickness, including face and backup wythes as well as accessories. At the direction of the Architect/Engineer, several wall panels may be required to represent each of the following conditions:

Each type of exposed unit masonry construction.

Typical exterior face brick wall.

Typical exterior face brick wall with windows.

Typical exterior face brick wall.

Typical exterior face brick wall with window.

Typical exterior wall with stone or precast window trim or accents.

Typical interior unit masonry wall.

The Architect/Engineer shall be notified a week in advance of the dates and times when the mock-ups will be erected. Mock-ups shall be maintained during construction in undisturbed condition as standard for judging completed unit masonry construction, and shall be protected with a weather-resistant membrane. When directed, demolish mock-ups and remove from site.

Where masonry is to match existing, erect panels parallel to existing surface.

SUBMITTALS:

Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.

Samples: For verification purposes submit the following:

Facing brick samples for each type of exposed brick required. Include in each set the full range of

exposed color and texture to be expected in the complete work.

Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.

Laboratory Test Reports: Submit laboratory test reports for masonry materials and mix design tests as specified.

JOB CONDITIONS

Protection of Work: During erection, cover top of walls with waterproof sheeting at end of each days' work. Cover partially completed structures when work is not in progress.

Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns.

Do not apply concentrated loads for at least 3 days after building masonry walls or columns.

Staining: Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

Protect sills, ledges and projections from droppings of mortar.

HOT WEATHER PROTECTION:

During periods of hot weather as defined by ACI 530.1/ASCE 6/TMS 602, above 90 degrees F with wind greater than 8 mph, the following precautions shall be taken:

Store masonry, brick and sand in cool or shade areas to control heat gain.

Maintain temperature of mortar and grout between 70°F and 120°F. Cold water may be used.

Limit open mortar beds to no longer than 4 feet and set units within one minute of spreading mortar. Mortar with high water retention is desirable.

Protect wall from rapid evaporation by covering, fogging, damp curing or other means.

Masonry units with high suction (IRA over 30 g/min/30 in²) should be properly wetted prior to use.

Concrete masonry units may be wetted during these conditions. Units shall not be saturated, surface wet only. Drying time of units must be within 2 hours after wetting.

COLD WEATHER PROTECTION:

Do not lay masonry units which are wet or frozen.

Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch.

Remove all masonry determined to be damaged by freezing conditions.

For clay units with initial rates of absorption (suction) which requires them to be wetted before laying, comply with the following requirements.

For units with surface temperatures above 32 degrees F (0 degrees C), wet with water heated to above 70 degrees F (21 degrees C).

For units with surface temperatures below 32 degrees F (0 degrees C), wet with water heated to above 130 degrees F (54 degrees C).

Perform the following construction procedures while masonry work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 degrees F (6 degrees C).

40 degrees F (4 degrees C) to 32 degrees F (0 degrees C):

Mortar: Heat mixing water to produce mortar temperature between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).

Grout: Follow normal masonry procedures.

32 degrees F (0 degrees C) to 25 degrees F (-4 degrees C):

Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.

Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of work day.

25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):

Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.

Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of work day.

Heat both sides of walls under construction using salamanders or other heat sources.

Use windbreaks or enclosures when wind is in excess of 15 mph.

20 degrees F (-7 degrees C) and below:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).

Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of work day.

Heat masonry units so that they are above 20 degrees F (-7 degrees C) at time of laying.

Provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4 degrees C) for 24 hours after laying units.

Do not heat water for mortar and grout to above 160 degrees F (71 degrees C).

Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry temperature ranges apply to anticipated minimum night temperatures.

40 degrees F (4 degrees C) to 32 degrees F (0 degrees C):

Protect masonry from rain or snow for at least 24 hours by covering with weather-resistive membrane.

32 degrees F (0 degrees C) to 20 degrees F (-7 degrees C):

Completely cover masonry with weather- resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.

20 degrees F (-7 degrees C) and below:

Except as otherwise indicated, maintain masonry temperature above 32 degrees F (0 degrees C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 40 degrees F (4 degrees C) for 48 hours.

PART 2 - PRODUCTS

MASONRY UNITS, GENERAL:

Manufacturer: Obtain masonry units from one manufacturer, of uniform texture and color for each kind required, for each continuous area and visually related areas.

Masonry Unit Characteristics: Provide units complying with standards referenced and requirements indicated.

BRICK:

Size: Unless otherwise indicated, provide bricks manufactured to the following actual dimensions:

Modular Standard: 2-1/4" x 3-3/4" x 7 5/8".

Utility: 3-1/2" x 3-1/2" x 3-1/2" x 11-1/2"

Provide special molded shapes where indicated and for application requiring brick of form, size and finish on exposed surfaces which cannot be produced from standard brick sizes by sawing.

For sills, caps and similar applications resulting in exposure of brick surfaces which otherwise would be concealed from view, provide uncured or unfroged units with all exposed surfaces finished.

Facing Brick: ASTM C 216, and as follows:

Grade SW - minimum average unit compressive strength: 3000 psi

Initial Rate of Absorption: Between 5 and 20 g/30 sq.in. (g/194 sq.cm) per minute when tested per ASTM C 67.

Efflorescence: Brick shall be rated "not effloresced" per ASTM C 67.

Type FBS - normal size and color variations.

Application - Use where brick is exposed, unless otherwise indicated.

Texture and Color - Match Architect's sample.

Wherever shown to "match existing", provide face brick of matching color, texture and size as existing adjacent brickwork.

Building Brick: ASTM C 62, and as follows:

Grade SW - minimum average unit compressive strength: 3000 psi

Application - Use where brick is indicated for concealed locations.

CONCRETE MASONRY UNITS:

Size: Manufacturer's standard units with nominal face dimensions of 16" long x 8" (15-5/8" x 7-5/8" actual), unless otherwise indicated.

Special Shapes: Provide where required for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions.

Hollow Loadbearing: Unless otherwise specified, all hollow concrete masonry units (load-bearing and non-load-bearing) shall conform to ASTM C 90 where shown and as follows:

Type I units with minimum average net area compressive strength of 1900 psi.

Weight Classifications: All units shall be lightweight units unless otherwise indicated. (95 lbs. per cu. ft. or more, oven dry weight of concrete).

Solid Loadbearing: ASTM C 145, where shown.

Type I units with minimum average net area compressive strength of 1800 psi.

Cure units in a moisture-controlled atmosphere or in an autoclave at normal pressure and temperature to comply with ASTM C 90, Type I.

Limit moisture absorption during delivery and until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the U.S. Weather Bureau Station nearest the project site.

Exposed Faces: Provide manufacturer's standard color and texture, unless otherwise indicated.

Fire Rated: All 8" block shall carry a 2-hr. minimum fire rating

MORTAR MATERIALS:

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

Hydrated Lime: ASTM C 207, Type S.

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

White Mortar Aggregates: Natural white sand or ground white stone.

Colored Mortar Pigments: Provide colored mortar for all exposed brick walls. Use mineral oxide or carbon black job site pigments. Use only pigments with record of satisfactory performance in masonry mortars. Limit the maximum percentage by weight of cement as follows:

Pigmented portland cement - lime mortar

Mineral oxide pigment	10%
Carbon black pigment	2%

Aggregate for Grout: ASTM C 404.

Water: Clean and potable.

MASONRY ACCESSORIES:

Horizontal Joint Reinforcing and Ties for Masonry:

Provide welded wire units prefabricated in straight lengths of not less than 10', with matching corner ("L") and intersecting ("T") units. Fabricate from cold-drawn steel wire complying with ASTM A 82, with deformed continuous side rods and plain cross rods, into units with widths of approximately 2" less than nominal width of walls and partitions as required to position side rods for full embedment in mortar with mortar coverage of not less than 5/8" on joint faces exposed to exterior and not less than 1/2" elsewhere.

Provide the following type of joint reinforcing unless otherwise indicated:

Truss type as indicated on drawings with diagonal cross rods spaced not more than 16" o.c.

Number of Side Rods: Single pair for single wythe masonry and as indicated for multi-wythe masonry, or if not otherwise indicated, one side rod for each brick wythe and one side rod for each face shell of each concrete masonry wythe.

For multi-wythe walls provide Seismic Dur-O-Eye as manufactured by DUR-O-WALL, Inc., or approved equal consisting of single pair of side rods, 14 ga. plate eyes and 11 ga. pintels spaced not more than 16" o.c. Space side rods for embedment within each face shell of back-up wythe and extend ties to within 1" of exterior face of facing wythe. Veneer shall be reinforce with Seismic Ladur joint reinforcing as manufactured by DUR-O-WALL, Inc., or approved equal consisting of two (2) parallel wires spaced 5/8 inch apart, out to out, and connected by cross-wires spaced at 16 inches maximum. This veneer joint reinforcing shall be mechanically connected to the each plate pintel.

Wire Sizes: Fabricate with 9-gage side and cross rods, unless otherwise indicated.

Wire Finish: Provide manufacturer's standard mill galvanized finish except as otherwise indicated.

For exterior walls hot-dip galvanize joint reinforcing, plate eyes, and pintels after fabrication to comply with ASTM A 153, Class B-2 coating (1.5 oz. per sq. ft.).

Individual Ties for Masonry:

Where brick anchors cannot be fabricated integrally with the block joint reinforcing and where approved by the Architect/Engineer, provide Seismic Dur-O-Eye D/A 5213 Veneer Anchors as manufactured by DIR-O-WALL, Inc., or approved equal. Fabricate eyes from 12 ga. plate and pintels from 11 ga. plate conforming to ASTM A-366 with 1.5 oz. zinc per sq. ft.

For interior walls, fabricate from steel with mill galvanized finish.

For exterior walls, fabricate from steel wire with 1.5 oz. hot-dip zinc coating, ASTM A 153 Class B-2, or fabricate from steel wire with not less than 7-mil copper coating, ASTM B 227, Grade 30 HS.

Anchors and Ties: Provide straps, bars, bolts and rods fabricated from not less than 16 ga. sheet metal or 3/8" diameter rod stock, unless otherwise indicated.

Vertical Bar Positioners for Reinforced Masonry

Provide welded wire units prefabricated to hold vertical reinforcing bars in position. Vertical bar positioners shall be placed at intervals not to exceed 48" O.C. vertically in each core containing reinforcing bars. Furnish D/A 811 as manufactured by Dur-O-Wall Inc. or approved equal. Positioners shall be manufactured with tabs to maintain alignment in cells.

Flexible Anchors: Where masonry is indicated to be anchored to structural framework with flexible anchors, provide 2-piece anchors which will permit horizontal and vertical movement of masonry but will provide lateral restraint.

For interior work, including devices which extend only into interior wythes of exterior masonry, fabricate from steel with mill galvanized or hot-dip coating.

For devices which extend into exterior wythe, fabricate from steel with hot-dip galvanized coating, ASTM A 153, Class B-2.

Flashings for Masonry:

Provide concealed flashings, shown to be built into masonry.

Provide concealed flashings as follows:

Copper: ASTM B 370, soft temper, 10 oz., uncoated copper for flashing fully concealed in masonry, 16 oz. elsewhere.

Fabricate through-wall metal flashings with deformations in both directions for integral mechanical mortar bond.

Virgin polyvinyl chloride with plasticizers and other modifiers, formed into uniform flexible sheets not less than 20-mils thick and black in color, unless otherwise indicated.

Miscellaneous Masonry Accessories:

Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60 for bars No. 3 to No. 18 (detailed and fabricated in accordance with latest edition of ACI 318 and 315).

Non-Metallic Expansion Joint Strips: Provide premolded compressible, elastic fillers of foam rubber, neoprene, or extruded plastic.

Bond Breaker Strips: 15-lb. asphalt roofing felt complying with ASTM D 226, or 15-lb., coal- tar roofing felt complying with ASTM D 227.

Premolded Control Joint Strips: Solid rubber strips with a Shore A durometer hardness of 60 to 80, designed to fit standard sash block and maintain lateral stability in masonry wall, size and configuration as indicated.

Weephole Cell Vents: Weephole cell vents shall be Hohmann & Barnard, Inc. #QV-Quadro Vent or equal. Color to match mortar.

Weephole Screen Material: Provide fibrous mesh of polyethylene at bottom of cavity to maintain drainage access to weepholes, equal to "Mortar Net" by AA Wire Products Company, 312-586-6700 or Mortar Net USA, 1-800-664-6638.

Insulation:

Extruded Polystyrene Board Insulation: Rigid, closed-cell, extruded polystyrene insulation board with integral high-density skin; complying with ASTM C 578, Type IV, min. 25 psi compressive strength; k-value of 0.20 at 75 degrees F mean temp.; 0.3% max. water absorption; 1.1 perm-inch max. water vapor transmission; manufacturer's standard lengths and widths. Thickness as indicated on drawings.

MORTAR AND GROUT MIXES:

Do not lower the freezing point of mortar by use of admixtures or anti-freeze agents.

Do not use calcium chloride in mortar or grout.

Mortar for Unit Masonry:

Comply with ASTM C 270, Proportion Specification, for types of mortar required, unless otherwise indicated.

Limit cementitious materials in mortar to portland cement-lime.

Use Type S Portland mortar for all masonry unless otherwise indicated.

Grout for Unit Masonry:

Comply with ASTM C 476 for grout for use in construction of reinforced and nonreinforced unit masonry. Grout shall attain a minimum compressive strength of 2500 psi at 28 days. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.

The allowable slump used for grouting concrete masonry units shall be between 8 and 10 inches.

Aggregates for grout shall meet the requirements of ASTM C 404, "Aggregates for Grout". Unless otherwise indicated, coarse aggregate grout shall be used to fill all grouted hollow core masonry units and bond beams.

PART 3 - EXECUTION

INSTALLATION, GENERAL:

Thickness: Build masonry construction to the full thickness shown, except, build single-wythe walls (if any) to the actual thickness of the masonry units, using units of normal thickness shown or specified.

Build chases and recesses as shown and as required for the work of other trades. Provide not less than 8" of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

Cut masonry units with motor-driven saw designed to cut masonry with clean sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining work neatly. Use full units without cutting wherever possible. Use dry cutting saws to cut concrete masonry units.

Wet clay brick which have ASTM C 67 initial rates of absorption (suction) of more than 30 grams per 30 sq. in. per minute. Use wetting methods which ensure that units are nearly saturated but surface dry when laid.

Match coursing, bonding, color and texture of new masonry work with existing work, where directed.

Do not wet concrete masonry units, unless as provided for under Hot Weather Protection.

Pattern Bond: Lay exposed masonry in the bond pattern shown, or if not shown, lay in running bond vertical joint in each course centered on units in courses above and below. Lay concealed masonry with all units in a wythe bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners, unless otherwise shown.

Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs and wherever possible at other locations.

Tolerances:

Erect masonry within the following tolerances from the specified dimensions:

Dimension of elements

In cross section or elevation..... -1/4 in. +1/2 in.

Mortar joint thickness

bed ±1/8 in.
head -1/4 in. +3/8 in.
collar -1/4 in. +3/8 in.
Grout space or cavity width -1/4 in. +3/8 in.

Thickness of bed joints shall not vary more than 1/16" over the length of the bed joint.

Elements

Variation from level

bed joints ±1/4 in. in 10 ft.
..... ±1/2 in. maximum
top surface of bearing walls ±1/4 in. in 10 ft.
..... ±1/2 in. maximum

Variation from plumb ±1/4 in. in 10 ft.
..... ±3/8 in. in 20 ft.
..... ±1/2 in. maximum

True to a line ±1/4 in. in 10 ft.
..... ±3/8 in. in 20 ft.
..... ±1/2 in. maximum

Alignment of columns & walls (bottom versus top)
..... ±1/2 in. for bearing walls
..... ±3/4 in. for nonbearing walls

Location of elements

Indicated in plan $\pm\frac{1}{2}$ in. in 20 ft.
..... $\pm\frac{3}{4}$ in. maximum

Indicated in elevation $\pm\frac{1}{4}$ in. in story height
..... $\pm\frac{3}{4}$ in. maximum

Tolerances for placing reinforcement

Tolerances for the placement of steel in walls and flexural elements shall be $\pm\frac{1}{2}$ in.

In walls, for vertical bars, 2 in. from the location along the length of the wall indicated on the project drawings.

If necessary to move bars to avoid interference with other reinforcing steel, conduits, or embedded items and bars are moved more than one bar diameter, or enough to exceed the specified tolerances, notify the Architect/Engineer for acceptance of the resulting arrangement of bars.

If the above conditions cannot be met due to previous construction, notify the Architect/ Engineer.

Stopping and Resuming Work: Rack back 1/2-masonry unit length in each course; do not tooth. Clean exposed surfaces of set masonry, and remove loose masonry units and mortar prior to laying fresh masonry.

Built-In Work: As the work progresses, build-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

Fill space between hollow metal frames and masonry solidly with mortar.

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.

Fill CMU cores with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar conditions unless otherwise indicated.

Intersecting walls shall be bonded at locations where they meet at corners or intersections by one of the following methods:

Bonding Pattern: Fifty percent of the units at the corner of intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than 3" on the unit below.

Steel Connectors: Block vertical joints with 8" maximum offset and provide rigid steel anchors spaced at not more than 48" o.c. vertically, or omit blocking and provide rigid steel anchors at not more than 24" o.c. vertically. Form rigid steel anchors of galvanized steel not less than 1 1/2" x 1/4" x 2' 0" long with ends turned up not less than 2" or with cross pins. End shall be embed in grout fill courses.

Joint Reinforcement: Walls shall be anchored by pre-fabricated "L" or "T" horizontal joint reinforcement spaced at a maximum distance of 8 inches. Joint reinforcement shall be at least W 1.7 and shall extend at least 30 inches in each direction at the corners or intersections.

Interior Nonbearing Walls: Interior nonbearing walls shall be anchored at their intersection or corners with prefabricated "L" or "T" horizontal joint reinforcement spaced at a maximum distance of 16 inches.

Joint reinforcement shall be at least W 1.7 and shall extend at least 30 inches in each direction at the corners or intersections.

Bond Beams: All bond beam reinforcing shall be continuous furnish corner bars at corners and intersections to match horizontal reinforcing shown.

Non-Loadbearing Interior Partition Walls: Build full height of story to underside of solid structure above, unless otherwise indicated.

MORTAR BEDDING AND JOINTING:

Lay brick and solid concrete masonry units with completely filled bed, head and collar joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and foundation walls and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or to be filled with concrete or grout. For starting courses on footings where cells are not grouted, spread out full mortar bed including areas under cells.

Joints: Construct bedjoint of the starting course of foundation with a thickness not less than 1/4 inch and not more than 3/4 inch. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not otherwise indicated, lay walls with 3/8" joints. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials. Tool exposed joints slightly concave using a jointer larger than joint thickness. Rake out mortar in preparation for application of caulking or sealants where shown. Remove masonry protrusions extending 1/2 inch or more into cells or cavities to be grouted.

Remove masonry units disturbed after laying; clean and relay in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

Collar Joints: Where filled collar joints are indicated, fill joints between wythes solidly with grout of the consistency indicated materials during construction. Strike joints facing cavity, flush.

Tie exterior wythe to back-up with individual metal ties spaced not more than 16" o.c. vertically and 24" o.c. horizontally. Stagger in alternate courses.

Tie exterior wythe to back-up with continuous horizontal joint reinforcing embedded in mortar joints at not more than 16" o.c. vertically.

Provide weepholes in exterior wythe of cavity, composite and veneer walls located immediately above all flashing, openings, and ledges spaced at 2'-0" o.c., unless otherwise indicated and fibrous mesh of polyethylene at bottom of cavity to maintain drainage access to weepholes, equal to "Mortar Net" by AA Wire Products Company, 312-586-6700 or Mortar Net USA, 1-800-664-6638. Provide flashing, weeps and mortar net at base of all walls, maximum 4" above grade.

STRUCTURAL BONDING OF MULTI- WYTHE MASONRY:

Use individual metal ties embedded in horizontal joints to bond wythes together. Provide ties as shown, but not less than one metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16" o.c. horizontally and vertically. Stagger ties in alternate courses. Provide additional ties within 1'-0" of all openings and space not more than 16" apart around perimeter of openings. At intersecting and abutting walls, provide ties at not more than 16" o.c. vertically.

Use continuous horizontal joint reinforcing embedded in horizontal joints for bond tie between wythes. Install at not more than 16" o.c. vertically as specified. Provide continuity at corners and intersections using prefabricated "L" and "T" units.

GROUT PLACEMENT:

Testing of grout shall be conducted by the designated testing agency in accordance with the requirements of ASTM C 1019 for each 5000 square feet of masonry wall surface.

Grout shall be poured in lifts not exceeding 5 feet in height. The top of all intermediate grout lifts shall stop 1-1/2 inches below course height of the block.

Consolidation of grout shall be at the time of placement and shall be conducted by mechanical vibration or puddling for lifts 12 inches or less in height. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred. Weepholes shall be created by weephole cell vents, color to match mortar.

CAVITY WALL AND MASONRY-CELL INSULATION:

On units of plastic insulation install small pads of mastic spaced approximately 1'-0" o.c. both ways on inside face, as recommended by manufacturer. 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.

HORIZONTAL JOINT REINFORCING:

Provide continuous horizontal joint reinforcing as shown and specified. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls and 1/2" at other locations. Lap reinforcement a minimum of 54 times the wire diameter if the splice is terminated inside a grouted cell. Otherwise, lap horizontal joint reinforcing a minimum of 75 times the wire diameter. Do not bridge control and expansion joints with reinforcing, unless otherwise indicated. Provide continuity at all corners and wall intersections by use of prefabricated "L" and "T" sections. "L" and "T" shall be placed in same course as continuous reinforcing. All bond beam horizontal reinforcing shall be continuous. Provide corner bars at all corners and intersections to match reinforcing shown. Cut and bend units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

Space "L" and "T" as indicated in other sections of this specification or as noted on drawing.

Space continuous horizontal reinforcing as follows:

For multi-wythe walls (solid or cavity) where continuous horizontal reinforcing acts as structural bond or tie between wythes, space reinforcing as required by code but not less than 16" o.c. vertically.

For single-wythe walls, space reinforcing at 16" o.c. vertically, unless otherwise indicated.

For parapets, space reinforcing at 8" o.c. vertically, unless otherwise indicated.

Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcing placed in 2 horizontal joints approximately 8" apart, both immediately above lintels and below sills. Extend reinforcing a minimum of 2'-0" beyond jambs of the opening, bridging control joints where provided.

VERTICAL REINFORCING

Provide continuous vertical reinforcing in the hollow masonry cores as shown and specified. Clean all reinforcement by removing mud, oil, or other materials that will adversely affect or reduce the bond at the time mortar or grout is placed. Reinforcement with rust, mill scale, or a combination of both will be accepted as being satisfactory without cleaning or brushing provided the dimensions and weights, including heights of deformations are not less than required by the ASTM specification covering this reinforcement in this specification.

Place reinforcement and accessories in accordance with the sizes, types, and locations indicated on the Project Drawings, and as specified. Do not place dissimilar metals in contact with each other.

Support and fasten reinforcement together to prevent displacement by construction loads or by placement of grout or mortar beyond the tolerances allowed herein. All reinforcing bars shall be tied together at splices with wire or other approved mechanical fastening system when the bars are placed. Vertical bar positioners shall be placed at the specified intervals. Maintain clear distance between reinforcing bars and any face of masonry unit or formed surface, as indicated on the Project Drawings, but not less than 1/4 in. for fine grout or 1/2 in. for coarse grout. Splice reinforcing bars only where indicated on the Project Drawings or on Approved Shop Drawings, unless directed by the Architect/ Engineer.

ANCHORING MASONRY WORK:

Provide anchoring devices of the type indicated. If not indicated, provide standard type for facing and back-up involved.

Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:

Provide an open space not less than 1" in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar or other rigid materials.

Anchor masonry to structural members with metal ties embedded in masonry joints and attached to structure.

Space anchors as shown, but not more than 16" o.c. vertically and 16" o.c. horizontally. Provide additional anchors within 1'-0" of openings and at intervals of not more than 8" around perimeter.

LINTELS:

Install loose lintels of steel and other materials where shown.

Provide masonry lintels where shown and wherever openings of more than 1'-0" are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Thoroughly cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

For hollow concrete masonry unit walls, use specially formed "U"-shaped lintel units with reinforcing bars placed as shown and filled with grout of consistency required to completely fill space between reinforcing bars and masonry unit.

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

CONTROL AND EXPANSION JOINTS:

Provide vertical expansion, control and isolation joints in masonry where shown or at a maximum spacing of 20'-0". Build-in related masonry accessory items as the masonry work progresses.

See Division-7 sections for "Joint Sealers".

Build-in joint fillers where shown, specified in a Division-7 section "Joint Sealers". Joint width for sealants: 3/8" unless otherwise indicated.

FLASHING OF MASONRY WORK:

Provide concealed flashings in masonry work at, or above, all shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place through-wall flashing on bed of mortar. Seal penetrations in flashing with mastic before covering with mortar. Cavities shall be free of mortar and furnished with weep hole screen material.

Extend flashings the full length of lintels and shelf angles and minimum of 4" into masonry each end. Extend flashing from a line 1/2" in from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form a pan.

Provide weepholes in the head joints of the same course of masonry bedded in the flashing mortar.

Weep hole shall be created by the omission of head joints and providing weep hole cell vents equal to Hohmann & Barnard, Inc. #QV-Quadro Vent.

Interlock end joints of deformed metal flashings by overlapping deformations not less than 1-1/2" and seal lap with elastic sealant.

Install flashings in accordance with manufacturer's instructions.

Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

REPAIR, POINTING AND CLEANING:

Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of caulking or sealant compounds.

Clean exposed brick masonry surfaces by the bucket and brush hand cleaning method or by high pressure water method. Comply with requirements of BIA Technical Notes No. 20 "Cleaning Brick Masonry".

Clean exposed CMU masonry by dry brushing at the end of each day's work and after final pointing to remove mortar spots and droppings. Comply with recommendations in NCMA TEK Bulletin No. 28.

QUALITY CONTROL TESTING DURING CONSTRUCTION:

The contractor will employ a testing laboratory to perform all test and to submit test reports.

Sampling and testing for quality control during placement of grout shall include the following, unless otherwise directed by architect.

Slump: Measure and record the slump in accordance with the requirements of ASTM C143.

Compression Test Specimen: Each grout specimen shall have a square cross section of 3" or larger on the sides and twice as high as its width. Dimensional tolerance shall be within 5% of the nominal width selected.

The specimens shall constitute one sample to be tested at each age of test.

Procedure for making specimens shall be in accordance with ASTM C1019.

Compressive Strength Tests: ASTM C39 a minimum of 7 specimens shall be taken on masonry grout and shall constitute a set. One set of specimens shall be taken from each 100 cu. yds. or fraction thereof placed in any one day or for each 5000 sq. ft. of surface area of wall placed, 3 specimens to be tested at 7 days, 3 specimens to be tested at 28 days and 1 specimen retained in reserve for later testing if required.

Strength level of grout will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.

Test results will be reported in writing to Architect and Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of grout placement, name of testing service, grout type and class, location of grout batch in structure, design compressive strength at 28 days, grout mix proportions and materials; compressive breaking strength and type of break for both 7 - day tests and 28 - day tests.

Additional Tests: The testing service will make additional tests of in-place grout when test results indicate specified grout strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of grout by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable grout is verified.

END OF SECTION 04200

SECTION 04800 – UNIT MASONRY

Split Faced Block

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-I Specifications sections, apply to work of this section.

Related sections:

Section 01020 - Allowances.

DESCRIPTION OF WORK:

Extent of each type of masonry work is indicated on drawings and schedule.

QUALITY ASSURANCE:

Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:

ACI 530-92 "Building Code Requirements for Masonry Structures."

ACI 530.1-92 "Specifications for Masonry Structures."

ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures."

ACI 117-90 "Standard Specifications for Tolerances for Concrete Construction and Materials."

Concrete Reinforcing Steel Institute, "Manual of Standard Practice."

Concrete Testing Service: Employ, at Contractor's expense a testing laboratory acceptable to Architect to perform material evaluation tests and to design concrete grout or mortar mixes.

System Performance Requirements: Provide unit masonry and mortar that develops the following minimum installed net area compressive strength $f'_m = 1500$ psi

Materials and installed work may require testing and retesting, as directed by the Architect/Engineer, at anytime during progress of work. Allow free access to material stockpiles and facilities. Tests required to document submittals, certify product compliance with these Specifications prior to use in construction, establish mix designs, provide acceptability of changes requested by the Contractor shall be performed by accepted independent laboratories under Contractor's responsibility. Tests, not specifically indicated to be done at Owner's expense, including retesting of rejected materials and installed work, shall be done at Contractor's expense.

Concrete Masonry Unit Tests: For each different concrete masonry unit indicated, units shall be tested for strength, absorption, and moisture content per ASTM C 140.

Prism tests: for each type of wall construction indicated, masonry prisms will be tested per ASTM E-447, Method B.

Mortar properties: shall be tested per property specification of ASTM C 270.

Mortar composition and properties: will be evaluated per ASTM C 780.

Grout compressive strength: will be tested per ASTM C -1019.

Fire Performance Characteristics: Where fire-resistance ratings are indicated for unit masonry work, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E 119 by a recognized testing and inspecting organization or by another means, as acceptable to authority having jurisdiction.

Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

Field Constructed Mock-Ups: Prior to installation of masonry work, erect sample wall panels representative of completed masonry work required for project with respect to qualities of appearance, materials and construction. Locate mock-ups on site in locations indicated or, if not indicated, as directed by Architect/Engineer. Retain mock-ups during construction as standard for judging completed masonry work. For the following types of masonry, build mock-ups which are approximately 4' long by 4' high by full thickness, including face and backup wythes as well as accessories. At the direction of the Architect/Engineer, several wall panels may be required to represent each of the following conditions:

Each type of exposed unit masonry construction.

Typical exterior wall with split faced.

The Architect/Engineer shall be notified a week in advance of the dates and times when the mock-ups will be erected. Mock-ups shall be maintained during construction in undisturbed condition as standard for judging completed unit masonry construction, and shall be protected with a weather-resistant membrane. When directed, demolish mock-ups and remove from site.

Where masonry is to match existing, erect panels parallel to existing surface.

SUBMITTALS:

Product Data: Submit manufacturer's product data for each type of masonry unit, accessory, and other manufactured products, including certifications that each type complies with specified requirements.

Samples: For verification purposes submit the following:

Split Faced Samples for each type required. Include in each set the full range of exposed color and texture to be expected in the completed work.

Colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.

Laboratory Test Reports: Submit laboratory test reports for masonry materials and mix design tests as specified.

JOB CONDITIONS

Protection of Work: During erection, cover top of walls with waterproof sheeting at end of each days' work. Cover partially completed structures when work is not in progress.

Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns.

Do not apply concentrated loads for at least 3 days after building masonry walls or columns.

Staining: Prevent grout or mortar or soil from staining the face of masonry to be left exposed or painted. Remove immediately grout or mortar in contact with such masonry. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

Protect sills, ledges and projections from droppings of mortar.

HOT WEATHER PROTECTION:

During periods of hot weather as defined by ACI 530.1/ASCE 6/TMS 602, above 90 degrees F with wind greater than 8 mph, the following precautions shall be taken:

Store masonry, brick and sand in cool or shade areas to control heat gain.

Maintain temperature of mortar and grout between 70°F and 120°F. Cold water may be used.

Limit open mortar beds to no longer than 4 feet and set units within one minute of spreading mortar. Mortar with high water retention is desirable.

Protect wall from rapid evaporation by covering, fogging, damp curing or other means.

Masonry units with high suction (IRA over 30 g/min/30 in²) should be properly wetted prior to use.

Concrete masonry units may be wetted during these conditions. Units shall not be saturated, surface wet only. Drying time of units must be within 2 hours after wetting.

COLD WEATHER PROTECTION:

Do not lay masonry units which are wet or frozen.

Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch.

Remove all masonry determined to be damaged by freezing conditions.

For clay units with initial rates of absorption (suction) which requires them to be wetted before laying, comply with the following requirements.

For units with surface temperatures above 32 degrees F (0 degrees C), wet with water heated to above 70 degrees F (21 degrees C).

For units with surface temperatures below 32 degrees F (0 degrees C), wet with water heated to above 130 degrees F (54 degrees C).

Perform the following construction procedures while masonry work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation except for grout. For grout, temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 10 degrees F (6 degrees C).

Mortar: Heat mixing water to produce mortar temperature between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).

Grout: Follow normal masonry procedures.

32 degrees F (0 degrees C) to 25 degrees F (-4 degrees C):

Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.

Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of work day.

25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C):

Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C); maintain temperature of mortar on boards above freezing.

Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of work day.

Heat both sides of walls under construction using salamanders or other heat sources.

Use windbreaks or enclosures when wind is in excess of 15 mph.

20 degrees F (-7 degrees C) and below:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C).

Grout: Heat grout materials to 90 degrees F (32 degrees C) to produce in-place grout temperature of 70 degrees F (21 degrees C) at end of work day.

Heat masonry units so that they are above 20 degrees F (-7 degrees C) at time of laying.

Provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4 degrees C) for 24 hours after laying units.

Do not heat water for mortar and grout to above 160 degrees F (71 degrees C).

Protect completed masonry and masonry not being worked on in the following manner. Temperature ranges indicated apply to mean daily air temperatures except for grouted masonry. For grouted masonry temperature ranges apply to anticipated minimum night temperatures.

40 degrees F (4 degrees C) to 32 degrees F (0 degrees C):

Protect masonry from rain or snow for at least 24 hours by covering with weather-resistive membrane.

32 degrees F (0 degrees C) to 20 degrees F (-7 degrees C):

Completely cover masonry with weather- resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.

20 degrees F (-7 degrees C) and below:

Except as otherwise indicated, maintain masonry temperature above 32 degrees F (0 degrees C) for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 40 degrees F (4 degrees C) for 48 hours.

PART 2 - PRODUCTS

MASONRY UNITS, GENERAL:

Manufacturer: Obtain masonry units from on manufacturer, of uniform texture and color for each kind required, for each continuous area and visually related areas.

Masonry Unit Characteristics: Provide units complying with standards referenced and requirements indicated.

Size: Unless otherwise indicated, provide blocks manufactured to the following actual dimensions:

Texture and Color - Match Architect's sample.

Wherever shown to "match existing", provide face block of matching color, texture and size as existing adjacent brickwork.

DECORATIVE CONCRETE MASONRY SPLIT FACED UNITS:

ASTM C55-85 Standard Specification for Concrete Building Brick:

1. Unit Compressive Strength: Provide units with minimum average gross area compressive strength of 3000 PSI.
2. Weight Classification: Normal weight.
3. Provide Type I, moisture-controlled units
4. Test Method C426.
5. Size: Nominal 16" Long x 8" (15 5/8" x 7 5/8" actual) unless otherwise indicated.

Sample and test in accordance with Method C140.

Weight Classifications: All units shall be normal weight units unless otherwise indicated. (125 lbs. per cu. ft. or more, oven dry weight of concrete).

Finish: Exposed faces of the following general description, pattern and texture: Normal weight aggregate, split-faced finish as shown on drawings.

Integral Water Repellant: Provide units made with liquid polymeric, integral water repellant admixture that does not reduce flexural bond strength. Units made with integral water repellant, when tested as a wall assemble made with mortar containing integral water repellant manufacturers's mortar additive

according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.

Products: Subject to compliance with requirements, provide on the following:

1. Dry-Block; W.R. Grace and Company
2. Rheopel; Master Builders

Fire Rated: All Block shall carry a 2 hour minimum fire rating.

MORTAR MATERIALS:

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

Hydrated Lime: ASTM C 207, Type S.

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

White Mortar Aggregates: Natural white sand or ground white stone.

Colored Mortar Pigments: Provide colored mortar for all exposed brick walls. Use mineral oxide or carbon black job site pigments. Use only pigments with record of satisfactory performance in masonry mortars. Limit the maximum percentage by weight of cement as follows:

Pigmented portland cement - lime mortar

Mineral oxide pigment	10%
Carbon black pigment	2%

Aggregate for Grout: ASTM C 404.

Water: Clean and potable.

MASONRY ACCESSORIES:

Horizontal Joint Reinforcing and Ties for Masonry:

Provide welded wire units prefabricated in straight lengths of not less than 10', with matching corner ("L") and intersecting ("T") units. Fabricate from cold-drawn steel wire complying with ASTM A 82, with deformed continuous side rods and plain cross rods, into units with widths of approximately 2" less than nominal width of walls and partitions as required to position side rods for full embedment in mortar with mortar coverage of not less than 5/8" on joint faces exposed to exterior and not less than 1/2" elsewhere.

Provide the following type of joint reinforcing unless otherwise indicated:

Truss type as indicated on drawings with diagonal cross rods spaced not more than 16" o.c.

Number of Side Rods: Single pair for single wythe masonry and as indicated for multi-wythe masonry, or if not otherwise indicated, one side rod for each brick wythe and one side rod for each face shell of each concrete masonry wythe.

For multi-wythe walls provide Seismic Dur-O-Eye as manufactured by DUR-O-WALL, Inc., or approved equal consisting of single pair of side rods, 14 ga. plate eyes and 11 ga. pintels spaced not more than 16" o.c. Space side rods for embedment within each face shell of back-up wythe and extend ties to within 1"

of exterior face of facing wythe. Veneer shall be reinforce with Seismic Ladur joint reinforcing as manufactured by DUR-O-WALL, Inc., or approved equal consisting of two (2) parallel wires spaced 5/8 inch apart, out to out, and connected by cross-wires spaced at 16 inches maximum. This veneer joint reinforcing shall be mechanically connected to the each plate pintel.

Wire Sizes: Fabricate with 9-gage side and cross rods, unless otherwise indicated.

Wire Finish: Provide manufacturer's standard mill galvanized finish except as otherwise indicated.

For exterior walls hot-dip galvanize joint reinforcing, plate eyes, and pintels after fabrication to comply with ASTM A 153, Class B-2 coating (1.5 oz. per sq. ft.).

Flashings for Masonry:

Provide concealed flashings, shown to be built into masonry.

Provide concealed flashings as follows:

Copper: ASTM B 370, soft temper, 10 oz., uncoated copper for flashing fully concealed in masonry, 16 oz. elsewhere.

Fabricate through-wall metal flashings with deformations in both directions for integral mechanical mortar bond.

Virgin polyvinyl chloride with plasticizers and other modifiers, formed into uniform flexible sheets not less than 20-mils thick and black in color, unless otherwise indicated.

Miscellaneous Masonry Accessories:

Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60 for bars No. 3 to No. 18 (detailed and fabricated in accordance with latest edition of ACI 318 and 315).

Non-Metallic Expansion Joint Strips: Provide premolded compressible, elastic fillers of foam rubber, neoprene, or extruded plastic.

Bond Breaker Strips: 15-lb. asphalt roofing felt complying with ASTM D 226, or 15-lb., coal- tar roofing felt complying with ASTM D 227.

Premolded Control Joint Strips: Solid rubber strips with a Shore A durometer hardness of 60 to 80, designed to fit standard sash block and maintain lateral stability in masonry wall, size and configuration as indicated.

Weephole Cell Vents: Weephole cell vents shall be Hohmann & Barnard, Inc. #QV-Quadro Vent or equal. Color to match mortar.

Weephole Screen Material: Provide fibrous mesh of polyethylene at bottom of cavity to maintain drainage access to weepholes, equal to "Mortar Net" by AA Wire Products Company, 312-586-6700 or Mortar Net USA, 1-800-664-6638.

Insulation: (if applicable)

Loose Granular EPS Insulation: Expanded polystyrene complying with ASTM C 578; k-value not more than 0.22 at 75 degrees F mean temp.

Extruded Polystyrene Board Insulation: Rigid, closed-cell, extruded polystyrene insulation board with integral high-density skin; complying with ASTM C 578, Type IV, min. 25 psi compressive strength; k-value of 0.20 at 75 degrees F mean temp.; 0.3% max. water absorption; 1.1 perm-inch max. water vapor transmission; manufacturer's standard lengths and widths.

MORTAR AND GROUT MIXES:

Do not lower the freezing point of mortar by use of admixtures or anti-freeze agents.

Do not use calcium chloride in mortar or grout.

Mortar for Unit Masonry:

Comply with ASTM C 270, Proportion Specification, for types of mortar required, unless otherwise indicated.

Limit cementitious materials in mortar to portland cement-lime.

Use Type S Portland mortar for all masonry unless otherwise indicated.

Grout for Unit Masonry:

Comply with ASTM C 476 for grout for use in construction of reinforced and nonreinforced unit masonry. Grout shall attain a minimum compressive strength of 2500 psi at 28 days. Use grout of consistency indicated or if not otherwise indicated, of consistency (fine or coarse) at time of placement which will completely fill all spaces intended to receive grout.

The allowable slump used for grouting concrete masonry units shall be between 8 and 10 inches.

Aggregates for grout shall meet the requirements of ASTM C 404, "Aggregates for Grout". Unless otherwise indicated, course aggregate grout shall be used to fill all grouted hollow core masonry units and bond beams.

PART 3 - EXECUTION

INSTALLATION, GENERAL:

Thickness: Build masonry construction to the full thickness shown, except, build single-wythe walls (if any) to the actual thickness of the masonry units, using units of normal thickness shown or specified.

Build chases and recesses as shown and as required for the work of other trades. Provide not less than 8" of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

Cut masonry units with motor-driven saw designed to cut masonry with clean sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining work neatly. Use full units without cutting wherever possible. Use dry cutting saws to cut concrete masonry units.

Match coursing, bonding, color and texture of new masonry work with existing work, where directed.

Do not wet concrete masonry units, unless as provided for under Hot Weather Protection.

Pattern Bond: Lay exposed masonry in the bond pattern shown, or if not shown, lay in running bond vertical joint in each course centered on units in courses above and below. Lay concealed masonry with

all units in a wythe bonded by lapping not less than 2". Bond and interlock each course of each wythe at corners, unless otherwise shown.

Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs and wherever possible at other locations.

Tolerances:

Erect masonry within the following tolerances from the specified dimensions:

Dimension of elements

In cross section or elevation..... -1/4 in. +1/2 in.

Mortar joint thickness

bed ±1/8 in.
head -1/4 in. +3/8 in.
collar -1/4 in. +3/8 in.

Grout space or cavity width -1/4 in. +3/8 in.

Thickness of bed joints shall not vary more than 1/16" over the length of the bed joint.

Elements

Variation from level

bed joints ±1/4 in. in 10 ft.
..... ±½ in. maximum

top surface of bearing walls ±1/4 in. in 10 ft.
..... ±½ in. maximum

Variation from plumb ±1/4 in. in 10 ft.
..... ±3/8 in. in 20 ft.
..... ±½ in. maximum

True to a line ±1/4 in. in 10 ft.
..... ±3/8 in. in 20 ft.
..... ±½ in. maximum

Alignment of columns & walls (bottom versus top)

..... ±½ in. for bearing walls
..... ±3/4 in. for nonbearing walls

Location of elements

Indicated in plan ±½ in. in 20 ft.
..... ±3/4 in. maximum

Indicated in elevation ±1/4 in. in story height
..... ±3/4 in. maximum

Tolerances for placing reinforcement

Tolerances for the placement of steel in walls and flexural elements shall be $\pm\frac{1}{2}$ in.

In walls, for vertical bars, 2 in. from the location along the length of the wall indicated on the project drawings.

If necessary to move bars to avoid interference with other reinforcing steel, conduits, or embedded items and bars are moved more than one bar diameter, or enough to exceed the specified tolerances, notify the Architect/Engineer for acceptance of the resulting arrangement of bars.

If the above conditions cannot be met due to previous construction, notify the Architect/ Engineer.

Stopping and Resuming Work: Rack back 1/2-masonry unit length in each course; do not tooth. Clean exposed surfaces of set masonry, and remove loose masonry units and mortar prior to laying fresh masonry.

Built-In Work: As the work progresses, built-in items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

Fill space between hollow metal frames and masonry solidly with mortar.

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.

Fill CMU cores with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar conditions unless otherwise indicated.

Intersecting walls shall be bonded at locations where they meet at corners or intersections by one of the following methods:

Bonding Pattern: Fifty percent of the units at the corner of intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than 3" on the unit below.

Steel Connectors: Block vertical joints with 8" maximum offset and provide rigid steel anchors spaced at not more than 48" o.c. vertically, or omit blocking and provide rigid steel anchors at not more than 24" o.c. vertically. Form rigid steel anchors of galvanized steel not less than 1 1/2" x 1/4" x 2' 0" long with ends turned up not less than 2" or with cross pins. End shall be embed in grout fill courses.

Joint Reinforcement: Walls shall be anchored by pre-fabricated "L" or "T" horizontal joint reinforcement spaced at a maximum distance of 8 inches. Joint reinforcement shall be at least W 1.7 and shall extend at least 30 inches in each direction at the corners or intersections.

Interior Nonbearing Walls: Interior nonbearing walls shall be anchored at their intersection or corners with prefabricated "L" or "T" horizontal joint reinforcement spaced at a maximum distance of 16 inches. Joint reinforcement shall be at least W 1.7 and shall extend at least 30 inches in each direction at the corners or intersections.

Bond Beams: All bond beam reinforcing shall be continuous furnish corner bars at corners and intersections to match horizontal reinforcing shown.

Non-Loadbearing Interior Partition Walls: Build full height of story to underside of solid structure above, unless otherwise indicated.

MORTAR BEDDING AND JOINTING:

Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course on footings and foundation walls and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or to be filled with concrete or grout. For starting courses on footings where cells are not grouted, spread out full mortar bed including areas under cells.

Joints: Construct bedjoint of the starting course of foundation with a thickness not less than 1/4 inch and not more than 3/4 inch. Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not otherwise indicated, lay walls with 3/8" joints. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials. Tool exposed joints slightly concave using a jointer larger than joint thickness. Rake out mortar in preparation for application of caulking or sealants where shown. Remove masonry protrusions extending 1/2 inch or more into cells or cavities to be grouted.

Remove masonry units disturbed after laying; clean and relay in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

Collar Joints: Where filled collar joints are indicated, fill joints between wythes solidly with grout of the consistency indicated materials during construction. Strike joints facing cavity, flush.

Tie exterior wythe to back-up with individual metal ties spaced not more than 16" o.c. vertically and 24" o.c. horizontally. Stagger in alternate courses.

Tie exterior wythe to back-up with continuous horizontal joint reinforcing embedded in mortar joints at not more than 16" o.c. vertically.

Provide weepholes in exterior wythe of cavity, composite and veneer walls located immediately above ledges and flashing, spaced 2'-0" o.c., unless otherwise indicated.

STRUCTURAL BONDING OF MULTI- WYTHE MASONRY:

Use individual metal ties embedded in horizontal joints to bond wythes together. Provide ties as shown, but not less than one metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16" o.c. horizontally and vertically. Stagger ties in alternate courses. Provide additional ties within 1'-0" of all openings and space not more than 16" apart around perimeter of openings. At intersecting and abutting walls, provide ties at not more than 16" o.c. vertically.

Use continuous horizontal joint reinforcing embedded in horizontal joints for bond tie between wythes. Install at not more than 16" o.c. vertically as specified. Provide continuity at corners and intersections using prefabricated "L" and "T" units.

GROUT PLACEMENT:

Testing of grout shall be conducted by the designated testing agency in accordance with the requirements of ASTM C 1019 for each 5000 square feet of masonry wall surface.

Grout shall be poured in lifts not exceeding 5 feet in height. The top of all intermediate grout lifts shall stop 1-1/2 inches below course height of the block.

Consolidation of grout shall be at the time of placement and shall be conducted by mechanical vibration or puddling for lifts 12 inches or less in height. Consolidate pours exceeding 12 inches in height by

mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred. Weepholes shall be created by weephole cell vents, color to match mortar.

CAVITY WALL AND MASONRY-CELL INSULATION:

Foam insulation designed for use in concrete block walls and cavities in commercial structures, PolyMaster R-501, Thermco or equal.

HORIZONTAL JOINT REINFORCING:

Provide continuous horizontal joint reinforcing as shown and specified. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 5/8" on exterior side of walls and 1/2" at other locations. Lap reinforcement a minimum of 54 times the wire diameter if the splice is terminated inside a grouted cell. Otherwise, lap horizontal joint reinforcing a minimum of 75 times the wire diameter. Do not bridge control and expansion joints with reinforcing, unless otherwise indicated. Provide continuity at all corners and wall intersections by use of prefabricated "L" and "T" sections. "L" and "T" shall be placed in same course as continuous reinforcing. All bond beam horizontal reinforcing shall be continuous. Provide corner bars at all corners and intersections to match reinforcing shown. Cut and bend units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.

Space "L" and "T" as indicated in other sections of this specification or as noted on drawing.

Space continuous horizontal reinforcing as follows:

For multi-wythe walls (solid or cavity) where continuous horizontal reinforcing acts as structural bond or tie between wythes, space reinforcing as required by code but not less than 16" o.c. vertically.

For single-wythe walls, space reinforcing at 16" o.c. vertically, unless otherwise indicated.

For parapets, space reinforcing at 8" o.c. vertically, unless otherwise indicated.

Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcing placed in 2 horizontal joints approximately 8" apart, both immediately above lintels and below sills. Extend reinforcing a minimum of 2'-0" beyond jambs of the opening, bridging control joints where provided.

VERTICAL REINFORCING

Provide continuous vertical reinforcing in the hollow masonry cores as shown and specified. Clean all reinforcement by removing mud, oil, or other materials that will adversely affect or reduce the bond at the time mortar or grout is placed. Reinforcement with rust, mill scale, or a combination of both will be accepted as being satisfactory without cleaning or brushing provided the dimensions and weights, including heights of deformations are not less than required by the ASTM specification covering this reinforcement in this specification.

Place reinforcement and accessories in accordance with the sizes, types, and locations indicated on the Project Drawings, and as specified. Do not place dissimilar metals in contact with each other.

Support and fasten reinforcement together to prevent displacement by construction loads or by placement of grout or mortar beyond the tolerances allowed herein. All reinforcing bars shall be tied together at splices with wire or other approved mechanical fastening system when the bars are placed. Vertical bar positioners shall be placed at the specified intervals. Maintain clear distance between reinforcing bars and any face of masonry unit or formed surface, as indicated on the Project Drawings, but not less than 1/4 in. for fine grout or 1/2 in. for coarse grout. Splice reinforcing bars only where indicated on the Project Drawings or on Approved Shop Drawings, unless directed by the Architect/ Engineer.

ANCHORING MASONRY WORK:

Provide anchoring devices of the type indicated. If not indicated, provide standard type for facing and back-up involved.

Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:

Provide an open space not less than 1" in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar or other rigid materials.

Anchor masonry to structural members with metal ties embedded in masonry joints and attached to structure.

Space anchors as shown, but not more than 16" o.c. vertically and 16" o.c. horizontally. Provide additional anchors within 1'-0" of openings and at intervals of not more than 8" around perimeter.

LINTELS:

Install loose lintels of steel and other materials where shown.

Provide masonry lintels where shown and wherever openings of more than 1'-0" are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Thoroughly cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

For hollow concrete masonry unit walls, use specially formed "U"-shaped lintel units with reinforcing bars placed as shown and filled with grout of consistency required to completely fill space between reinforcing bars and masonry unit.

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

CONTROL AND EXPANSION JOINTS:

Provide vertical expansion, control and isolation joints in masonry where shown or at a maximum spacing of 20'-0". Build-in related masonry accessory items as the masonry work progresses.

See Division-7 sections for "Joint Sealers".

Build-in joint fillers where shown, specified in a Division-7 section "Joint Sealers". Joint width for sealants: 3/8" unless otherwise indicated.

FLASHING OF MASONRY WORK:

Provide concealed flashings in masonry work at, or above, all shelf angles, lintels, ledges and other obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Prepare masonry surfaces smooth and free from projections which could puncture flashing. Place through-wall flashing on bed of mortar. Seal penetrations in flashing with mastic before covering with mortar. Cavities shall be free of mortar and furnished with weephole screen material.

Extend flashings the full length of lintels and shelf angles and minimum of 4" into masonry each end. Extend flashing from a line 1/2" in from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4", and through the inner wythe to within 1/2" of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2". At heads and sills turn up ends not less than 2" to form a pan.

Provide weepholes in the head joints of the same course of masonry bedded in the flashing mortar. Weephole shall be created by the omission of head joints and providing weephole cell vents equal to Hohmann & Barnard, Inc. #QV-Quadro Vent.

Interlock end joints of deformed metal flashings by overlapping deformations not less than 1-1/2" and seal lap with elastic sealant.

Install flashings in accordance with manufacturer's instructions.

Install reglets and nailers for flashing and other related work where shown to be built into masonry work.

REPAIR, POINTING AND CLEANING:

Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

Pointing: During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of caulking or sealant compounds.

Clean exposed brick masonry surfaces by the bucket and brush hand cleaning method or by high pressure water method. Comply with requirements of BIA Technical Notes No. 20 "Cleaning Brick Masonry".

Clean exposed CMU masonry by dry brushing at the end of each day's work and after final pointing to remove mortar spots and droppings. Comply with recommendations in NCMA TEK Bulletin No. 28.

QUALITY CONTROL TESTING DURING CONSTRUCTION:

The contractor will employ a testing laboratory to perform all test and to submit test reports.

Sampling and testing for quality control during placement of grout shall include the following, unless otherwise directed by architect.

Slump: Measure and record the slump in accordance with the requirements of ASTM C143.

Compression Test Specimen: Each grout specimen shall have a square cross section of 3" or larger on the sides and twice as high as its width. Dimensional tolerance shall be within 5% of the nominal width selected.

The specimens shall constitute one sample to be tested at each age of test.

Procedure for making specimens shall be in accordance with ASTM C1019.

Compressive Strength Tests: ASTM C39 a minimum of 7 specimens shall be taken on masonry grout and shall constitute a set. One set of specimens shall be taken from each 100 cu. yds. or fraction thereof placed in any one day or for each 5000 sq. ft. of surface area of wall placed, 3 specimens to be tested at 7 days, 3 specimens to be tested at 28 days and 1 specimen retained in reserve for later testing if required.

Strength level of grout will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.

Test results will be reported in writing to Architect and Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of grout placement, name of testing service, grout type and class, location of grout batch in structure, design compressive strength at 28 days, grout mix proportions and materials; compressive breaking strength and type of break for both 7 - day tests and 28 - day tests.

Additional Tests: The testing service will make additional tests of in-place grout when test results indicate specified grout strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of grout by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable grout is verified.

PolyMaster R-501 foam insulation is a cost-effective, environmentally green thermal and acoustical insulation that is designed for use in concrete block walls and cavities in commercial structures. PolyMaster R-501 yields an R-4.6 per inch.

END OF SECTION 04800

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of structural steel work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.

Structural steel is that work defined in AISC "Code of Standard Practice" and as otherwise shown on drawings.

Miscellaneous Metal Fabrications are specified elsewhere in Division 5.

QUALITY ASSURANCE:

Codes and Standards: Comply with provisions of following, except as otherwise indicated:

AISC "Code of Standard Practice for Steel Buildings and Bridges".

AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued.

AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

AWS D1.1 "Structural Welding Code".

ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".

Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.

If recertification of welders is required, retesting will be Contractor's responsibility.

CERTIFICATION:

Fabricator for structural steel shall be certified by AISC as a Group II Fabricator: Complex steel Building Structures, under the AISC Quality Certification Program. No part of the structural fabrication may be subcontracted to a shop which does not maintain a minimum of Group II AISC Certification without the prior written consent of the structural engineer.

If a fabricator is not certified by AISC they may request to be pre-approved by the Architect or Engineer prior to bidding. The Architect or Engineer shall visit the fabricator's facility to observe the fabricators operation to include facilities, testing, and quality control. The fabricator requesting pre-approval shall be responsible for all cost incurred by the Architect or Engineer associated with this request.

SUBMITTALS:

Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.

High-strength bolts (each type), including nuts and washers.

Structural steel primer paint.

Shrinkage-resistant grout.

Shop Drawings: Submit shop drawings prepared under supervision of a registered professional engineer, including complete details and schedules for fabrication and assembly of structural steel members procedures and diagrams.

Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld.

Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages to be installed by others.

Test Reports: Submit copies of reports of tests conducted on shop and field bolted and welded connections. Include data on type (s) of tests conducted and test results.

DELIVERY, STORAGE AND HANDLING:

Deliver materials to site at such intervals to insure uninterrupted progress of work.

Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay work.

Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

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.

PART 2 - PRODUCTS

MATERIALS:

Metal Surfaces, General: For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

Structural Steel Shapes, Plates and Bars: ASTM A572, Grade 50.

Cold-Formed Steel Tubing: ASTM A 500, Grade B.

Hot-Formed Steel Tubing: ASTM A 501.

Steel Pipe: ASTM A 53, Type E or S, Grade B.

Anchor Bolts: ASTM F1554 (with S1 supplement), grade as indicated.

Provide hexagonal heads and nuts for all connections.

High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:

Electrodes for Welding: Comply with AWS Code.

Structural Steel Primer Paint: Fabricator's standard rust-inhibiting primer.

Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean, uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum water required for placement and hydration.

Non-metallic Shrinkage-Resistant Grout: Pre-mixed, non-metallic, non-corrosive, non-staining product containing selected silica sands, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents, complying with CRD-C621.

Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

Euco N.C.; Euclid Chemical Co.
Crystex; L&M Construction Chemicals
Masterflow 713; Master Builders
Five Star Grout; U.S. Grout Corp.
Upcon; Upco Chem. Div., USM Corp.
Propak; Protex Industries, Inc.

FABRICATION:

Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings. Provide camber in structural members where indicated.

Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A 325.

Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.

Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

Connections: Weld or bolt shop connections, as indicated.

Bolt field connections, except where welded connections or other connections are indicated.

Provide high-strength threaded fasteners for principal bolted connections.

Provide unfinished threaded fasteners for only bolted connections of secondary framing members to primary members (including purlins, girts, and other framing members taking only nominal stresses) and for temporary bracing to facilitate erection.

High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" (RCRBSJ).

Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.

Assemble and weld built-up sections by methods which will produce true alignment of axes without warp.

Steel Wall Framing: Select members which are true and straight for fabrication of steel wall framing.

Build up welded door frames attached to structural steel framing. Weld exposed joints continuously and grind smooth. Plug weld steel bar stops to frames, except where shown removable. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10" o.c., unless otherwise indicated.

Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings.

Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.

SHOP PAINTING:

General: Shop paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel which is partially exposed on exposed portions and initial 2" of embedded areas only. Structural steel items that are to have fireproofing applied shall be unpainted and unprimed (coordinate with architectural).

Apply 2 coats of paint to surfaces which are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

Surface Preparation: After inspection and before shipping, clean steelwork to be painted. Remove loose rust, loose mill scale, and spatter, slag or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) as follows:

SP-1 "Solvent Cleaning".

SP-2 "Hand Tool Cleaning".

SP-3 "Power Tool Cleaning".

SP-7 "Brush-off Blast Cleaning".

Painting: Immediately after surface preparation, apply structural steel primer paint in accordance with manufacturer's instructions and at a rate to provide dry film thickness of not less than 1.5 mils. Use painting methods which result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 _ EXECUTION

ERECTION:

Surveys: Employ a registered professional engineer or land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect. Do not proceed

with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Architect.

Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.

Temporary Planking: Provide temporary planking and working platforms as necessary to effectively complete work.

Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work.

Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.

Refer to Division 3 of these specifications for anchor bolt installation requirements in concrete, and Division 4 for masonry installation.

Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

Set loose and attached base plates and bearing plates for structural members on wedges or other adjusting devices.

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.

Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow curing.

For proprietary grout materials, comply with manufacturer's instructions.

Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

Level and plumb individual members of structure within specified AISC tolerances.

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.

Splice members only where indicated and accepted on shop drawings.

Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members which are not under stress, as acceptable to Architect. Finish gas-cut sections equal to a sheared appearance when permitted.

Touch-Up 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.

Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

QUALITY CONTROL:

Engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.

Testing agency shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom.

Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

Testing agency may inspect structural steel at plant before shipment; however, Architect reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

Correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor's expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

Shop Bolted Connections: Inspect in accordance with AISC specifications.

Shop Welding: Inspect and test during fabrication of structural steel assemblies, as follows:

Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

Perform visual inspection of all welds.

Perform tests of welds as follows. Inspection procedures listed are to be used at Contractor's option.

Liquid Penetrant Inspection: ASTM E 165.

Magnetic Particle Inspection: ASTM E 109; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration not acceptable.

Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2-2T".

Ultrasonic Inspection: ASTM E 164.

Field Bolted Connections: Inspect in accordance with AISC specifications.

Field Welding: Inspect and test during erection of structural steel as follows:

Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

Perform visual inspection of all welds.

Perform tests of welds as follows:

All full penetration field welds at moment and torsion connections shall be tested.

Liquid Penetrant Inspection: ASTM E 165.

Magnetic Particle Inspection: ASTM E 109; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration not acceptable.

Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level "2- 2T".

Ultrasonic Inspection: ASTM E 164.

END OF SECTION 05120

SECTION 05301 - METAL DECKING (Roof Deck Units)

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections apply to work of this section.

DESCRIPTION OF WORK:

Extent of metal decking is indicated on drawings, including basic layout and type of deck units required.

QUALITY ASSURANCE:

Codes and Standards: Comply with provisions of the following codes and standards, except as otherwise indicated or specified:

AISI "Specification for the Design of Cold-Formed Steel Structural Members".

AWS "Structural Welding Code".

SDI "Design Manual for Floor Decks and Roof Decks".

Qualification of Field Welding: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure".

Welded decking in place is subject to inspection and testing. Expense of removing and replacing portions of decking for testing purposes will be borne by Owner if welds are found to be satisfactory. Remove work found to be defective and replace with new acceptable work.

FM Listing: Provide metal roof deck units which have been evaluated by Factory Mutual System and are listed in "Factory Mutual

Approval Guide" for "Class I" fire rated construction.

SUBMITTALS:

Product Data: Submit manufacturer's specifications and installation instructions for each type of decking and accessories. Include manufacturer's certification as may be required to show compliance with these specifications and the associated drawings..

Shop Drawings: Submit detailed drawings showing layout and types of deck panels, section and material properties, anchorage details, and conditions requiring closure panels, anchorage details, and conditions requiring closure panels, supplementary framing, sump pans, cant strips, cut openings, special jointing or other accessories.

Insurance Certification: Assist Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

METAL ROOF DECK UNITS:

Bowman/E.G. Smith, Div. Cyclops Corp.
Epic Metals Corp.
Mac-Fab Products, Inc.
United Steel Deck, Inc.
Vulcraft/Div. Nucor Corp.

Wheeling Corrugating Co.
Wolverine Deck Co.

MATERIALS:

Steel for Painted Metal Deck Units: Steel conforming to Section A3 of the latest edition of *AISI Specification for the Design of Cold-Formed Steel Structural Members*, with minimum yield point of 33 ksi.

Miscellaneous Steel Shapes: ASTM A 36.

Sheet Metal Accessories: ASTM A 526, commercial quality, galvanized.

Paint: Manufacturer's baked-on, rust-inhibitive paint, for application to metal surfaces which have been chemically cleaned and phosphate chemical treated.

Flexible Closure Strips: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.

FABRICATION:

General: Form deck units in lengths to span 3 or more supports, with flush, telescoped or nested 2" laps to ends and interlocking or nested side laps, unless otherwise indicated.

Roof Deck Units: Provide deck configurations complying with SDI "Roof Deck Specifications", of metal thickness, depth and width as shown on drawings.

Roof Sump Pans: Fabricate from single piece of 0.071" min. (14 gage) galvanized sheet steel with level bottoms and sloping sides to direct water flow to drain, unless otherwise shown. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 3" wide. Recess pans not less than 1-1/2" below roof deck surface, unless otherwise shown or required by deck configuration. Holes for drains will be cut in the field.

PART 3 - EXECUTION

INSTALLATION:

General: Install deck units and accessories in accordance with manufacturer's recommendations and final shop drawings, and as specified herein.

Place deck units on supporting steel framework and adjust to final position with ends accurately aligned and bearing on supporting members before being permanently fastened. Do not stretch or contract side lap interlocks.

Place deck units in straight alignment for entire length of run of cells and with close alignment between cells at ends of abutting units.

Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.

Do not place deck units on concrete supporting structure until concrete has cured and is dry.

Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading or structural members.

Do not use floor deck units for storage or working platforms until permanently secured.

FASTENING DECK UNITS:

Fasten roof deck units as shown on drawings.

Comply with ANSI/AWS D1.3 *Structural Welding Code - Sheet Metal* requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

Use welding washers where recommended by deck manufacturer.

Deck welds shall be periodically inspected per AWS D1.3.

Uplift Loading: Install and anchor roof deck units to resist gross uplift loading of 45 lbs. per sq. ft. at eave overhang and 30 lbs. per sq. ft. for other roof areas.

Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking, as shown.

Reinforcement at Openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking and support of other work shown.

Joint Covers: Provide metal joint covers at abutting ends and changes in direction of floor deck units, except where taped joints are required.

Roof Sump Pans: Place over openings provided in roof decking and weld to top decking surface. Space welds not more than 12" o.c. with at least one weld at each corner. Cut opening in roof sump bottom to accommodate drain size indicated.

Cant Strips: Weld to top surface of roof decking, and secure to wood nailers with galvanized nails, and to steel framing with welds at 12" o.c. Lap end joints not less than 3", and secure with galvanized sheet metal screws.

Closure Strips: Provide metal closure strips at open uncovered ends and edges of roof decking, and in voids between decking and other construction. Weld into position to provide a complete decking installation.

Touch-Up Painting: After decking installation, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members.

Touch-up painted surfaces with same type of shop paint used on adjacent surfaces.

In areas where shop-painted surfaces are to be exposed, apply touch-up paint to blend into adjacent surfaces.

END OF SECTION 05301

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Definition: Metal fabrications include items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.

Extent of metal fabrications is indicated on drawings and schedules.

Types of work in this section include metal fabrications for:

Rough hardware.

Ladders

Nosings.

Loose bearing and leveling plates.

Loose steel lintels.

Miscellaneous framing and supports.

Miscellaneous steel trim.

Structural steel door frames.

Steel pipe railings.

Structural steel is specified in another section within Division 5.

SYSTEM PERFORMANCES:

Structural Performances: Provide assemblies which, when installed, comply with the following minimum requirements for structural performance, unless otherwise indicated.

Handrails and Toprails: Capable of withstanding the following loads applied as indicated when tested per ASTM E 935.

Concentrated loads of 200 lbs. applied at any point in any direction.

Uniform load of 50 lbs. per linear ft. applied simultaneously in both vertical and horizontal directions.

Concentrated and uniform loads above need not be assumed to act concurrently.

Guards: Intermediate rails, balusters and panel fillers capable of withstanding a uniform load of 25 lbs. per sq. ft. of gross area of guard, including any open areas, of which they are a part.

Above load need not be assumed to be acting concurrently with uniform horizontal loads on top rails of railing assembly in determining stress on guard supporting members.

QUALITY ASSURANCE:

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. Clearly mark units for reassembly and coordinated installation.

SUBMITTALS:

Product Data: Submit manufacturer's specifications, anchor details and installation instructions for products used in miscellaneous metal fabrications, including paint products and grout.

Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others.

Where materials or fabrications are indicated to comply with certain requirements for design loadings, include structural computations, material properties and other information needed for structural analysis.

Samples: Submit 2 sets of representative samples of materials and finished products as may be requested by Architect.

PART 2 - PRODUCTS

MATERIALS:

FERROUS METALS:

Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.

Steel Plates, Shapes and Bars: ASTM A 36.

Steel Tubing: Cold-formed, ASTM A 500; or hot-rolled, ASTM A 501.

Structural Steel Sheet: Hot-rolled, ASTM A 570, or cold-rolled ASTM A 611, Class 1; of grade required for design loading.

Galvanized Structural Steel Sheet: ASTM A 446, of grade required for design loading. Coating designation as indicated, or if not indicated, G90.

Steel Pipe: ASTM A 53; Type and grade (if applicable) as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (schedule 40), unless otherwise indicated.

Gray Iron Castings: ASTM A 48, Class 30.

Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.

Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153.

Non-Shrink Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with CE CRD-C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.

FASTENERS:

General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.

Bolts and Nuts: Regular hexagon head type, ASTM A 307, Grade A.

Lag Bolts: Square head type, FS FF-B-561.

Machine Screws: Cadmium plated steel, FS FF-S-92.

Wood Screws: Flat head carbon steel, FS FF-S-111.

Plain Washers: Round, carbon steel, FS FF-W-92.

Masonry Anchorage Devices: Expansion shields, FS FF-S-325.

Toggle Bolts: Tumble-wing type, FS FF-B-588, type, class and style as required.

Lock Washers: Helical spring type carbon steel, FS FF-W-84.

PAINT:

Shop Primer for Ferrous Metal: Manufacturer's or Fabricator's standard, fast-curing, lead-free, "universal" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure; complying with performance requirements of FS TT-P-645.

Galvanizing Repair Paint: High zinc dust content paint for reglazing welds in galvanized steel, complying with the Military Specifications MIL-P-21035 (Ships) or SSPC-Paint- 20.

FABRICATION, GENERAL:

Workmanship: Use materials of size and thickness indicated, or if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

Weld corners and seams continuously complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flathead (countersunk) screws or bolts.

Provide for anchorage of type indicated, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

Galvanizing: Provide a zinc coating for those items indicated or specified to be galvanized, as follows:

ASTM A 153 for galvanizing iron and steel hardware.

ASTM A 123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strip 1/8" thick and heavier.

ASTM A 386 for galvanizing assembled steel products.

Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.

SHOP PAINTING:

Apply shop primer to surfaces of metal fabrications except those which are galvanized or as indicated to be embedded in concrete or masonry, unless otherwise indicated, and in compliance with requirements of SSPC-PAL "Paint Application Specification No. 1" for shop painting.

Surface Preparation: Prepare ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

Exteriors (SSPC Zone 1B): SSPC-SP6 "Commercial Blast Cleaning".

Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning".

ROUGH HARDWARE:

Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division-6 sections.

Fabricate items to sizes, shapes and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

Ladders:

Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3, unless otherwise indicated.

Unless otherwise indicated, provide 1/2" x 2-1/2" continuous structural steel flat bar side rails with eased edges, spaced 18" apart.

Provide 3/4" diameter solid structural steel bar rungs, spaced 12" o.c.

Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.

Support each ladder at top and bottom and at intermediate points spaced not more than 5'-0" o.c. Use welded or bolted steel brackets, designed for adequate support and anchorage, and to hold ladder clear

of the wall surface with a minimum of 7" clearance from wall to centerline of rungs. Extend rails 42" above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

Cages for ladders shall be provided where noted on the drawings and shall comply with OSHA requirements.

LOOSE BEARING AND LEVELING PLATES:

Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required.

LOOSE STEEL LINTELS:

Provide loose structural steel lintels for openings and recesses in masonry walls and partitions as shown. Weld adjoining members together to form a single unit where indicated. Provide not less than 8" bearing at each side of openings, unless otherwise indicated.

Galvanize loose steel lintels to be installed in exterior walls.

MISCELLANEOUS FRAMING AND SUPPORTS:

Provide miscellaneous steel framing and supports which are not a part of structural steel framework, as required to complete work.

Fabricate miscellaneous units to sizes, shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise indicated, fabricate from structural steel shapes, plates and steel bars of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.

Except as otherwise indicated, space anchors 24" o.c. and provide minimum anchor units of 1-1/4" x 1/4" x 8" steel straps.

Galvanize miscellaneous frames and supports where indicated.

MISCELLANEOUS STEEL TRIM:

Provide shapes and sizes indicated for profiles shown. Unless otherwise indicated, fabricate units from structural steel shapes, plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work.

Galvanize miscellaneous steel trim where indicated.

STEEL PIPE RAILINGS AND HANDRAILS:

Fabricate steel pipe railings and handrails to design, dimensions, and details indicated. Provide railings and handrails members formed of pipe of sizes and wall thickness indicated, but not less than that required to support design loading.

Verticals and horizontals shall be 1¼" dia. std. pipe with vertical spaced a maximum of 6'0". Stair rails shall be 2'-0" from stair nosing to top rail. Landings shall be 3'-6" from floor to top of rail.

Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

At tee and cross intersections provide coped joints.

At bends interconnect pipe by means of prefabricated elbow fittings or flush radius bends, as applicable, of radiuses indicated.

At elbow bends provide mitered joints.

Form bends by use of prefabricated elbow fittings and radius bends or by bending pipe, at fabricator's option.

Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting or otherwise deforming exposed surfaces of pipe.

Provide wall returns at ends of wall-mounted handrails, except where otherwise indicated.

Close exposed ends of pipe by welding 3/16" thick steel plate in place or by use of prefabricated fittings.

Toe Boards: Where indicated, provide toeboards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated, or if not indicated, use a 4" high x 1/4" plate welded to, and centered between each railing post.

Brackets, Flanges, Fittings and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.

For railing posts set in concrete provide sleeves of galvanized steel pipe with an inside diameter not less than 1/2" greater than the outside diameter of pipe. Provide steel plate closure welded to bottom of sleeve and of width and length not less than 1" greater than outside diameter of sleeve.

PART 3 - EXECUTION

PREPARATION:

Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

INSTALLATION:

General:

Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plus, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete masonry or similar construction.

Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with the edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated.

Pack grout solidly between surfaces and plates to ensure that no voids remain.

STEEL PIPE RAILINGS AND HANDRAILS:

Adjust railing prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:

Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non-shrink, non-metallic grout, mixed and placed to comply with grout manufacturer's directions.

Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to steel supporting members.

Anchor rail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into wall construction with lead expansion shields and bolts.

Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1-1/2" clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required for design loading. Secure wall brackets and wall return fittings to building construction as follows:

For concrete and solid masonry anchorage, use drilled- in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.

For hollow masonry anchorage, use toggle bolts having square heads.

Expansion Joints: Provide expansion joints at locations indicated, or if not indicated, at intervals not to exceed 40 feet. Provide slip joint with internal sleeve extending 2" beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6" of posts.

ADJUST AND CLEAN:

Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting.

Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION 05500

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Definition: Rough carpentry includes carpentry work not specified as part of other sections and which is generally not exposed, except as otherwise indicated. Types of work in this section include rough carpentry for:

1. Wood framing.
2. Wood grounds, nailers, blocking and sleepers.
3. Wood furring.

B. Finish carpentry is specified in another section within Division 6.

1.03 REFERENCES

A. Lumber Standards: Comply with PS 20 and with applicable rules of the respective grading and inspecting agencies for species and products indicated.

B. Plywood Product Standards: Comply with PS 1 (ANSI A 199.1) or, for products not manufactured under PS 1 provisions, with applicable APA Performance Standard for type of panel indicated.

1.04 SUBMITTALS

A. Wood Treatment Data: Submit treatment manufacturer's instructions for proper use of each type of treated material.

B. Pressure Treatment: For each type specified, include certification by treating plant stating chemicals and process used, net amount of preservative retained and conformance with applicable standards.

C. For water-borne preservatives, include statement that moisture content of treated materials was reduced to a maximum of 15% prior to shipment to project site.

D. Fire-Retardant Treatment: Include certification by treating plant that treatment material complies with governing ordinances and that treatment will not bleed through finished surfaces.

1.05 PRODUCT HANDLING

Delivery and Storage: Keep materials dry at all times. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and plywood, and provide air circulation within stacks.

1.06 JOB CONDITIONS

Coordination: Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow proper attachment of other work.

PART 2 - PRODUCTS

2.01 MATERIALS

2.02 LUMBER, GENERAL

- A. **Factory-mark** each piece of lumber with type, grade, mill and grading agency, except omit marking from surfaces to be exposed with transparent finish or without finish.
- B. **Nominal sizes** are indicated, except as shown by detail dimensions. Provide actual sizes as required by PS 20, for moisture content specified for each use.
- C. **Provide dressed lumber**, S4S, unless otherwise indicated.
- D. **Provide kiln-dried lumber** with 15% maximum moisture content at time of dressing.
- E. **Framing Lumber (2" through 4" thick):**
- F. **For light framing** (less than 6" wide), provide "Stud" grade lumber for stud framing and "Standard" grade for other light framing, any species.
- G. **For structural framing** (6" and wider and from 2" to 4" thick), provide the following grade and species:
 - 1. No. 2 grade.
 - 2. Southern Pine (SPIB).
- H. **Exposed Framing Lumber (2" through 4" thick):**
 - 1. Where framing will not be concealed by other work, provide the following grade and species:
 - a. Southern Pine, Appearance Grade, Kiln-Dried (SPIB).
 - 2. **Boards (less than 2" thick):**
 - 3. **Exposed Boards:** Where boards will be exposed in the finished work, provide the following:
 - a. Moisture Content: 15% maximum, "MC-15" or "K-D".
 - 4. **Where painted** finish is indicated, provide Southern Pine, No. 2 Boards (SPIB), or Douglas Fir Construction Boards (WCLB or WWPA).
- I. **Concealed Boards:** Where boards are concealed by other work, provide lumber of 15% maximum moisture content (MC-15) and of following species and grade:
 - Redwood Construction Common (RIS), Southern Pine No. 2 Boards (SPIB), or any species graded Construction Boards (WCLB or WWPA).
- J. **Board Sizes:** Provide sizes indicated or, if not indicated (for sheathing, subflooring and similar uses), provide 1" x 8" boards.

2.03 MISCELLANEOUS LUMBER

Provide wood for support or attachment of other work including cant strips, bucks, nails, blocking, furring, grounds, stripping and similar members. Provide lumber of sizes indicated, worked into shapes shown, and as follows:

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- A. **Moisture content:** 15% maximum for lumber items not specified to receive wood preservative treatment.
 - B. **Grade:** Construction Grade light framing size lumber of any species or board size lumber as required. Provide construction grade boards (RIS or WCLB) or No. 2 boards (SPIB or WWPA).
 - C. **Plywood:**
 - D. **Trademark:** Identify each plywood panel with appropriate APA trademark.
 - E. **Concealed Performance-Rated Plywood:** Where plywood panels will be used for the following concealed types of applications, provide APA Performance-Rated Panels complying with requirements indicated for grade designation, span rating, exposure durability classification, edge detail (where applicable) and thickness.
 - F. **Wall Sheathing:** APA rated sheathing.
 - G. **Exposure Durability Classification:** Exterior.
 - H. **Span Rating:** As specified on structural construction documents or as the minimum span rating allowed for supporting member spacing and loading type.
 - I. **Roof Sheathing:** APA rated sheathing.
 - J. **Exposure Durability Classification: Exterior.**
 - K. **Span Rating:** As specified on structural construction documents or as the minimum span rating allowed for supporting member spacing and loading type.
 - L. **Plywood Backing Panels:** For mounting electrical or telephone equipment, provide fire-retardant treated plywood panels with grade designation, APA C-D PLUGGED INT with exterior glue, in thickness indicated, or, if not otherwise indicated, not less than 3/4".
 - M. **Extruded Polystyrene Plastic Board Sheathing:** Rigid, closed cell, expanded polystyrene insulating sheathing panels with integral high-density skin; complying with FS HH-I- 524, Type Ii, Class B; min. 18 psi compressive strength; aged k- value of 0-185 at 40 degrees F (4.4 degrees C) mean temperature; 0.5% max. water absorption; in manufacturer's standard lengths and widths with T & G long edges.
 - N. **Available Products:** Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 - 1. Foamular by UC Industries.
 - 2. Styrofoam TG by Dow Chemical U.S.A.

2.04 MISCELLANEOUS MATERIALS

- A. **Fasteners and Anchorages:** Provide size, type, material and finish as indicated and as recommended by applicable standards, complying with applicable Federal Specifications for nails, staples, screws, bolts, nuts, washers and anchoring devices. Provide metal hangers and framing anchors of the size and type recommended by the manufacturer for each use including recommending nails.

Where rough carpentry work is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating (ASTM A 153).

B. Building Paper: Asphalt saturated felt, non-perforated, ASTM 226.

2.05 WOOD TREATMENT

A. Preservative Treatment: Where lumber or plywood is indicated as "Treated", or is specified herein to be treated, comply with applicable requirements of AWPB Standards C2 (Lumber) and C9 (Plywood) and of AWPB Standards listed below. Mark each treated item with the AWPB Quality Mark Requirements.

B. Pressure-treat above-ground items with water-borne preservatives complying with AWPB LP-2. After treatment, kiln-dry to a maximum moisture content of 15%. Treat indicated items and the following:

1. Wood cants, nailers, curbs, 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 framing members less than 18" above grade.

C. Pressure-treat the following with water-borne preservatives for ground contact use complying with AWPB LP-22:

- Wood members in contact with ground.

D. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

E. Fire-Retardant Treatment: Where "Fire-Treated" lumber or plywood is specified or otherwise indicated provide materials which comply with AWPB standards for pressure impregnation with fire- retardant chemicals, and which have a flame spread rating of not more than 25 when tested in accordance with UL Test 723 or ASTM E 84, and show no increase in flame spread and significant progressive combustion upon continuation of test for additional 20 minutes.

1. Where treated items are exposed to exterior or to high humidities or are to have a transparent finish in form of stain or sealer, provide materials which show no change in fire-hazard classification when subjected to standard rain test (UL 790 or ASTM B 2898).
2. Use fire-retardant treatment which will not bleed through or adversely affect type of finish indicated and which does not require brush treatment of field-made end cuts to maintain fire- hazard classification.
3. Where transparent finish is indicated use type of treatment and species which permits milling of lumber after treatment without altering indicated fire-hazard classification, as determined by fire testing.
4. Kiln-dry treated items to maximum moisture content of 19%.
5. Provide UL label on each piece of fire-retardant lumber or plywood.

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- F. **Inspect** each piece of treated lumber or plywood after drying and discard damaged or defective pieces.

PART 3 - EXECUTION

3.01 INSTALLATION

3.02 GENERAL

- A. **Discard units of material** with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.
- B. **Set carpentry work** accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
- C. **Securely attach carpentry work** to substrate by anchoring and fastening as shown and as required by recognized standards. Countersink nail heads on exposed carpentry work and fill holes. Use common wire nails, except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

3.03 WOOD GROUNDS, NAILERS, BLOCKING AND SLEEPERS:

- A. **Provide wherever shown** and where required for screeding or attachment of other work. Form to shapes as shown and cut as required for true line and level of work to be attached. Coordinate location with other work involved.
- B. **Attach to substrates** as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise shown. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.
- C. **Provide permanent grounds** of dressed, preservative treated, key- bevelled lumber not less than 1-1/2" wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

3.04 WOOD FURRING:

- A. **Install plumb and level** with closure strips at edges and openings. Shim with wood as required for tolerance of finished work.
- Firestop furred spaces on walls at each floor level, with wood blocking or incombustible materials, accurately fitted to close furred spaces.
- B. **Furring to Receive Gypsum Drywall:** Unless otherwise shown, provide 1" x 2" furring at 16" o.c., vertically.
- C. **Suspended Furring:** Provide size and spacing shown, including hangers and attachment devices. Level to a tolerance of 1/8" in 10', except 1/4" in 10' for thick-coat plaster work.

3.05 WOOD FRAMING, GENERAL:

- A. **Provide framing members** of sizes and on spacings shown, and frame openings as shown, or if not shown, comply with recommendations of "Manual for House Framing" of National

Forest Products Association and the building code of jurisdiction. Do not splice structural members between supports.

- B. **Anchor and nail** as shown, and to comply with "Recommended Nailing Schedule" of "Manual for House Framing" and other recommendations of N.F.P.A and the building code of jurisdiction.
- C. **Firestop** concealed spaces with wood blocking not less than 2" thick, if not blocked by other framing members. Provide blocking at each building store level and at ends of joist spans.

3.06 STUD FRAMING:

- A. **General:** Provide stud framing where shown. Unless otherwise shown, use 2" x 4" wood studs spaced 16" o.c. with 4" face perpendicular to direction of wall or partition. Provide single bottom plate and double top plates 2" thick by width of studs.
 - Construct corners and intersections with not less than 3 studs. Provide miscellaneous blocking and framing as shown and as required for support of facing materials, fixtures, specialty items and trim.
- B. **Provide continuous horizontal blocking** row at mid-height of single-story partitions over 8' high and at midpoint of multi-story partitions, using 2" thick members of the same width wall or partitions.
- C. **Frame openings** with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Set headers on edge and support on jamb studs.
- D. **For load-bearing partitions**, provide double-jamb studs for openings 6' and less in width, and triple-jamb studs for wider openings. Provide headers of depth shown, or if not shown, provide as recommended by N.F.P.A. "Manual for House Framing".
- C. **Provide diagonal bracing** in stud framing of exterior walls, except as otherwise indicated. Brace both walls at each external corner, full story height, at a 45 degree angle, using either a let-in 1 x 4 or 2 x 4 blocking or metal diagonal bracing. Omit bracing where following types of sheathing are indicated.
 - Plywood sheathing or corner bracing, 4' wide panels vertically.

3.07 JOIST FRAMING:

- A. **General:** Provide framing of sizes and spacings shown. Install with crown edge up and support ends of each member with not less than 1-1/2" of bearing on wood or metal, or 3" on masonry. Attach to wood bearing members by toe nailing or metal connectors; frame to wood supporting members with wood ledgers as shown, or if not shown, with metal connectors. Fire-cut members built into masonry (if any). Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 4'. Do not notch in middle third of joists; limit notches to 1/6-depth of joist, 1/3 at ends. Do not bore holes larger than 1/3-depth of joist or locate closer than 2" from top or bottom. Provide solid blocking (2" thick by depth of joists) at ends of joists unless nailed to header or brand member.
- B. **Lap members** framing from opposite sides of beams, girders or partitions not less than 4" or securely tie opposing members together. Provide solid blocking (2" thick by depth of joist) over supports.

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- C. **Anchor members paralleling masonry** with 1/4" x 1-1/4" metal strap anchors spaced not more than 8' o.c. Extend anchors at least 4" into masonry, turn up 4" and extend over and fasten to 3 joists.
 - D. **Under jamb studs at openings**, provide solid blocking between joist.
 - E. **Under non-load-bearing partitions**, provide double joists separated by solid blocking equal to depth of studs above.
 - Provide triple-joists separated as above, under partitions receiving ceramic tile and similar heavy finishes or fixtures, unless otherwise shown.
 - F. **Provide bridging** between joists where nominal depth-to-thickness ratio exceeds 4, at intervals of 8'. Use bevel cut 1" x 4" or 2" x 3" wood bracing, double-crossed and nailed both ends to joists, or use solid wood bridging 2" thick by depth of joist, end nailed to joist.

3.08 RAFTER AND CEILING JOIST FRAMING:

- A. **Ceiling Joists:** Provide member size and spacing shown, and as previously specified for joist framing. Face nail to ends of parallel rafters.
- B. **Rafters:** Provide member size and spacing shown. Notch to fit exterior wall plates and toe nail or use special metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing (if any), and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
- C. **At valleys**, provide valley rafter of size shown, or if not shown, provide rafter twice as thick as regular rafters and 2" deeper. Bevel ends of jack rafters for full bearing against valley rafter.
- D. **At hips**, provide hip rafters of size shown, or if not shown, provide of same thickness as regular rafters and 2" deeper. Bevel ends of jack rafters for full bearing against hip rafters.
 - 1. **Provide collar beams** (ties) as shown, or if not shown, provide 1" x 6" boards between every third pair of rafters. Locate below ridge member, one-third of distance to ceiling joists. Cut ends to fit slope and nail to rafters.
 - 2. **Provide special framing** as shown for eaves, overhangs, dormers and similar conditions, if any.

3.09 INSTALLATION OF PLYWOOD:

- A. **General:** Comply with applicable recommendations contained in Form No. E 304, "APA Design/Construction Guide - Residential & Commercial," for types of plywood products and applications indicated.
- B. **Fastening Methods:** Fasten panels as indicated below:
- C. **Sheathing:** Nail to framing.
- D. **Plywood Backing Panels:** Nail to supports.
- E. **Plastic Board Sheathing:** Comply with manufacturer's printed directions for application of sheathing. Provide vapor relief strips or equivalent for permitting escape of any moisture vapor that otherwise would be trapped in stud cavity behind sheathing.

END OF SECTION 061000

SECTION 072000 - INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK:

A. Extent of insulation work is shown on drawings and indicated by provisions of this section.

B. Applications of insulation specified in this section include the following:

1. Blanket-type building insulation
2. Insulation under slabs-on-grade.

1.03 QUALITY ASSURANCE:

A. Thermal Conductivity: Thicknesses indicated are for thermal conductivity (k-value at 75 degrees F or 24 degrees C) specified for each material. Provide adjusted thicknesses as directed for equivalent use of material having a different thermal conductivity. Where insulation is identified by "R" value, provide thickness required to achieve indicated value.

B. Fire and Insurance Ratings: Comply with fire-resistance, flammability and insurance ratings indicated, and comply with regulations as interpreted by governing authorities.

1.04 SUBMITTALS:

A. Product Data: Submit manufacturer's product specifications and installation instructions for each type of insulation and vapor barrier material required.

B. Product Handling:

C. General Protection: Protect insulations from physical damage and from becoming wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Extruded Polystyrene Board Insulation: Rigid, closed-cell, extruded, expanded polystyrene insulation board with integral high-density skin; complying with FS HH-I524, Type IV, min. 20 psi compressive strength, k-value of 0.20; 0.3% maximum water absorption; 1.1 perm-inch max. water vapor transmission; manufacturer's standard lengths and widths.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. Dow Chemical Co., Midland, MI
2. UC Industries/U.S. Gypsum, Chicago, IL
3. Owens Corning, Toledo, OH

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- C. Mineral/Glass Fiber Blanket/Batt Insulation:** Inorganic (nonasbestos) fibers formed with binders into resilient flexible blankets or semi-rigid batts; FS HH-I-521, Type as indicated, densities of not less than 0.5 lb. per cu. ft. for glass fiber units and not less than 2.5 lb. per cu. ft. for mineral wool units, k-value of 0.27; manufacturer's standard lengths and widths as required to coordinate with spaces to be insulated; types as follows:
- D. Provide Type I** unfaced units where indicated, semi-rigid in vertical spaces and where self-support is required.
- E. Flame-Spread Rating:** Provide units with rating of 25, ASTM E 84.
- F. Fire-Resistance Ratings:** Where units are included in rated wall/ceiling/floor construction, provide mineral wool units which have been tested and rated as required for the indicated assembly.
- G. Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
1. Certain-Teed Products Corp., Valley Forge, PA
 2. Clecon Inc., Cleveland, OH
 3. Manville Bldg. Materials Corp., Denver, CO
 4. Mizell Bros. Co., Atlanta, GA
 5. Owens-Corning Fiberglas Corp., Toledo, OH
 6. Forty-Eight Insulations, Inc., Aurora, IL
 7. Rockwool Industries, Inc., Englewood, CO
 8. United States Gypsum Co., Chicago, IL
- H. Paper-Laminate Vapor Barrier:** Kraft paper sheets laminated together with asphalt or other vapor retarding compound, with laboratory-tested vapor transmission rating of 0.5 perms, scrim reinforced at edges of sheets.
- I. Loose Granular Perlite Insulation:** Expanded aggregate; FS HH-I-574 or ASTM C 549; k-value of 0.33; treated with silicone for water-repellency where used in exterior wall construction.
- J. Adhesive for Bonding Insulation:** Type recommended by insulation manufacturer, and complying with fire-resistance requirements.
- K. Mechanical Anchors:** Type and size shown or, if not shown, as recommended by insulation manufacturer for type of application and condition of substrate.
- L. Protection Board:** Pre-molded, semi-rigid asphalt-fiber composition board, 1/8" thick, formed under heat and pressure, standard sizes.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION:

- A. Installer must examine** substrates and conditions under which insulation work is to be performed, and must notify Contractor in writing of unsatisfactory conditions. Do not proceed

with insulation work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

- B. Clean substrates** of substances harmful to insulations or vapor barriers, including removal of projections which might puncture vapor barriers.
- C. Close off openings** in cavities to receive poured-in-place and foamed-in-place insulation, sufficiently to prevent escape of insulation. Provide bronze or stainless steel screen (inside) where openings must be maintained for drainage or ventilation.

3.02 INSTALLATION:

General:

- A. Comply with manufacturer's instructions** for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with work.
- B. Extend insulation full thickness** as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.
- C. Apply a single layer** of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.03 PERIMETER AND UNDER-SLAB INSULATION:

- A. Protect insulation on vertical surfaces** (from damage during back- filling) by application of protection board. Set in adhesive in accordance with recommendations of manufacturer of insulation.
- B. Protect top surface** of horizontal insulation (from damage during concrete work) by application of protection board.

3.04 VAPOR BARRIER INSTALLATIONS:

General: Extend vapor barriers to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor barriers to cover miscellaneous voids in insulated substrates, including those which have been stuffed with loose fiber-type insulation.

- A. Lap edges of sheets** of vapor barrier not less than 4" so as to provide complete coverage of protected areas.
- B. Repair punctures** and tears in vapor barriers, immediately before concealment by other work. Cover with adhesively applied vapor barrier material or with self-adhesive vapor barrier tape.

3.05 PROTECTION:

General: Protect installed insulation and vapor barriers from harmful weather exposures and from possible physical abuses, where possible by non-delayed installation of concealing work or, where that is

not possible, by temporary covering or enclosure. Installer shall advise Contractor of exposure hazards, including possible sources of deterioration and fire hazards.

END OF SECTION 072000

SECTION 072700 - FIRESTOPPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This section includes firestopping for the following:
- B. Penetrations through fire-resistance-rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
- C. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
- D. Sealant joints in fire-resistance-rated construction.

1.03 RELATED SECTIONS

The following Sections contain requirements that relate to this Section:

- A. Division 3 Section "Cast-In-Place Concrete" for construction of openings in concrete slabs.
- B. Division 4 Section "Unit Masonry" for joint fillers for non-fire-resistive-rated masonry construction.
- C. Division 7 Section "Building Insulation" for safing insulation and accessories
- D. Division 7 Section "Joint Sealants" for non-fire-resistive-rated joint sealants.
- E. Division 15 Sections specifying ducts and piping penetrations.
- F. Division 16 Sections specifying cable and conduit penetrations.

1.04 SYSTEM PERFORMANCE REQUIREMENTS

General: Provide firestopping systems that are produced and installed to resist the spread of fire, according to requirements indicated, and the passage of smoke and other gases.

- A. F-Rated Through-Penetration Firestop Systems:** Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding the fire-resistance rating of the constructions penetrated.
- B. T-Rated Through-Penetration Firestop Systems:** Provide through-penetration firestop systems with T-ratings, in addition to F ratings, as determined per ASTM E 814, where indicated and where systems protect penetrating items exposed to contact with adjacent materials in occupiable floor areas. T-rated assemblies are required where the following conditions exist:
 - 1. Where firestop systems protect penetrations located outside of wall cavities.
 - 2. Where firestop systems protect penetrating items larger than a 4-inch-diameter nominal pipe or 16 square inch overall cross-sectional area.

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- C. Fire-Resistive Joint Sealants:** Provide joint sealants with fire-resistance ratings indicated, as determined per ASTM E 119, but not less than that equaling or exceeding the fire-resistance rating of the construction in which the joint occurs.
 - F. For Firestopping exposed to view,** traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
 - 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** or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the 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.
 - G. For firestopping exposed to view,** provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined per ASTM E 84.

1.05 SUBMITTALS

General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

- A. Product Data** for each type of product specified.
- B. Certification** by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.
- C. Shop drawings** detailing materials, installation methods, and relationships to adjoining construction for each through-penetration firestop system, and each kind of construction condition penetrated and kind of penetrating item. Include firestop design designation of qualified testing and inspecting agency evidencing compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop configuration for construction and penetrating items.
 - 2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration approved by firestopping manufacturer's fire protection engineer with modifications marked.
- D. Product certificates** signed by manufacturers of firestopping products certifying that their products comply with specified requirements.
- E. Product test reports** from, and based on tests performed by, a qualified testing and inspecting agency evidencing compliance of firestopping with requirements based on comprehensive testing of current products.
- F. Qualification data** for firms and persons specified in "Quality Assurance" article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

1.06 QUALITY ASSURANCE

- A. **Fire-Test-Response Characteristics:** Provide firestopping that complies with the following requirements and those specified under "System Performance Requirements" article:
- B. **Firestopping tests** are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, Warnock Hersey, or another agency performing testing and follow-up inspection services for firestop systems that is acceptable to authorities having jurisdiction.
- C. **Information on drawings** referring to specific design designations of through-penetration firestop systems is intended to establish requirements for performance based on conditions that are expected to exist during installation. Any changes in conditions and designated systems require the Architect's prior approval. Submit documentation showing that the performance of proposed substitutions equals or exceeds that of the systems they would replace and are acceptable to authorities having jurisdiction.

1.07 INSTALLER QUALIFICATIONS

Engage an experienced Installer who has completed firestopping that is similar in material, design, and extent to that indicated for Project and that has performed successfully.

1.08 SINGLE-SOURCE RESPONSIBILITY

- A. Obtain through-penetration firestop systems for each kind of penetration and construction condition indicated from a single manufacturer.
- B. **Provide firestopping products** containing no detectable asbestos as determined by the method specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, "Polarized Light Microscopy."

1.09 COORDINATING WORK

Coordinate construction of openings and penetrating items to ensure that designated through-penetration firestop systems are installed per specified requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. **Deliver firestopping products** to Project site in original, unopened containers or packages with intact and legible manufacturer's labels identifying product and manufacturer; date of manufacture, lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to project; curing time; and mixing instructions for multicomponent materials.
- B. **Store and handle firestopping materials** to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.11 PROJECT CONDITIONS

- A. **Environmental Conditions:** Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. **Ventilation:** Ventilate firestopping per firestopping manufacturers' instructions by natural means or, where this is inadequate, forced air circulation.

PART 2 - PRODUCTS

2.01 FIRESTOPPING, GENERAL

- A. **Compatibility:** Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.
- B. **Accessories:** Provide components for each firestopping system that are needed to install fill materials and to comply with "System Performance Requirements" article in Part 1. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Accessories include but are not limited to the following items.

2.02 APPLICATIONS

- A. Provide firestopping systems composed of materials specified in this Section that comply with system performance and other requirements.
- B. **Fill Materials For Through-penetration Firestop Systems**
- C. **Ceramic-Fiber and Mastic Coating:** Ceramic fibers in bulk form formulated for use with mastic coating, and ceramic fiber manufacturer's mastic coating.
- D. **Ceramic-Fiber Sealant:** Single-component formulation of ceramic fibers and inorganic binders.
- E. **Endothermic, Latex Compound Sealant:** Single component, endothermic, latex formulation.
- F. **Intumescent, Latex Sealant:** Single-component, intumescent, latex formulation
- G. **Intumescent Putty:** Non-hardening, dielectric, water-resistant putty containing no solvents, inorganic fibers, or silicone compounds.
- H. **Intumescent Wrap Strips:** Single-component, elastomeric sheet with aluminum foil on one side.
- I. **Job-Mixed Vinyl Compound:** Prepackaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E 136, with flame-spread and smoke-developed ratings of zero per ASTM E 84.
- J. **Mortar:** Prepackaged dry mix composed of a blend of inorganic binders, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogenous mortar.
- K. **Silicone Sealant:** Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealant of grade indicated below.
- L. **Grade:** Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces and non-sag formulation for openings in vertical and other surfaces requiring a non-slumping/ gunnable sealant, unless indicated firestop system limits use to non-sag grade for both opening conditions.

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- M. Grade for Horizontal Surfaces:** Pourable (self-leveling) grade for openings in floors and other horizontal surfaces.
 - N. Grade for Vertical Surfaces:** Non-sag grade for openings in vertical and other surfaces.
 - O. Solvent-Release-Curing Intumescent Sealant:** Solvent-release-curing, single-component, Synthetic-polymer-based sealant of grade indicated below.

2.03 PRODUCTS

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

A. Ceramic-Fiber and Mastic Coating:

1. FireMaster Bulk - Thermal Ceramics
2. FireMaster Mastic - Thermal Ceramics
3. Ceramic Fiber Blanket K-lite – GLT Products

B. Ceramic-Fiber Sealant:

1. Metacaulk 525 - RectorSeal Corporation
2. Fyre-Shield - Tremco Inc.
3. Dyna-Shield Ceramic Fiber Grade 600 – Williams Products

C. Endothermic, Latex Sealant:

1. Fyre-Shield - Tremco Inc.
2. LC Endothermic Sealant – Spec Seal
3. LC Endothermic Sealant Series “Pen300”– Sterling Building Materials

D. Endothermic, Latex Compounds:

1. Flame-Safe FS500/600 Series - International Protective Coatings Corp.
2. Flame-Safe FS900/FST900 Series - International Protective Coatings Corp.
3. Fire Dam 150 - 3M Fire Protection Products

E. Intumescent Latex Sealant:

1. Metacaulk 950 - RectorSeal Corporation
2. Fire Barrier CP 25 WB Caulk - 3M Fire Protection Products
3. Fire Barrier CP 25WB Caulk - 3M Fire Protection Products

F. Intumescent Putty:

1. Pensil 500 Intumescent Putty, General Electric Co.
2. Flame-Safe FSP1000 Putty, International Protective Coatings
3. Fire Barrier Moldable Putty, 3M Fire Protection Products

G. Intumescent Wrap Strips:

1. Dow Corning Fire Stop Intumescent Wrap Strip 2002, Dow Corning Corp.
2. CS2420 Intumescent Wrap, Hilti Construction Chemicals, Inc.

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3. Fire Barrier FS195 Wrap/Strip, 3M Fire Protection Products

H. Job-Mixed Vinyl Compound: USG Firecode Compound, United States Gypsum Co.

I. Mortar:

1. K-2 Firestop Mortar, Bio Fireshield, Inc.
2. Novasit K-10 Firestop Mortar, Bio Fireshield, Inc.
3. KBS-Mortar Seal, International Protective Coatings Corp.

J. Silicone Sealants:

1. Dow Corning Firestop Sealant 2000, Dow Corning Corp.
2. Dow Corning Firestop Sealant SL 2003, Dow Corning Corp.
3. Pensil 100 Firestop Sealant, General Electric Co.
4. CS240 Firestop Sealant, Hilti Construction Chemicals, Inc.
5. Metacaulk 835, The RectorSeal Corporation
6. Metacaulk 880, The RectorSeal Corporation
7. Fyre-Sil, Tremco Inc.
8. Fyre-Sil S/L, Tremco Inc.

K. Solvent-Release-Curing Intumescent Sealants:

1. Biostop 500 Intumescent Firestop Caulk, Bio Fireshield, Inc.
2. Fire Barrier CP25N/S Caulk, 3M Fire Protection Products
3. Fire Barrier Cp25S/L Caulk, 3M Fire Protection Products

L. Fire-Resistive Elastomeric Joint Sealants:

1. **Elastomeric Sealant Standard:** Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer indicated that complies with ASTM C 920 requirements, including those referenced for Type, Grade, Class, and Uses, and requirements specified in this Section applicable to fire-resistive joint sealants.
2. **Sealant Colors:** Provide color of exposed joint sealants to comply with the following.
3. **Provide custom colors** to match Architect's samples
4. **Match colors** indicated by reference to manufacturer's standard designations.
5. **Provide selections** made by Architect from manufacturer's full range of standard colors for products of type indicated.
6. **Single-Component, Neutral-Curing Silicone Sealant:** Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O.

M. Additional Movement Capability:

1. Provide sealant with the capability to withstand the following percentage changes in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:

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2. 50 percent movement in both extension and compression for a total of 100 percent movement.

N. Multicomponent, Nonsag, Urethane Sealant: Type M; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, A, and (as applicable to joint substrates indicated) O.

O. Additional Movement Capability:

1. Provide sealant with the capability to withstand the following percentage change in joint width existing at time of installation, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, and remain in compliance with other requirements of ASTM C 920 for uses indicated:
2. 40 percent movement in extension and 25 percent in compression for a total of 65 percent movement.

P. Single-Component, Non-sag, Urethane Sealant: Type S; Grade NS; Class 25; and Uses NT, M, A, and (as applicable to joint substrates indicated) O.

2.04 AVAILABLE PRODUCTS

Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

A. PRODUCTS: Subject to compliance with requirements, provide one of the following:

1. Single-Component, Neutral-Curing, Silicone Sealant:

- a. Dow Corning 790, Dow Corning Corp.
- b. Dow Corning 795, Dow Corning Corp.
- c. Silpruf, General Electric Co.
- d. Ultraglaze, General Electric Co.
- e. 864, Pecora Corp.

2. Multicomponent, Nonsag, Urethane Sealant:

- a. Vulkem 922, Mameco International Inc.
- b. Dynflex, Pecora Corp.
- c. Dynatred, Pecora Corp.
- d. Dynatrol II, Pecora Corp.
- e. Sikaflex 2cn NS, Sika Corp.
- f. Sonolastic NP 2, Sonneborn Building Products Div., Chem Rex Inc.
- g. Dymeric, Tremco Inc.

3. Single-Component, Nonsag, Urethane Sealant:

- a. Isoflex 880 GB, Harry S. Peterson Co., Inc.
- b. Isoflex 881, Harry S. Peterson Co., Inc.
- c. Vulkem 921, Mameco International Inc.
- d. Sikaflex--15LM, Sika Corp.

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- B. MIXING:** For those products requiring mixing prior to application, comply with firestopping manufacturer's directions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning:

- 1. Clean out openings and joints** immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and the following requirements.
- 2. Remove all foreign materials** from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
- 3. Clean opening and joint substrates** and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
- 4. Remove laitance** and form release agents from concrete.

B. Priming: Prime substrates where recommended by firestopping 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 firestopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently stained or damaged by such contract or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing firestopping's seal with substrates.

3.03 INSTALLING THROUGH-PENETRATION FIRESTOPS

A. General: Comply with the "System Performance Requirements" article in Part 1 and the through-penetration firestop manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross-sectional shapes and depths required to achieve fire ratings of designated through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for through-penetration firestop systems by proven techniques to produce the following results:

D. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.

E. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

- For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 INSTALLING FIRE-RESISTIVE JOINT SEALANTS

A. General: Comply with the "System Performance Requirements" article in Part 1, with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install joint fillers 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 and develop fire-resistance rating required.

C. 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 width that optimum sealant movement capability. Install sealants at the same time joint fillers are installed.

D. Tool nonsag sealants immediately after sealant application and prior to the time skinning or curing begins. Form smooth, uniform beads of configuration indicated or required to produce fire-resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealants with sides of joint. Remove excess sealant from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.05 CLEANING

A. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of firestopping products and of products in which opening and joints occur.

B. Protect firestopping 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 firestopping immediately and install new materials to produce firestopping complying with specified requirements.

END OF SECTION 072700

SECTION 075300 – TPO FLEXIBLE SHEET ROOFING SYSTEM (Fully Adhered Systems)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 SUMMARY

- A. **Extent** of flexible sheet roofing (FSR) is indicated on drawings and is hereby defined to include non-traffic-bearing sheet membrane system intended for weather exposure as primary roofing.
- B. **Types** of roofing systems specified in this section utilizing flexible sheet roofing membranes include the following:
 - Fully adhered systems.
- C. **Flexible sheet roofing membranes shall be:**
 - Polyester reinforced thermoplastic polyolefin membrane.
- D. **Roof protector board/insulation** related to flexible sheet roofing is specified in this section.

1.03 DEFINITIONS

Thermal Resistance: Where thermal resistance properties of insulating materials are designated by R-values they represent the rate of heat flow through a material of thickness indicated, measured by test method included in reference material standard or otherwise indicated. They are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

- Combustibility Characteristics: ASTM E 136.

1.04 SUBMITTALS

- A. **Product Data:** Submit specifications, installation instructions and general recommendations from manufacturers of flexible sheet roofing system materials, for types of roofing required. Include data substantiating that materials comply with requirements.
- B. **Samples:** Submit 12" square samples of finished roofing sheets, including "T-shaped" side/end-lap seam.
 - Submit 12" square samples of required insulation.
- C. **Shop Drawings:** Submit complete shop drawings showing roof configuration, sheet layout, seam locations, colors (as applicable), details at perimeter, and special conditions.
- D. **Pre-Roofing Conference:** Submit copies of pre-roofing conference records.

1.05 QUALITY ASSURANCE

- A. Manufacturer:** Obtain primary flexible sheet roofing from a single manufacturer. Provide secondary materials as recommended by manufacturer of primary materials.
- B. Installer:** A firm with not less than 3 years of successful experience in installation of roofing systems similar to those required for this project and which is acceptable to or licensed by manufacturer of primary roofing materials.
- Work associated with flexible sheet roofing, including (but not limited to) vapor retarders, insulation, flashing and counterflashing, expansion joints, and flexible sheet joint sealers, is to be performed by installer of flexible sheet roofing.
- C. Insurance Certification:** Assist Owner in preparation and submittal of roof installation acceptance certification necessary in connection with fire and extended coverage insurance on roofing and associated work.
- D. UL Listing:** Provide labeled materials which have been tested and listed by UL in "Building Materials Directory" for application indicated, with "Class A" rated materials/system for roof slopes shown.
- E. Fire Performance Characteristics:** Provide insulation materials which are identical to those whose fire performance characteristics, as listed for each material or assembly of which insulation is a part, have been determined by testing, per methods indicated below, by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.
- F. Surface Burning Characteristics:** ASTM E 84.
- G. Fire Resistance Ratings:** ASTM E 119.

1.06 PROJECT CONDITIONS

- A. Pre-Roofing Conference:** Prior to installation of roofing and associated work, meet at project site, with installer, roofing sheet manufacturer, installers of related work and other entities concerned with roofing performance, (where applicable) Owner's insurer, test agencies, governing authorities, Architect and Owner. Record discussions and agreements and furnish copy to each participant. Provide at least 72 hours advance notice to participants prior to convening pre-roofing conference.
- B. Weather:** Proceed with roofing work when existing and forecasted weather conditions permit work to be performed in accordance with manufacturers' recommendations and warranty requirements.

1.07 SPECIAL PROJECT WARRANTY

Provide written warranty, signed by manufacturer of primary roofing materials and his authorized installer, agreeing to replace/repair defective materials and workmanship as required to maintain roofing system in watertight condition.

- Warranty period is 20 years after date of substantial completion.

PART 2 - PRODUCTS

2.01 GENERAL

- A. **Performance:** Provide roofing materials recognized to be of generic type indicated and tested to show compliance with indicated performances, or provide other similar materials certified in writing by manufacturer to be equal or better than specified in every significant respect, and acceptable to Architect.
- B. **Compatibility:** Provide products which are recommended by manufacturers to be fully compatible with indicated substrates, or provide separation materials as required to eliminate contact between incompatible materials.

2.02 TPO FSR MEMBRANE

Top and Bottom film with a polyester reinforcement for added dimensional stability and tear strength. The top and bottom film thermoplastic polyolefin membrane.

1. **Thickness:** 60 mils.
2. **Exposed Face Color:** White

2.03 FULLY ADHERED TPO MEMBRANE

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. **Firestone Building Products Co.**
2. **John Manville**
3. **GenFlex Roofing Systems**
4. **Stevens Roofing Systems**
5. **Carlisle Syntec Incorporated**

2.04 AUXILIARY MATERIALS FOR FSR

- A. **Sheet Seaming System:** Manufacturer's standard materials for sealing lapped joints, including edge sealer to cover exposed spliced edges as recommended by manufacturer of FSR system.
- B. **Cant Strips, Tapered Edge Strips and Flashing Accessories:** Types recommended by manufacturer of FSR material, provided at locations indicated and at locations recommended by manufacturer, including adhesive tapes, flashing cements, and sealants.
- C. **Flashing Material:** Manufacturer's standard system compatible with flexible sheet membrane.
- D. **Slip Sheet:** Type recommended by manufacturer of FSR material for protection of membrane from incompatible substrates.
- E. **Insulation:** Rigid roof insulation board of a closed cell polyisocyanurate foam core on ¼"/ft minimum slope. Insulation board shall be furnished and installed in accordance with and as recommended by the FSR system manufacturer.

-
- F. **Mechanical Fasteners:** Metal plates, caps, battens, accessory components, fastening devices, and adhesives to suit substrate and as recommended by FSR membrane manufacturer.
 - G. **Fully Adhered FSR:** Install membrane by unrolling over prepared substrate, lapping adjoining sheets as recommended by manufacturer, and boding and seating seams.
 - Adhesive over entire surface per manufacturer's recommendations. Install flashing and counter flashing as shown or recommended by manufacturer.
 - H. **Membrane Adhesive:** As recommended by FSR membrane manufacturer for particular substrate and project conditions, formulated to withstand minimum 90 psf uplift force.

PART 3 - EXECUTION

3.01 PREPARATION OF SUBSTRATE

- A. **General:** Comply with manufacturers' recommendation for preparation of substrate to receive FSR system.
- B. **Clean substrate** of dust, debris, and other substances detrimental to FSR system work. Remove sharp projections.
- C. **Install tapered insulation**, cant strips, flashings, and accessory items as shown, and as recommended by manufacturer even though not shown.
- D. **Prime substrate** where recommended by manufacturer of materials being installed.
- E. **Prevent compounds** from entering and clogging drains and conductors, and from spilling or migrating onto surfaces of other work.

3.02 INSTALLATION

General: Comply with manufacturers' instructions, except where more stringent requirements are indicated.

3.03 MEMBRANE INSTALLATION

General: Start installation only in presence of manufacturer's technical representative.

END OF SECTION 075300

SECTION 07600.02 - FLASHING AND SHEET METAL

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of each type of flashing and sheet metal work is indicated on drawings and by provisions of this section.

Types of work specified in this section include the following:

Metal counter flashing; and base flashing (if any).

Metal wall flashing and expansion joints.

Built-in metal valleys, gutters and scuppers.

Gutters and downspouts (rain drainage).

Miscellaneous sheet metal accessories.

Elastic roof/wall expansion joint systems.

Integral masonry flashings are specified as masonry work in sections of Division 4.

Roofing accessories which are installed integral with roofing membrane are specified in roofing system sections as roofing work.

SUBMITTALS:

Product Data; Flashing, Sheet Metal, Accessories: Submit manufacturer's product data, installation instructions and general recommendations for each specified sheet material and fabricated product.

Samples; Flashing, Sheet Metal, Accessories: Submit 8" square samples of specified sheet materials to be exposed as finished surfaces.

JOB CONDITIONS:

Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PART 2 - PRODUCTS

FLASHING AND SHEET METAL MATERIALS:

SHEET METAL FLASHING/TRIM:

Where not exposed to view:

Zinc-Coated Steel: Commercial quality with 0.20% copper, ASTM A 526 except ASTM A 527 for lock forming, G90 hot dip galvanized, mill phosphatized where indicated for painting; 0.0359" thick (20 gage) except as otherwise indicated.

Extruded Aluminum: Manufacturer's standard extrusions of sizes and profiles indicated, 6063_T52, AA_C22A41 white anodized finish; 0.08" minimum thickness for primary legs of extrusions.

Elastic Sheet Flashing/Membrane: Manufacturer's standard flexible, elastic, black, reinforced, flashing sheet of 50 _ 65 mils thickness; 50 - 70 Shore A hardness (ASTM D 2240); 1200 psi tensile strength (ASTM D 412); 120 lbs. per lin in. tear resistance (ASTM D 624, Die C); ultimate elongation of 250% (ASTM D 412); brittleness temperature of -30 degrees F (_35 degrees C) (ASTM D 746); resistance to ozone aging of no cracks for 10% elongated sample for 100 hours in 50 pphm (50.5 mPa) ozone at 104 degrees F (70 degrees C) (ASTM D 1149); resistance to heat aging of maximum hardness increase of 15 points, elongation reduction of 40%, and tensile strength reduction of 30%, for 70 hours at 212 degrees F (100 degrees C) (ASTM D 573).

Provide EPDM synthetic rubber sheet.

PREFINISHED METAL FLASHING:

Where exposed to view:

Prefinished Steel: 24 gauge hot-dipped galvanized steel ASTM A 446-85 Grade C, G-90 coating ASTM 525-86.

Prefinished Galvalume: 24 gauge ASYM 792-86.

Finish:

Finish shall be Kynar 500 fluoro-carbon coating applied with a top side film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat to provide a total dry film thickness of 0.95 to 1.25 mil. Bottom side shall be coated with a primer with a dry film thickness of 0.25 mil. Finish shall conform to all tests for adhesion, flexibility, and longevity as specified by Kynar 500 finish supplier.

Color to be selected by Designer.

Strippable coating shall be liquid applied to the top side to protect the finish during lubrication, shipping and field handling. This strippable coating shall be removed before installation.

Field protection must be provided by the contractor at the job site so material is not exposed to weather and moisture.

MISCELLANEOUS MATERIALS AND ACCESSORIES:

Fasteners: Same metal as flashing/sheet metal or, other non-corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.

Bituminous Coating: FS TT-C-494 or SSPC - Paint 12, solvent type bituminous mastic, nominally free of sulfur, compounded for 15- mil dry film thickness per coat.

Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, non-drying, nonmigrating sealant.

Adhesives: Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.

Paper Slip Sheet: 5-lb. rosin-sized building paper.

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 gage required for performance.

Elastic Flashing Filler: Closed-cell polyethylene or other soft closed-cell material recommended by elastic flashing manufacturer as filler under flashing loops to ensure movement with minimum stress on flashing sheet.

Roofing Cement: ASTM D 2822, asphaltic.

FABRICATED UNITS:

General Metal Fabrication: Shop-fabricate work to greatest extent possible. Comply with details shown, and with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, damage or deterioration of the work. Form work to fit substrates. Comply with material manufacturer instructions and recommendations for forming material. Form exposed sheet metal work without excessive oil-canning, buckling and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. For metal other than aluminum, tin edges to be seamed, form seams, and solder. Form aluminum seams with epoxy seam sealer; rivet joints for additional strength where required.

Expansion Provisions: Where lapped or bayonet-type expansion provisions in work cannot be used, or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1" deep, filled with mastic sealant (concealed within joints).

Sealant Joints: Where movable, non-expansion type joints are indicated or required for proper performance of work, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.

Separations: Provide for separation of metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating or other permanent separation as recommended by manufacturer/fabricator.

Aluminum Extrusion Units: Fabricate extruded aluminum running units with formed or extruded aluminum joint covers, for installation behind main members where possible. Fabricate mitered and welded corner units.

Shop Finish, Rain Drainage: Provide Kynar 500 finish from manufacturer's standard colors on sheet metal rain drainage units (gutters, downspouts, and similar exposed units); 1.0 mil dry film thickness.

ELASTIC EXPANSION JOINT FABRICATION:

General: Provide manufacturer's standard units of size and type indicated, complete with prefabricated corner and intersection units and splicing materials; with elastic sheet flashing forming the primary joint membrane, in a supported bellows arrangement to be secured to both sides of expansion joints; with bellows insulated from below with adhesively applied, flexible, closed-cell rubber or plastic not less than 3/8" thick.

Type: Metal flanged edges, 3" - 4" wide, formed to profiles as indicated to fit curbs, for nailing to substrate.

Metal Flanges: 0.0179" (26 ga.) zinc-coated steel.

Looped Bellows Width: 5" to 6", exclusive of flanges.

PART 3 - EXECUTION

INSTALLATION REQUIREMENTS:

General: Except as otherwise indicated, comply with manufacturer's installation instructions and recommendations, and with SMACNA "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 which will be permanently watertight and weatherproof.

Underlayment: Where stainless steel or aluminum is to be installed directly on cementitious or wood substrates, install a slip sheet of red rosin paper and a course of polyethylene underlayment.

Bed flanges of work in a thick coat of bituminous roofing cement where required for waterproof performance.

Install reglets to receive counter-flashing in manner and by methods indicated. Where shown in concrete, furnish reglets to trades of concrete work for installation as work of Division-3 sections. Where shown in masonry, furnish reglets to trades of masonry work, for installation as work of Division-4 sections.

Install counter-flashing in reglets, either by snap-in seal arrangement, or by wedging in place for anchorage and filling reglet with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.

Nail flanges of expansion joint units to curb nailers, at maximum spacing of 6". Fabricate seams at joints between units with minimum 3" overlap, to form a continuous waterproof system.

CLEANING AND PROTECTION:

Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes.

Protection: Installer shall advise Contractor of required procedures for surveillance and protection of flashings and sheet metal work during construction, to ensure that work will be without damage or deterioration, other than natural weathering, at time of substantial completion.

END OF SECTION 07600.02

SECTION 079000 - JOINT SEALERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. **The extent** of each form and type of joint sealer is indicated on drawings and by provisions of this section.
- B. **The applications** for joint sealers as work of this section include the following:
 - 1. Pavement and sidewalk joints.
 - 2. Concrete construction joints.
 - 3. Flashing and coping joints.
 - 4. Interior wall/ceiling joints.
 - 5. Gasketing of assemblies.
- C. **Refer to Division-8 sections** for glazing requirements; not work of this section.
- D. **Refer to sections of Divisions 15 and 16** for joint sealers in mechanical and electrical work; not work of this section.
- E. **General Performance:** Except as otherwise indicated, joint sealers are required to establish and maintain airtight and waterproof continuous seals on a permanent basis, within recognized limitations of wear and aging as indicated for each application. Failures of installed sealers to comply with this requirement will be recognized as failures of materials and workmanship.

1.03 SUBMITTALS

- A. **Product Data:** Submit manufacturer's product specifications, handling/installation/curing instructions, and performance tested data sheets for each elastomeric product required.
- B. **Certified Tests:** With product data submit certified test reports for elastomeric sealants on aged performances as specified, including hardness, stain resistance, adhesion, cohesion or tensile strength, elongation, low-temperature flexibility, compression set, modulus of elasticity, water absorption, and resistance (aging, weight loss, deterioration) to heat and exposures to ozone and ultraviolet.

1.04 JOB CONDITIONS

Weather Conditions: Do not proceed with installation of liquid sealants under unfavorable weather conditions. Install elastomeric sealants when temperature is in lower third of temperature range recommended by manufacturer for installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. General:** Manufacturers listed in this article include those known to produce the indicated category of prime joint sealer material, either as a nominally pure generic product or as an equivalent-performance modification thereof or proprietary product.
- B. Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
- 1. Manufacturers of Elastomeric Sealants (Liquid):**
 - a. Dow Corning Corp., Midland, MI
 - b. General Electric Co., Waterford, NY
 - c. W. R. Meadows, Inc., Elgin, IL
 - d. Sonneborn/Contech, Inc., Minneapolis, MN
 - e. Tremco, Inc., Cleveland, OH
 - 2. Manufacturers of Non-Elastomeric Sealants/ Caulks (Liquid/Tape):**
 - a. W. R. Meadows, Inc., Elgin, IL
 - b. Sonneborn/Contech, Inc., Minneapolis, MN
 - c. Tremco, Inc., Cleveland, OH
 - 3. Manufacturers of Joint Fillers/Sealant Backers:**
 - a. Dow Chemical Co., Midland, MI
 - b. W. R. Meadows, Inc., Elgin, IL
 - c. Sonneborn/Contech, Inc., Minneapolis, MN

2.02 MATERIALS

- A. General Sealer Requirements:** Provide colors indicated or, if not otherwise indicated, as selected by Architect from a minimum of 100 of the manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated. Where exposed to foot traffic, select nontracking materials of sufficient strength and hardness to withstand stiletto heel traffic without damage or deterioration of sealer system.
- B. Elastomeric Sealants:**
- 1. Multi-Component Polyurethane Sealant:** Except as otherwise indicated, provide manufacturer's standard, non-modified, 2-or- more-part, polyurethane-based, elastomeric sealant; complying with either ASTM C 920 Type M Class 25, or FS TT-S-00227E Class A; self-leveling grade/type where used in joints of surfaces subject to traffic, otherwise nonsag grade/type.
 - 2. Single-Component Polyurethane Sealant:** Except as otherwise indicated, provide manufacturer's standard, non-modified, one- part, polyurethane-based, air-curing, elastomeric sealant; complying with either ASTM C 920 Type S Class 25, or FS TT-S-

00230C Class A; self-leveling grade/type where used in joints of surfaces subject to traffic, otherwise nonsag grade/type.

3. **Bituminous Modification:** Where joint surfaces contain or are contaminated with bituminous materials, provide manufacturer's modified type sealant which is compatible with joint surfaces (modified with coal tar or asphalt as required).
4. **Single-Component Silicon Rubber Sealant:** Except as otherwise indicated, provide manufacturer's standard, non-modified, one- part, silicone-rubber-based, air-curing, nonsag, elastomeric sealant; complying with either ASTM C 920 Type S Class 25 Grade NS, or FS TT-S-001543A Class A Type Non-sag.
5. **Sanitary Interior Type:** Where indicated and where applied in high-humidity or wet service, provide manufacturer's mold/mildew- resistant, acid type sealant for application to nonporous sealant bond surfaces.

C. Non-Elastomeric Sealants and Caulking Compounds:

1. **Single-Component Acrylic Sealant:** Provide acrylic terpolymer, solvent-based, one-part, thermo-plastic sealant compound; solids not less than 95% acrylic; recommended by manufacturer for general use as an exposed building construction sealant.
2. **Performance Standard:** Comply with either ASTM C 920 Type S Class 12-1/2 Grade NS, or FS TT-S-00230C Class B Type Non- sag.

D. Joint Fillers, Pavement Types:

- **Bituminous and Fiber Joint Filler:** Provide resilient and non- extruding type premolded bituminous-impregnated fiberboard units complying with ASTM D 175I; FS HH-F-341, Type I; or AASHTO M 213.

E. Gaskets:

- **Hollow Neoprene Pavement Gasket:** Provide hollow or compartmentalized neoprene extrusion, designed to withstand compression to 40% of normal width without extrusion from joint, and will full recovery; with heavy, durable top member, suitable for long-term exposure to severe traffic abrasion and contamination; hardness of approximately 55 Shore A; comply with ASTM D 2628.

2.03 MISCELLANEOUS MATERIALS

- A. **Joint Primer/Sealer:** Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.
- B. **Bond Breaker Tape:** Provide polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self- adhesive tape where applicable.
- C. **Sealant Backer Rod:** Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended by sealant manufacturer for back-up of and compatibility with sealant. Where used with hot-applied sealant, provide heat-resistant type which will not be deteriorated by sealant application temperature as indicated.

PART 3 - EXECUTION

3.01 INSPECTION

Installer must examine substrates, (joint surfaces) and conditions under which joint sealer work is to be performed, and must notify Contractor of unsatisfactory conditions. Do not proceed with joint sealer work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 JOINT PREPARATION

- A. Clean joint surfaces** immediately before installation of gaskets, sealants or caulking compounds. Remove dirt, insecure coatings, moisture and other substrates which could interfere with seal of gasket or bond of sealant or caulking compound. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer.
- Roughen vitreous and glazed joint surfaces as recommended by sealant manufacturer.
- B. Prime or seal joint surfaces** where indicated, and where recommended by sealant manufacturer. Confine primer/sealer to areas of sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION

- A. Comply with manufacturer's printed instructions** except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.
- B. Set joint filler units at depth** or position in joint as indicated to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.
- C. Install sealant backer rod** for liquid-applied sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.
- D. Install bond breaker tape** where required by manufacturer's recommendations to ensure that liquid-applied sealants will perform as intended.
- E. Employ only proven installation techniques**, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- F. Install liquid-applied sealant to depths** as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of beads; (not applicable to sealants in lapped joints):
- 1. For sidewalks, pavements** and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 5/8" deep nor less than 3/8" deep.

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2. **For normal moving joints** sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than ½" deep nor less than 1/4" deep.
 3. **For joints sealed with non-elastomeric** sealants and caulking compounds, fill joints to a depth in range of 75% to 125% of joint width.
- G. Spillage:** Do not allow sealants or compounds to overflow from confines of joints, or to spill onto adjoining work, or to migrate into voids of exposed finishes. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.
- H. Do not overheat** or reheat hot-applied sealants; discard (do not use).
- I. Recess exposed edges** of gaskets and exposed joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.
- J. Bond ends of gaskets** together with adhesive or "weld" by other means as recommended by manufacturer to ensure continuous watertight and airtight performance. Miter-cut and bond ends at corners unless molded corner units are provided.
- K. Install fire-resistant foamed-in-place filler** in openings where indicated, and at thicknesses indicated. Dam bottom of vertical openings and one side of horizontal openings with temporary containment forms or, where required to achieve fire-resistance ratings, provide permanent mineral composition board forms. On horizontal penetrations, provide partial face containment forms where required for foam placement. Allow installed fillers to cure 24 hours; remove temporary forms; trim ragged edges with sharp knife; inspect and fill voids with additional filler to form uniform thickness of filler.

3.04 CURE AND PROTECTION

Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealers during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of substantial completion. Cure and protect sealants in a manner which will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants which are damaged or deteriorated during construction period.

END OF SECTION 079000

SECTION 081000 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

Extent of standard steel doors and frames is shown and scheduled on drawings.

1.03 QUALITY ASSURANCE

- A. Provide doors and frames** complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames" (SDI-100) and as herein specified.
- B. Manufacturer:** Provide standard steel doors and frames by a single firm specializing in production of this type of work.
- C.** Provide steel doors and frames by one of the following:
 - 1. Amweld Building Products Div.
 - 2. Ceco Corp.
 - 3. Curries Mfg. Inc.
 - 4. Dittco Products Div.
 - 5. Fenestra
 - 6. Mesker Industries, Inc.
 - 7. Republic Builders Prod. Corp.
 - 8. Steelcraft Mfg. Co.

1.04 SUBMITTALS

- A. Product Data:** Submit manufacturer's specifications for fabrication and installation, including data substantiating that products comply with requirements.
- B. Shop Drawings:** Submit for 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 finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.
- C.** Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver** hollow metal work cartoned or crated to provide protection during transit and job storage. Provide additional sealed plastic wrapping for factory finished doors.

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- B. **Inspect** hollow metal work upon delivery for damage. Minor damages may be repaired provided finish items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.
 - C. **Store** doors and frames at building site under cover. Place units on wood sills at least 4" high, or otherwise store on floors in manner that will prevent rust and damage. Avoid use of non_vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4" spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. **Hot-Rolled Steel Sheets and Strip:** Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.
- B. **Cold-Rolled Steel Sheets:** Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.
- C. **Galvanized Steel Sheets:** Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526, with ASTM A 525, G60 zinc coating, mill phosphatized.
- D. **Supports and Anchors:** Fabricate of not less than 18 gage galvanized sheet steel.
- E. **Inserts, Bolts and Fasteners:** Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D as applicable.

2.02 SHOP APPLIED PAINT

Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints.

2.03 FABRICATION, GENERAL:

- A. **Fabricate steel door** and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, 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.
- B. **Fabricate exposed faces** of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel.
- C. **Fabricate frames**, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot- rolled steel (at fabricator's option).
- D. **Fabricate exterior doors**, panels, and frames from galvanized sheet steel. Close top and bottom edges of exterior doors as integral part of door construction or by addition of inverted steel channels.
- E. **Exposed Fasteners:** Unless otherwise indicated, provide countersunk flat Phillips heads for exposed screws and bolts.

2.04 FINISH HARDWARE PREPARATION

- A. Prepare doors and frames to receive mortised and concealed finish hardware in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A 115 series specifications for door and frame preparation for hardware.
- B. **For concealed overhead door closers**, provide space, cutouts, reinforcing and provisions for fastening in top rail of doors or head of frames, as applicable.
- C. **Reinforce doors and frames** to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.
- D. **Locate finish hardware** as shown on final shop drawings or, if not shown, in accordance with "Recommended Locations for Builder's Hardware," published by Door and Hardware Institute.

2.05 SHOP PAINTING

- A. **Clean, treat, and paint** exposed surfaces of steel door and frame units, including galvanized surfaces.
- B. **Clean steel surfaces** of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
- C. **Apply shop coat** of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint.

2.06 STANDARD STEEL DOORS

Provide metal doors of types and styles indicated on drawings or schedules.

2.07 STANDARD STEEL FRAMES

- A. **Provide metal frames** for doors and other openings, of types and styles as shown on drawings and schedules. Conceal fastenings, unless otherwise indicated.
- B. **Fabricate frames** with mitered corners, welded construction for exterior applications and interior applications.
- C. **Form exterior frames** of hot dip galvanized steel.
- D. **Door Silencers:** Except on weatherstripped frames, drill stops to receive 2 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.
 - Manufacturer's "stick-on" silencers will be acceptable in lieu of drilled type.
- E. **Plaster Guards:** Provide 26 gage steel plaster guards or mortar boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation.

PART 3 - EXECUTION

3.01 INSPECTION

Installer must examine substrate and conditions under which steel doors and frames are to be installed and must notify Contractor in writing of any conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION

- A. General:** Install standard steel doors, frames, and accessories in accordance with final shop drawings and manufacturer's data, and as herein specified.
- B. Placing Frames:**
 - 1. Comply with provisions of SDI-105 "Recommended Erection Instructions For Steel Frames", unless otherwise indicated.
 - 2. Except for frames located at in-place concrete or masonry and at drywall installations, place frames prior to construction of enclosing walls and ceilings. 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.
 - 3. In plaster or masonry walls constructed with antifreeze additives, protect inside (concealed) faces of door frames using fibered asphalt emulsion coating. Apply approximately 1/8" thick over shop primer and allow to thoroughly dry before handling.
- C. In masonry construction,** locate 3 wall anchors per jamb at hinge and strike levels. Building-in of anchors and grouting of frames is specified in Section 03010.
- D. At in-place concrete or masonry** construction, set frames and secure to adjacent construction with machine screws and masonry anchorage devices.

3.03 DOOR INSTALLATION

Fit hollow metal doors accurately in frames, within clearances specified in SDI-100.

3.04 ADJUST AND CLEAN

- A. Prime Coat Touch-up:** Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Protection Removal:** Immediately prior to final inspection, remove protective plastic wrappings from prefinished doors.
- C. Final Adjustments:** Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper condition.

END OF SECTION 081000

SECTION 083300 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION OF WORK

- A. **Extent** of overhead coiling doors is shown on drawings.
- B. Provide complete operating door assemblies including door curtains, guides, counterbalance mechanism, hardware, operators and installation accessories.
- C. **Field painting** is specified in Division-9.

1.03 QUALITY ASSURANCE

- A. Furnish each overhead coiling door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.
- B. Unless otherwise acceptable to Architect, furnish overhead coiling door units by one manufacturer for entire project.
- C. **Inserts and Anchorages:** Furnish inserts and anchoring devices which must be set in concrete or built into masonry for installation of units. Provide setting drawings, templates, instructions and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay.
- D. See concrete and masonry sections of these specifications for installation of inserts and anchorage devices.
- E. **Wind Loading:** Design and reinforce overhead coiling doors to withstand a 20 lb. per sq. ft. wind loading pressure.

1.04 SUBMITTALS

- A. **Product Data:** Submit manufacturer's product data, roughing-in diagrams, and installation instructions for each type and size of overhead coiling door. Provide operating instructions and maintenance information, and complete information describing electrical rough-in instructions.
- B. **Shop Drawings:** Submit shop drawings for special components and installation which are not fully dimensioned or detailed on manufacturer's data sheets.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

- A. The Cookson Co.
- B. Cornell Iron Works, Inc.
- C. Raynor, Inc.
- D. Overhead Door Corp.

2.02 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtain:** Fabricate overhead coiling door curtain of interlocking slats designed to withstand required wind loading, of continuous length for width of door without splices. Unless otherwise indicated, provide slats of material gage recommended by door manufacturer for size and type of door required, and as follows:
- B. Steel Door Curtain Slats:** Structural quality, cold-rolled galvanized steel sheets complying with ANSI/ASTM A 446, Grade A, with G90 zinc coating, complying with ASTM A 525, and phosphate treated before fabrication. Furnish manufacturer's standard "flat-face" insulated slats.
- C. Endlocks:** Malleable iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets. Provide locks on alternate curtain slats for curtain alignment and resistance against lateral movement.
- D. Windlocks:** Malleable iron castings secured to curtain slats with galvanized rivets. Unless otherwise recommended by door manufacturer, provide windlocks on doors exceeding 16' wide. Space windlocks approximately 24" o.c. on both edges of curtain.
- E. Bottom Bar:** Consisting of 2 angles, each not less than 1-1/2" x 1-1/2" x 1/8" thick, either galvanized or stainless steel or aluminum extrusions to suit type of curtain slats with seal.
- F. Curtain Jamb Guides:** Fabricate curtain jamb guides of steel angles, or channels and angles with sufficient depth and strength to retain curtain loading. Build-up units with minimum 3/16" thick steel sections, galvanized after fabrication. Slot bolt holes for track adjustment.
 - Secure continuous wall angle to wall framing by 3/8" minimum bolts at not more than 30" o.c., unless closer spacing recommended by door manufacturer. Extend wall angles above door opening head to support coil brackets, unless otherwise shown. Place anchor bolts on exterior wall guides so they are concealed when door is in closed position. Provide removable stops on guides to prevent over-travel of curtain, and continuous bar for holding windlocks.
- G. Weather Seals:** Provide vinyl or neoprene weatherstripping for exterior exposed doors. At door heads, use 1/8" thick continuous sheet secured to inside of curtain coil hood. At door jambs, use 1/8" thick continuous strip secured to both sides of jamb guide.

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- H. Counterbalancing Mechanism:** Counterbalance doors by means of adjustable steel helical torsion spring, mounted around a steel shaft and mounted in a spring barrel and connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- I. Counterbalance Barrel:** Fabricate spring barrel of hot-formed structural quality carbon steel, welded or seamless pipe, of sufficient diameter and wall thickness to support roll-up of curtain without distortion of slats and limit barrel deflection to not more than 0.03" per ft. of span under full load.
1. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.
 2. Fabricate torsion rod for counterbalance shaft of case-hardened steel, or required size to hold fixed spring ends and carry torsional load.
- J. Brackets:** Provide mounting brackets of manufacturer's standard design, either cast iron or cold-rolled steel plate with bell mouth guide groove for curtain.
- K. Hood:** Form to entirely enclose coiled curtain and operating mechanism at opening head, and act as weather seal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods, and any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
- Fabricate steel hoods for doors of not less than 24 gauge hot-dip galvanized steel sheet with G 90 zinc coating, complying with ASTM A 525. Phosphate treat before fabrication.

2.03 PAINTING

Shop clean and prime ferrous metal and galvanized surfaces, exposed and unexposed, except faying and lubricated surfaces, with door manufacturer's standard rust inhibitive primer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, manufacturer's instructions, and as specified herein.
- B. Upon completion of installation including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting weathertight for entire perimeter.

END OF SECTION 083300

SECTION 084100 - ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. **Extent** of aluminum entrances and storefronts is indicated on drawings and schedules.
- B. **Types** of aluminum entrances and storefronts required include the following:
 - Exterior entrance doors.
- C. **Glazing:** Refer to "Glass and Glazing" section of Division 8 for glazing requirements for aluminum entrances and storefronts including doors specified herein to be factory-preglazed.
- D. **Mortise lock cylinders** are specified in Division 8 Hardware Section.

1.03 SYSTEM PERFORMANCE

- A. **General:** Provide exterior entrance and storefront assemblies that have been designed and fabricated to comply with requirements for system performance characteristics listed below as demonstrated by testing manufacturer's corresponding stock systems according to test methods designated.
- B. **Thermal Movement:** Allow for expansion and contraction resulting from ambient temperature range of 120 degrees F (49 degrees C).
- C. **Wind Loading:** Provide capacity to withstand loading indicated below, tested per ASTM E 330.
 - Uniform pressure of 20 psf inward and 20 psf outward.
- D. **Transmission Characteristics of Fixed Framing:** Comply with requirements indicated below for transmission characteristics and test methods.
- E. **Air and Water Leakages:** Air infiltration of not more than 0.06 CFM per sq. ft. of fixed area per ASTM E 283 and no uncontrolled water penetration per ASTM E 331 at pressure differential of 6.24 psf (excluding operable door edges).
- F. **Transmission Characteristics of Entrances:** Provide entrance doors with jamb and head frames which comply with requirements indicated below for transmission characteristics and test methods.
- G. **Air Leakage:** Air infiltration per linear foot of perimeter crack of not more than 0.50 CFM for single doors and 1.0 CFM for pairs of doors per ASTM E 283 at pressure differential of 1.567 psf.

1.04 QUALITY ASSURANCE

Drawings are based on one manufacturer's standard aluminum entrance and storefront system. Another standard system of a similar and equivalent nature will be acceptable when differences do not materially detract from design concept or intended performances, as judged solely by Architect.

1.05 SUBMITTALS

- A. Product Data:** Submit manufacturer's specifications, standard details, and installation recommendations for components of aluminum entrances and storefronts required for project, including test reports certifying that products have been tested and comply with performance requirements.
- B. Shop Drawings:** Submit shop drawings for fabrication and installation of aluminum entrances and storefronts, including elevations, detail sections of typical composite members, hardware mounting heights, anchorages, reinforcement, expansion provisions, and glazing.
- C. Samples:** Submit samples of each type and color of aluminum finish.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

1. U. S. Aluminum Company
2. Kawneer Company, Inc.
3. Vista-Wall Company

2.02 MATERIALS AND ACCESSORIES

- A. Aluminum Members:** Alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish; ASTM B 221 for extrusions, ASTM B 209 for sheet/plate.
- B. Fasteners:** Aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum components.
- C. Do not use exposed fasteners** except where unavoidable for application of hardware. Match finish of adjoining metal.
- D. Provide Phillips** flat-head machine screws for exposed fasteners.
- E. Concealed Flashing:** Dead-soft stainless steel, 26 gage minimum, or extruded aluminum 0.062" minimum, of an alloy and type selected by manufacturer for compatibility with other components.
- F. Brackets and Reinforcements:** Manufacturer's high-strength aluminum units where feasible; otherwise, non-magnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386.

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- G. Concrete/Masonry Inserts:** Cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386.
 - H. Compression Weatherstripping:** Manufacturer's standard replaceable stripping of either molded neoprene gaskets complying with ASTM D 2000 or molded PVC gaskets complying with ASTM D 2287.
 - I. Sliding Weatherstripping:** Manufacturer's standard replaceable stripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing, complying with AAMA 701.2.
 - J. Glass and Glazing Materials:** Provide glass and glazing materials which comply with requirements of "Glass and Glazing" section of these specifications.

2.03 HARDWARE

- A. General:** Refer to hardware section of Division 8 for requirements for hardware items other than those indicated herein to be provided by manufacturer of aluminum entrances.
- B. Provide door manufacturer's standard** heavy duty hardware units as indicated, scheduled, or required for operation of each door, including the following items of sizes, number, and type recommended by manufacturer for service required, finished to match door unless otherwise indicated.
- C. Ball-Bearing Butts:** 5-knuckle, 2 bearings, steel/bronze sized to comply with ANSI A156.1, Grade 2 requirements, 3 butts per door.
- D. Overhead Closers:** Units complying with ANSI A156.4, of the following type, grade, functions and features.
- E. Type:** Overhead, exposed, modern type with cover, ADA compliant.
 - 1. Grade 1.
 - 2. Parallel arm mounting.
- F. Deadlocks:** Mortised maximum security type, with 1" minimum length pivoted bolt, stainless steel strike box.
- G. Keyed Cylinders:** Outside units, 5-pin tumbler, with cast aluminum face.
- H. Pull Handles:** Standard aluminum units of style indicated, or as recommended by manufacturer, if not indicated.
- I. Push Bars:** Standard aluminum units of style indicated, or single bar full door width of type recommended by manufacturer, if not indicated.
- J. Thresholds:** Extruded aluminum in mill finish, complete with anchors and clips, of size indicated or manufacturers standard ADA compliant, if not indicated.

2.04 FABRICATION - GENERAL

- A. **Sizes and Profiles:** Required sizes for door and frame units, including profile requirements, are indicated on drawings. Any variable dimensions are indicated, together with maximum and minimum dimensions required to achieve design requirements and coordination with other work.
- B. **Prefabrication:** To greatest extent possible, complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site. Disassemble components only as necessary for shipment and installation.
- C. **Pre-glaze** door and frame units to greatest extent possible, in coordination with installation and hardware requirements.
- D. **Do not drill** and tap for surface-mounted hardware items until time of installation at project site.
- E. **Perform fabrication** operations, including cutting, fitting, forming, drilling and grinding of metal work in manner which prevents damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.
- F. **Welding:** Comply with AWS recommendations to avoid discoloration; grind exposed welds smooth and restore mechanical finish.
- G. **Reinforcing:** Install reinforcing as necessary for performance requirements; separate dissimilar metals with bituminous paint or other separator which will prevent corrosion.
- H. **Continuity:** Maintain accurate relation of planes and angles, with hairline fit of contacting members.
- I. **Fasteners:** Conceal fasteners wherever possible.
- J. **Weatherstripping:** For exterior doors, provide compression weatherstripping against fixed stops; at other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge.
 - Provide EPDM/vinyl gasket weatherstripping in bottom door rail, adjustable for contact with threshold.

2.05 STOREFRONT FRAMING SYSTEM

General: Provide inside - outside matched resilient flush-glazed system with provisions for glass replacement. Shop-fabricate and preassemble frame components where possible.

2.06 STILE-AND-RAIL TYPE ALUMINUM DOORS

- A. **Frame:** Provide tubular frame members, fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie-rods or j-bolts, or fabricate with structurally welded joints, at manufacturer's option.
- B. **Design:** Provide doors 1-3/4" thick and of design indicated.
 - Wide stile (See Drawings)

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- C. **Glazing:** Fabricate doors to facilitate replacement of glass or panels, without disassembly of door stiles and rails. Provide snap-on extruded aluminum glazing stops, with exterior stops anchored for non-removal.

2.07 ALUMINUM DOOR FRAMES

Fabricate tubular and channel frame assemblies as indicated, with either welded or mechanical joints in accordance with manufacturer's standard, reinforced as necessary to support required loads.

2.08 FINISHES

Anodized Aluminum Finishes: Class I Color Anodized Finish: AA-M12C22A42/A44 (non-specular as fabricated mechanical finish; chemical etch, medium matte; 0.7 mil min. thick integrally or electrolytically deposited colored anodic coating). Color to be dark bronze.

PART 3 - EXECUTION

3.01 PREPARATION

Field Measurement: Wherever possible, take field measurements prior to preparation of shop drawings and fabrication, to ensure proper fitting of work. However, proceed with fabrication and coordinate installation tolerances as necessary when field measurements might delay work.

3.02 INSTALLATION

- A. **Comply with manufacturer's instructions** and recommendations for installation of aluminum entrances and storefronts.
- B. **Set units plumb**, level, and true to line, without warp or ract of framing members, doors, or panels. Anchor securely in place, separating aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.
- C. **Set sill members** and other members in bed of sealant as indicated, or with joint fillers or gaskets as indicated to provide weathertight construction.
- D. **Refer to "Glass and Glazing"** section of Division 8 for installation of glass and other panels indicated to be glazed into doors and framing, and not preglazed by manufacturer.

3.03 ADJUST AND CLEAN

- A. **Adjust operating hardware** to function properly, without binding, and to prevent tight fit at contact points and weatherstripping.
- B. **Clean completed system**, inside and out, promptly after erection and installation of glass and sealants. Remove excess glazing and joint sealants, dirt, and other substances from aluminum surfaces.
- C. **Institute protective measures** and other precautions required to assure that aluminum entrances and storefronts will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 084100

SECTION 08520 - ALUMINUM WINDOWS

PART 1 - GENERAL

RELATED DOCUMENTS:

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

SUMMARY:

Extent of each type, grade and performance class of aluminum window units required is indicated on the drawings.

Aluminum window units required are heavy commercial grade of the performance class indicated.

Types of aluminum window units required include the following:

Fixed Windows

Applications of aluminum windows on the project include individual units set in conventional wall construction.

DEFINITIONS:

Performance class number included as a part of the window designation system is the actual design pressure in pounds per sq. ft. used to determine the structural test pressure and water test pressure.

Structural test pressure, windload test, is equivalent to 150 percent of the design pressure.

Water leakage resistance test pressure is equivalent to 15 percent of the design pressure with 2.86 psf as a minimum.

SYSTEM DESCRIPTION:

Design Requirements: Comply with air infiltration, water penetration and structural performance requirements indicated in AAMA 101-85 for the type, grade and performance class of window units required.

Design wind velocity at the project site is 100 mph.

Testing: Test each type and size of required window unit through a recognized testing laboratory or agency, in accordance with ASTM E 330 for structural performance, with ASTM E 283 for air infiltration and with both ASTM E 331 and ASTM E 547 for water penetration. Provide certified test results.

Structural Performance: Provide units with no failure or permanent deflection for a positive (inward) and negative (outward) test pressure of 30 lbf/sq.ft.

Air Infiltration: Provide units with an air infiltration rate of not more than 0.37 cfm/ft. of operable sash joint for an inward test pressure of 6.24 lbf/sq.ft.

Water Penetration: Provide units with no water penetration as defined in the test method at an inward test pressure of 3.00 lbf/sq.ft.

SUBMITTALS:

Product Data: Submit manufacturer's product specifications, technical product data, recommendations and standard details for each type of aluminum window unit required. Include the following information:

Fabrication methods.
Finishing.
Hardware.
Accessories.

QUALITY ASSURANCE:

Standards: Requirements for aluminum windows, terminology and standards of performance, and fabrication workmanship are those specified and recommended in AAMA 101-85 and applicable general recommendation published by AAMA and AA.

Single Source Responsibility: Provide aluminum windows produced by a single manufacturer capable of showing prior production of units similar to those required.

Design Criteria: Drawings indicate sizes, profiles and dimensional requirements of aluminum windows. Window units having minor deviations from indicated dimensions and profiles may be accepted, subject to the Architect's/Engineer's approval, provided such deviations do not materially detract from the design concept or intended performance.

PROJECT CONDITIONS:

Field Measurements: Where possible, check actual window openings in construction work by accurate field measurement before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit of window units.

PART 2 - PRODUCTS

MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Fixed Windows:

Acorn Building Components, Inc.
Alenco, Division of Redman Industries, Inc.
Capitol Windows
EFCO Corporation
Fisher-Insley
Graham Architectural Products Corporation
Milco Division, Wausau Metals Corporation
Three Rivers Aluminum Co., Inc.
Ultralum/Division of Alside, Inc.
Winco Manufacturing Co.

MATERIALS:

Aluminum Extrusions: Provide alloy and temper recommended by the window manufacturer for the strength, corrosion-resistance, and application of required finish, but not less than 22,000 psi ultimate tensile strength and not less than 0.062" thickness at any location for main frame and sash member.

Fasteners: Provide aluminum, non-magnetic stainless steel, epoxy adhesive, or other materials warranted by the manufacturer to be non-corrosive and compatible with aluminum window members, trim, hardware, anchors and other components of window units.

Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125" thick, reinforce the interior with aluminum or non-magnetic stainless steel to receive screw threads, or provide standard non-corrosive pressed-in splined grommet nuts.

Exposed Fasteners: Except where unavoidable for applications of hardware, do not use exposed fasteners. For application of hardware, use fasteners that match the finish of the member or hardware being fastened, as appropriate.

Anchors, Clips and Window Accessories: Fabrication anchors, clips and window accessories of aluminum, non-magnetic stainless steel or hot-dip zinc coated steel or iron complying with the requirements of ASTM A 386; provide sufficient strength to withstand design pressure indicated.

Sliding Type Weatherstripping: Provide woven pile weatherstripping of wool, polypropylene or nylon pile and resin- impregnated backing fabric, and aluminum backing strip. Comply with AAMA 701.2.

Wire Fabric Insect Screen: Provide 18 x 18 x 16, or 18 x 14 mesh of 0.013" diameter coated aluminum wire, complying with FS RR-W- 365, Type VII.

WINDOW GRADES AND PERFORMANCE CLASSIFICATION:

Heavy Commercial Windows: Provide window units complying with requirements of AAMA Grade and Performance Class HC40.

WINDOW TYPES:

General: The following paragraphs define the operating arrangement for the types of sash required in window units and specify minimum provisions for each type.

Fixed Windows

FABRICATION:

General: Except to the extent that more specific or stringent requirements are indicated, provide manufacturer's standard fabrication that complies with indicated standards and that produces unit that are reglazable without dismantling sash framing. Include a complete system for assembly of components and anchorage of window units, and prepare sash for glazing except where preglazing at the factory is indicated.

Sizes and Profiles: Required sizes for window units and profile requirements are indicated on the drawings. Variable dimensions are indicated along with maximum and minimum dimensions as required to achieve design requirements and coordination with other work.

Details shown are based upon standard details by one or more manufacturers. Similar details by other manufacturers will be acceptable, provided they comply with size requirements, minimum/maximum profile requirements, and performance standards as indicated or specified.

Provide weepholes and internal water passages to conduct infiltrating water to the exterior.

Provide subframes with anchors for window units where shown, of profile and dimensions indicated but not less than 0.062" thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units.

Preglazed Fabrication: Preglaze window units at the factory where possible and practical for applications indicated. Comply with glass and glazing requirements of the "Glass and Glazing" sections of these specifications, and AAMA 101-85.

FINISHES:

Natural Anodized Finish: Provide NAAMM AA-C22A41, Class I (minimum thickness of 0.7 mils), dark bronze color.

Apply temporary protective coating of clear acrylic lacquer; comply with AAMA recommendations.

PART 3 - EXECUTION

INSPECTION:

Inspect openings before beginning installation. Verify that rough or masonry opening is correct and the sill plate is level.

Masonry surfaces shall be visibly dry and free of excess mortar, sand and other construction debris.

INSTALLATION:

Comply with manufacturer's specifications and recommendations for installation of window units, hardware, operators, and other components of the work.

Set units plumb, level and true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.

Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with the requirements specified under paragraph "Dissimilar Materials" in the Appendix to AAMA 101-85.

Set sill members and other members in a bed of compound or with joint fillers or gaskets, as shown, to provide weathertight construction. Refer to the "Joint Sealer" sections of Division-7 for compounds, fillers, and gaskets to be installed concurrently with window units. Coordinate installation with wall flashings and other components of the work.

ADJUSTING:

Adjust operating sash and hardware to provide a tight fit at contact points and at weatherstripping, for smooth operation and a weathertight closure.

CLEANING:

Clean aluminum surfaces promptly after installation of windows. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.

Clean glass of preglazed units promptly after installation of windows; comply with requirements of the "Glass and Glazing" section for cleaning and maintenance.

PROTECTION:

Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure that, except for normal weathering, window units will be free of damage or deterioration at the time of substantial completion.

END OF SECTION 08520

SECTION 08 71 00 FINISH HARDWARE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Hinges and Pivots.
- B. Mortise Locksets and Deadbolts.
- C. Cylindrical Locksets and Deadbolts.
- D. Dead Bolts.
- E. Cylinders.
- F. Keying.
- G. Exit Devices.
- H. Surface Door Closers.
- I. Miscellaneous Trim.
- J. Weatherstripping for exterior doors
- K. Protection Plates
- L. Thresholds

1.2 RELATED SECTIONS

- A. Section 05100 - Structural Metal Framing: Door Frames.
- B. Section 06100 - Rough Carpentry: Door Frames.
- C. Section 08100 - Metal Doors and Frames.
- D. Section 08410 - Aluminum Entrance Systems, except cylinders.
- E. Section 087100 - Weatherstripping: Weatherstripping and thresholds

1.3 REFERENCES

- A. ANSI A117.1 - American National Standard for Accessible and Useable Buildings and Facilities.
- B. ANSI/BHMA A156.1, "Butts and Hinges" (copyrighted by BHMA, ANSI approved).
- C. ANSI/BHMA A156.2 - American National Standard for Bored and Preassembled Locks & Latches.
- D. ANSI/BHMA A156.3 - American National Standard for Exit Devices.
- E. ANSI/BHMA A156.4 - American National Standard for Door Controls - Closers.
- F. ANSI/BHMA A156.5 - American National Standard for Auxiliary Locks and Associated Products.

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- G. ANSI/BHMA A156.6, "Architectural Door Trim" (copyrighted by BHMA, ANSI approved).
 - H. ANSI/BHMA A156.7, "Template Hinge Dimensions" (copyrighted by BHMA, ANSI approved).
 - I. ANSI/BHMA A156.8, "Door Controls - Overhead Holders" (copyrighted by BHMA, ANSI approved).
 - J. ANSI/BHMA A156.13 - American National Standard for Mortise Locks and Latches Series 1000.
 - K. ANSI/BHMA A156.15 - Life Safety Closer/Holder/Release Devices.
 - L. ANSI/BHMA A156.16 - Auxiliary Hardware.
 - M. ANSI/BHMA A156.18 - Materials and Finishes.
 - N. ANSI A156.19 - American National Standard for Power Assist and Low Energy Power Operated Doors.
 - O. ANSI A156.23 - American National Standard for Electromagnetic Locks
 - P. ANSI A156.24 - American National Standard for Delayed Egress Locks
 - Q. ANSI A156.25 - American National Standard for Electrified Locking Devices
 - R. ANSI A156.28 - American National Standard for Keying Systems
 - S. ANSI A156.29 - American National Standard for Exit Locks and Alarms, Exit Locks with Exit Alarms and Alarms for Exit Devices
 - T. ANSI A156.31 - American National Standard for Electric Strikes and Frame Mounted Actuators
 - U. NFPA 80 - Standard for Fire Doors, Fire Windows.
 - V. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
 - W. Underwriters Laboratories (UL). - Fire Resistance Directory.
 - X. ANSI/UL 10C - Standard for Safety for Positive Pressure Fire Tests of Door Assemblies.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire Rated Openings: Provide door hardware listed by UL or Intertek Testing Services (Warnock Hersey Listed), or other testing laboratory approved by applicable authorities.
 - 1. Comply with NFPA 80 for fire ratings indicated, based on testing according to NFPA 252.
 - 2. Comply with UL10C, Positive Pressure Fire Tests of Door Assemblies.
- B. Accessibility Requirements: Comply with requirements of Local building code, and Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.

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- B. Product Data: Manufacturer's catalog cuts on each product to be used.
 - C. Shop Drawings: Indicate locations and mounting heights of each type of hardware, schedules, electrical characteristics and connection requirements.
 - D. Schedule:
 - 1. Submit schedule indicating each type of hardware for each door.
 - 2. List manufacturer's name with each manufacturer's hardware number together with finishes in US standards.
 - 3. Show door number/location, handing, door and frame material, manufacture and catalog numbers, all finishes and keying information. Explain fully all abbreviations.
 - E. Shop Drawings:
 - 1. Indicate locations and mounting heights of each type of hardware.
 - 2. Supply templates to door and frame manufacturer(s) to enable proper and accurate sizing and locations of cut-outs for hardware.
 - 3. Detail any conditions requiring custom extended lip strikes, or any other special or custom conditions.
 - 4. Wiring diagrams including point to point and riser diagrams, function statements and system descriptions for all electrical hardware
 - F. Verification Samples: For each finish product specified.
 - 1. If required by the Architect, submit one sample of each type of typical hardware required illustrating style, color, and finish.
 - 2. Approved samples may be incorporated into Work.
 - G. Closeout Submittals:
 - 1. Project Record Documents: Schedule showing actual locations of installed cylinders and their master key code.
 - 2. Parts lists and maintenance instructions including data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 - 3. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer with a minimum of ten years experience manufacturing door hardware.
- B. Supplier Qualifications: A supplier with a minimum of two years demonstrated experience in the sale and distribution of builders' hardware for commercial projects and who has successfully completed at least three projects of similar complexity to the project specified.
- C. Hardware Supplier Personnel: Employ Architectural Hardware Consultant (AHC) or equally qualified person to supervise and prepare all schedules, details, and services required for the project.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually with necessary fasteners and installation templates when necessary; label and identify each package with door opening code to match hardware schedule.
- B. Store products in manufacturer's unopened packaging until ready for installation.

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- C. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
 - D. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

- A. Provide factory warranty against defects in material and workmanship as follows:
 1. Overhead Surface Closers, Grade 1, 25 Year Warranty.
 2. Mortise locks, Grade 1, 10 Year Warranty.
 3. Cylindrical locks, Grade 1, 10 Year Warranty.
 4. Exit Devices, Grade 1, 10 Year Warranty.
 5. Standard and Interchangeable Cylinders, 2 Year Warranty.
 6. Electrical components 2 Year Warranty.

1.10 MAINTENANCE MATERIALS

- A. Provide special wrenches and tools applicable to each different or special hardware component.

1.11 COORDINATION

- A. Coordinate work with other directly affected components involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.
- B. Coordinate work with other directly affected components involving electrical wiring and components.

PART 2 PRODUCTS

2.2 MANUFACTURERS

- A. Basis of Design: Dorma Architectural Hardware, which is located at: Dorma Dr. Drawer AC ; Reamstown, PA 17567-0411; Toll Free Tel: 800-523-8483; Tel: 717-336-3881; Email: request info; Web: www.dorma-usa.com
- B. Other approved manufactures are: HINGES- McKinney, Ives, Stanley, and PBB. GEARED HINGES- Pemko no substitutions. LOCKSETS- Yale 8800FL Series and Yale 5400LN Series. CLOSERS- LCN 1461 Series and Norton 8301 Series. EXIT DEVICES- Von Duprin 99 Series and Precision 2000 Series. FLATGOODS- Rockwood and Trimco. THRESHOLDS AND GASKETING- Pemko and National Guard.

2.3 HINGES AND PIVOTS

- A. Hinges: ANSI A156.1, full mortise template type complying with following general requirements unless otherwise scheduled.
 1. Widths: Sufficient to clear trim projection when door swings 180 degrees.
 2. Number: Furnish minimum three hinges to 90 inches (2 286 mm) high, four hinges to

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- 120 inches (3 048 mm) high for each door leaf.
 - a. Fire Rated Doors To 86 inches (2 184 mm) High: Minimum three ball bearing hinges.
 - b. Residential Wood Doors: Furnish minimum two hinges.
 - 3. Size and Weight: 4-1/2 inch (114 mm) heavy weight typical for 1-3/4 inch (44 mm) doors.
 - a. Doors Over 40 inches (1 016 mm) Wide: Extra heavy weight ball or oilite bearing hinges.
 - b. Doors 1-3/8 inch (35 mm) Thick: 3-1/2 inch (89 mm) size.
 - c. Doors 2 inch (50 mm) Thick: 5 inch (125 mm) extra heavy weight ball or oilite bearing.
 - d. Doors Over 48 inches (1 220 mm) Wide: 5 inch (125 mm) extra heavy weight ball or oilite bearing.
 - 4. Pins: Furnish nonferrous hinges with non-removable pins (NRP) at exterior and locked outswinging doors, non-rising pins at interior doors.
 - 5. Tips: Furnish with matching plug.
 - 6. Material: Steel - Polished and plated.
 - 7. Material: Stainless Steel - Polished and satin finished.

2.4 MORTISE LOCKSETS AND DEADBOLTS

- A. Lockset: DORMA ML9000 Series.
 - 1. Standards:
 - a. ANSI Conformance - ANSI A156.13, Operational Grade 1, Security Grade 1.
 - b. U.L. and C.U.L. listed for use on 3-hour fire-rated doors and for all positive pressure applications.
 - c. U.L. and C.U.L. listed for UL 10B/10C and UBC 7.2 (1997).
 - d. Lever trim meets A117.1 and ADA requirements.
 - 2. Features:
 - a. Stainless steel latch.
 - b. Stainless steel dead bolt.
 - c. Hardened steel rollers in dead bolt.
 - d. Security spacer between inside and outside lever.
 - e. Steel lock case and internal components.
 - f. Full length face plate.
 - g. All trim through-bolted through the lock case.
 - h. Accepts standard and interchangeable core cylinders.
 - 3. Trim:
 - a. Lever: LCB, 2-9/16 inch (65 mm) rose.
 - 4. Lock Cylinder:
 - a. DORMA standard keyway with two nickel silver keys.
 - 5. Finish:
 - a. Stainless: 630 (Satin).

2.5 CYLINDRICAL LOCKSETS AND DEADBOLTS

- A. Lockset: DORMA CL800 Series, Heavy Duty.
 - 1. Standards:
 - a. ANSI Conformance - ANSI A156.2, Series 4000, Grade 1.
 - b. U.L. and C.U.L. listed for use on 3-hour fire-rated doors and for all positive pressure applications.
 - c. U.L. and C.U.L. listed for UL 10B/10C and UBC 7.2 (1997).
 - d. Lever trim meets ANSI A117.1 and ADA requirements.
 - 2. Features:

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- a. Stainless steel latch.
 - b. Auxiliary deadlocking latch bolt.
 - c. Cast stainless steel latch retractor with bronze bearings.
 - d. Lock chassis constructed of steel and stainless steel components.
 - e. Key-in-lever lock through-bolted.
- 3. Trim:
 - a. Lever: LC, 3-7/16 inch (87 mm) rose.
 - 4. Lock Cylinder:
 - a. DORMA standard keyway with two nickel silver keys.
 - 5. Finish:
 - a. Chrome: 626 (Satin).

2.6 DEAD BOLTS

- A. Tubular Auxiliary Dead Bolts: DORMA DB800 Series.
 - 1. Features:
 - a. Solid steel reinforced strike plate.
 - 2. Backset: 2-3/4 inch (70 mm) backset 1 inch (25.5 mm) throw dead bolt with hardened steel roller.
 - 3. Lock Cylinder:
 - a. DORMA standard keyway with two nickel silver keys.
 - 4. Finish:
 - a. Chrome: 626 (Satin).

2.7 CYLINDERS

- A. Conventional Lock Cylinder: ANSI A156.5, Grade 1, 6 pin cylinders.

2.8 KEYING

- A. Keying:
 - 1. Keying: Factory Keyed as directed by Architect and Owner.
 - 2. Keying: Factory Master keyed.
 - 3. Keying: Factory Grand master keyed.
 - 4. Include construction keying.
 - 5. Supplier must submit key schedule for approval before ordering hardware.
- B. Keys:
 - 1. Nickel silver. Stamp keys with "DO NOT DUPLICATE".
 - 2. Supply keys in the following minimum quantities:
 - a. Master keys 2.
 - b. Grand master keys 2.
 - c. Construction keys 10.
 - d. Change keys 2.
- C. Key Cabinet:
 - 1. Construction: Sheet steel or aluminum construction, piano hinged door with cylinder type lock master keyed to building system.
 - 2. Size: Size for Project keys plus sufficient space for 10 percent growth.
 - 3. Key and key hook labeling system.
 - 4. Finish:
 - a. Manufacturer's standard as selected by the Architect.

2.9 EXIT DEVICES

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- A. General:
 - 1. DORMA exit devices are listed by U.L. and C.U.L. under their continuing reinspection programs and conform to standards U.L. 10C and U.B.C. 7-2 (1997) positive pressure testing. They are BHMA certified to the requirements of ANSI A156.3 for Grade 1 exit devices.
 - 2. Exit Devices: Exit devices shall be type and function as listed in hardware sets. Use fire exit hardware where exit devices are scheduled for fire door assemblies. Where lever handle trim is specified, match lever trim on locksets. Furnish free wheeling lever trim as standard. Construct device touchbar, rail and cover assemblies of heavy gauge solid wrought materials for true architectural finishes. Provide cylinder dogging on all non-rated devices. Furnish all devices with stainless 3/4 inch (19 mm) throw deadlocking latchbolts.
 - 3. All exit devices must have past a surpass a 2.5 million cycle test.
 - B. 9000 Series Heavy Duty Exit Device: ANSI A156.3, Grade 1, heavy duty exit devices.
 - 1. Model: 9300 Rim Device, panic listed only.
 - 2. Model: F9300 Rim Device, panic and fire listed.
 - 3. Strikes: Provide types suitable for opening.
 - 4. Finish:
 - a. Stainless: 630 (Satin).
 - C. Removable Mullions:
 - 1. F1340KR-8 Key Removable Steel Mullion: For use with U.L. listed fire exit devices. Standard in 8 foot length.
 - a. Finish: Prime 600.
 - 2. 1340KR-8 Key Removable Steel Mullion: 8 foot non-fire rated
 - a. Finish: Prime 600.

2.10 SURFACE DOOR CLOSERS

- A. Closers used in conjunction with overhead stops and holders shall be templated and coordinated to function properly. Properly detail closers to meet application requirements by providing drop plates, brackets, etc. to meet application and installation requirements as indicated.
- B. 8600 Series: ANSI A156.4, Grade 1, surface door closer.
 - 1. Model 8616 for interior and exterior applications and meets ANSI A117.1 and ADA for barrier-free accessibility.
 - 2. Model 8616 features adjustable spring sizes from 1 to 6.
 - 3. Compliant with UL10C and UBC 7.2 (1997) for positive pressure.
 - 4. Non-handed.
 - 5. Door control also features a backcheck positioning adjustment for parallel arm applications, to maintain an ANSI backcheck range similar to regular and top jamb applications.
 - 6. Independent sweep and latch non-critical closing speed adjustment.
 - 7. Standard Sprayed Finish: As selected.
 - a. 689 (Aluminum).
- C. STA Series: ANSI A156.4, Grade 1, corrosion resistant surface door closer.
 - 1. Model STA8616 for interior and exterior applications and meets ANSI A117.1 and ADA for barrier-free accessibility. Model 8616 features adjustable spring sizes from 1 to 6.
 - 2. Compliant with UL10C and UBC 7.2 (1997) for positive pressure.
 - 3. Non-handed.

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4. Stainless steel S-IS option available for use in severe climate conditions, or where there is exposure to corrosive environments.
 5. Finish: As specified in the Door Hardware Schedule.
- D. Spring Assist Arm Dead Stop: ANSI A156.4, Grade 1, DORMA Spring Assist Arm Systems for high volume high traffic applications. Meets requirements for UL10C and UBC 7.2 (1997) for positive pressure (non-hold open).
1. Model S-DS heavy duty, dead stop, parallel arm, pull side mount.
 2. Model S-IS regular, dead stop and top jamb mount, push side mount.
 3. Arms:
 - a. Heavy-Duty Parallel Arm x Spring Door Saver:
 - b. Regular x Spring Integra Stop Arm:
 - c. Top Jamb x Spring Integra Stop Arm
 4. Finish: 689 (Aluminum).

2.11 MISCELLANEOUS TRIM

- A. Push/Pulls: ANSI A156.6; push plates minimum 0.050 inch (1.27 mm) thick.
1. Type:
 - a. Push-pull plate.
 2. Size: Push plates shall be ANSI J302, size 4 inches (102 mm) by 16 inches (406 mm), thickness .050 inch.
 3. Size: Pull plates shall be ANSI J405, size 4 inches (102 mm) by 16 inches (406 mm), thickness .050 inch.
 4. Cut plates for cylinder or thumb piece when used with deadlock.
 5. Provide with through bolts to secure from opposite door face.
 6. Finish: As specified in the Door Hardware Schedule.
- B. Flush Bolts: ANSI A156.16 Grade 1 top and bottom flush bolts, with dust-proof floor strike.
1. Manual.
 2. Automatic.
 3. Provide as indicated on the Schedule.
 4. Finish: As specified in the Door Hardware Schedule.
- C. Kickplates, Mop Plate, Armor Plates: ANSI A156.6, metal; height indicated in Schedule by 1 inch (25 mm) less than door width:
1. Minimum 0.050 inch (1.27 mm) thick stainless steel.
 2. Width: 2 inches (51 mm) less than the width of each door..
 3. Provide as indicated on the Schedule.
- D. Stops: Provide for all doors to control the desired limit of opening helping to prevent damage to adjacent walls, columns, equipment, the door or its hardware
1. Provide floor or wall stops when overhead stops have not been listed except in areas where their location would impede traffic. Stops of correct height shall be used on exterior and interior doors.
 2. Doors with surface closers may be provided with S-DS or S-IS dead stop arms
 3. Use roller type stops in areas where the interfering swing of one door may cause damage through contact with another door.
 4. Wall Stops: ANSI A156.1, Grade 1, with no visible screws:
 - a. Concave pad wall stop.
 - b. Finish: As specified in the Door Hardware Schedule.

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- E. Standard Duty Door Stops and Holders: 700 Series, Standard Duty door stops and holders. Conforms to ANSI A156.8 Grade 3.
 - 1. Type:
 - a. 700S: Surface applied stop only.
 - b. 700H: Surface applied stop and hold open.
 - 2. Built-in cushioned stop.
 - 3. Non-handed.
 - 4. Adjustable friction tension with friction stop unit
 - 5. Standard Sprayed Finish: As selected.
 - a. 689 (Aluminum).
 - F. Silencers for Metal Door Frames: ANSI A156.16, Type L03011; grey rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame, specifically designed to form an air pocket to absorb shock and reduce noise of door closing. Provide 2 silencers for each pair of doors, 3 silencers for each single door.
 - G. All thresholds must comply with ADA guidelines.

PART 3 EXECUTION

3.2 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings.
- C. Verify electric power is available to power operated devices and is of correct characteristics.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate mounting heights with door and frame manufacturers. Use templates provided by hardware item manufacturer.
- C. Install with fasteners provided by hardware item manufacturer.
- D. Adjust hardware for smooth operation.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

DOOR FINISH HARDWARE SCHEDULE

Manufacture's Abbreviations:

1. PBB Hinges- PBB or Equal
2. DORMA-DM or Equal
3. Rockwood-RW or Equal
4. Pemko-PM or Equal

Treatment Building Doors refer to Sheet 24 & 25

Door A: Hardware to be furnished by door supplier refer to Note 14, Sheet 25.

Hardware Set 01: Door B

1 Geared Hinge CFM83HD1	C	PM
1 Exit Device 9300B x YC09C	630	DM
1 Mortise Cylinder	626	DM
1 Closer 8616 S-DST	689	DM
1 Kickplate K1050 10 x 34	630	RW
1 Threshold 2005AT 36"	Alum	PM
1 Door Sweep 315 CN 36"		PM
1 Set of Gasketing 303AS 1 x 36" + 2 x 84"		PM
1 Drip Cap 346C 40"		PM

Hardware Set 02: Door C, D

2 Pin and Barrel Hinge SPBFMHD83	630	PM
2 Exit Devices 9300B x YC09C	630	DM
2 Mortise Cylinders	626	DM
1 Mullion 1340KR-8	600	DM
1 Rim Cylinder	626	DM
2 Closers STA 8616 ARP STA FMC	630	DM
2 Kickplates K1050 10 x 34	630	RW
2 Floor Stops 470	630	RW
2 Thresholds 1715 36"	AK	PM
2 Door Sweeps 315CN 36"		PM
2 Sets of Gasketing 303AS 1 x 36" + 2 x 84"		PM
1 Drip Cap 346C 76"		PM

Door E: Hardware to be furnished by door supplier refer to Note 15, Sheet 25.

Hardware Set 03: Door F

3 Hinges BB81 4 ½ x 4 ½	626	PBB
1 Push Plate 70C 6 x 16	630	RW
1 Pull Plate 110 x 70C	630	RW
1 Closer 8616 AF86P	689	DM
1 Kickplate K1050 10 x 34	630	RW
1 Wall Stop 409	630	RW
3 Silencers 608	Grey	RW

Hardware Set 04: Doors G

3 Hinges BB81 4 ½ x 4 ½	626	PBB
1 Lockset CL880D LC Knurled	626	DM
1 Closer 8616 DS	689	DM
1 Kickplate K1050 10 x 34	630	RW
3 Silencers 608	Grey	RW

Hardware Set 05: Door H, N

3 Hinges BB81 4 ½ x 4 ½	626	PBB
1 Lockset CL870D LC	626	DM
1 Closer 8616 AF86P	689	DM
1 Kickplate K1050 10 x 34	630	RW
1 Wall Stop 409	630	RW
3 Silencers 608	Grey	RW

Hardware Set 06: Door J, K

1 Pin and Barrel Hinge SPBFMHD83	630	PBB
1 Lockset ML9070D LCB	630	DM
1 Closer STA 8616 ARP STA FMC	630	DM
1 Kickplate K1050 10 x 34	630	RW
1 Wall Stop 409	630	RW
3 Silencers 608	Grey	RW
1 Set of Smoke Gasketing S88D 17' @ fire rated openings		PM

Hardware Set 07: Door L

3 Hinges PB81 4 ½ x 4 ½	626	PBB
1 Lockset CL853D LC	626	DM
1 Wall Stop 409	630	RW
3 Silencers 608	Grey	RW

Hardware Set 08: Door M

3 Hinges PB81 4 ½ x 4 ½	626	PBB
1 Passage Set CL810 LC	626	DM
1 Wall Stop 409	630	RW
3 Silencers 608	Grey	RW

Hardware Set 09: Door P

1 Pin and Barrel Hinge SPBFMHD83	630	PM
1 Exit Device 9300B x YC09C	630	DM
1 Mortise Cylinder	626	DM
1 Closer STA 8616 ARP STA FMC	630	DM
1 Kickplate K1050 10 x 34	630	RW
1 Floor Stop 470	630	RW
3 Silencers 608	Grey	RW

Hardware Set 10: Door Q

6 Hinges PB81 4 ½ x 4 ½	626	PBB
1 Lockset CL870D LC	626	DM
2 Flushbolts 557 12"	626	RW
1 Dust Proof Strike 570	626	RW
2 Overhead Holders 702H	689	DM
2 Silencers 608	Grey	RW

Backwash Basin Building Doors refer to Sheet 38

Hardware Set 11: Door A

1 Pin and Barrel Hinge SPBFMHD83	630	PM
1 Lockset ML9080D LCB	630	DM
1 Closer STA 8616 AR STA FMC	630	DM
1 Threshold 2005AT 36"	Alum	PM
1 Door Sweep 315CN 36"		PM
1 Set of Gasketing 303AS 1 x 36" + 2 x 84"		PM
1 Drip Cap 346C 40"		PM

Door B: Hardware to be furnished by door supplier refer to Note 14, Sheet 38.

Hardware Set 12: Door C

2 Pin and Barrel Hinge SPBFMHD83	630	PM
1 Lockset ML9080D LCB	630	DM
2 Flushbolts 555 12"	630	RW
1 Dust Proof Strike 570	630	RW
2 Closers STA 8616 ARP STA FMC	630	DM
2 Floor Stops 440	630	RW
2 Silencers 608	Grey	RW
• Astragal by door manufacture		

Raw Water Building Doors refer to Sheet 41 & 42

Hardware Set 13: Door A

2 Geared Hinges CFM83HD1	C	PBB
2 Exit Devices 9300B x YC09C	630	DM
2 Mortise Cylinders	626	DM
1 Mullion 1340KR	600	DM
1 Rim Cylinder	626	DM
2 Closers 8616 S-DST	689	DM
2 Kickplates K1050 10 x 34	630	RW
2 Thresholds 2005AT 36"	Alum	PM
2 Door Sweeps 315CN 36"		PM
2 Sets of Gasketing 303AS 1 x 36" + 2 x 84"		PM
1 Drip Cap 346C 76"		PM

END OF SECTION 087100

SECTION 088000 – GLASS AND GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Definitions:** "Glass" includes both primary and fabricated glass products as described in FGMA "Glazing Manual". "Glazing" includes glass installation and materials used to install glass.
- B. Extent** of glass and glazing work is indicated on drawings and schedules.
- C. Types** of work in this section include glass and glazing for:
 - 1. Twin insulating glass as shown on Drawings.
 - 2. Window units, not indicated as "pre-glazed".
 - 3. Entrances and other doors, not indicated as "pre-glazed".

1.03 SYSTEM PERFORMANCES

Provide glass and glazing that has been produced, fabricated and installed to withstand normal temperature changes, wind loading, impact loading (where applicable), without failure including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glass and glazing materials, and other defects in the work.

1.04 QUALITY ASSURANCE

- A. Glazing Standards:** Comply with recommendations of Flat Glass Marketing Association (FGMA) "Glazing Manual" and "Sealant Manual" except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this section or other referenced standards.
- B. Safety Glazing Standard:** Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for category II materials.
- C. Single Source Responsibility:** Provide materials obtained from one source for each type of glass and glazing product indicated.

1.05 SUBMITTALS

- A. Product Data:** Submit manufacturer's technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions.
- B. Samples:** Submit, for verification purposes, 12" square samples of each type of glass indicated except for clear single pane units, and 12" long samples of each color required (except black) for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative of adjoining framing system in color.

C. Certificate: Submit certificates from respective manufacturers attesting that glass and glazing materials furnished for project comply with requirements.

- Separate certification will not be required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authorities having jurisdiction.

D. Test Reports: Submit sealant-substrate adhesion and sealant compatibility test reports, including glazing sealant manufacturer's findings and recommendations.

1.06 DELIVERY, STORAGE, AND HANDLING

Protect glass and glazing materials during delivery, storage and handling to comply with manufacturer's directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes.

1.07 PROJECT CONDITIONS

Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing material manufacturer or when joint substrates are wet due to rain, frost, condensation or other causes. Install glazing sealants only when temperatures are in middle third of manufacturer's recommended installation temperature range.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

A. Manufacturers of Clear Float Glass and Sealed Insulating Glass Units:

1. Ford Motor Co., Glass Div.
2. Libbey-Owens-Ford Co.
3. PPG Industries, Inc.

B. Manufacturers of Wire Glass:

1. AFG Industries, Inc.
2. Guardian Industries Corp.
3. Hordis Brothers, Inc.
4. Pilkington Sales (North America) Limited.

2.02 GLASS PRODUCTS, GENERAL

A. Primary Glass Standard: Provide primary glass which complies with FS DD-G-451 requirements, including those indicated by reference to type, class, quality, and form.

B. Heat-Treated Glass Standard: Provide heat-treated glass which complies with FS DD-G-1403 requirements, including those indicated by reference to grade, style, type, quality, and class.

C. Insulating Glass Standard: Provide preassembled sealed insulating glass units which comply with ASTM E 774 requirements for classification designated below:

- Class A.

D. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses indicated, or, if not otherwise indicated, as recommended by glass manufacturer for application indicated.

2.03 PRIMARY GLASS PRODUCTS

A. Clear Float Glass: Type I, Class 1 (transparent), quality q3 (glazing select).

B. Wire Glass: Type II (rolled), class 1 (translucent), quality q8 (glazing); complying with ANSI Z97.1; 1/4" thick; of form and mesh pattern indicated below:

C. Polished Wire Glass: Form 1 (wired, polished both sides), mesh m1 (diamond).

2.04 HEAT-TREATED GLASS PRODUCTS

A. Manufacturing Process: Manufacture heat-treated glass as follows:

- By horizontal (roller hearth) process with roll wave distortion parallel with bottom edge of glass as installed, unless otherwise indicated.

B. Clear Tempered Float Glass: Grade B (fully tempered), style I (uncoated surfaces), type I (float), quality q3 (glazing quality), class 1 (transparent).

C. Clear Heat-Strengthened Float Glass: Grade A (heat strengthened), style I (uncoated surfaces), type I (float), quality q3 (glazing select), class 1 (transparent).

2.05 SEALED INSULATING GLASS UNITS

A. General: Provide preassembled units consisting of organically sealed panes of glass enclosing a hermetically sealed dehydrated air space; comply with requirements indicated for glass characteristics, air space, sealing system, sealant, spacer material, corner design, and dessicant.

B. Provide heat-treated panes of grade and at locations indicated or, if not indicated, provide heat-strengthened panes where recommended by manufacturer for application indicated and tempered where indicated or where safety glass is designated or required.

C. U-values indicated are expressed in Btu/(hr x sf x °F).

D. Thickness of Each Pane: 1/4".

E. Air Space Thickness: 1/2".

-
- F. Sealing System:** Manufacturer's standard.
 - G. Spacer Material:** Manufacturer's standard metal.
 - H. Dessicant:** Manufacturer's standard material.
 - I. Corner Design:** Manufacturer's standard.
 - J. Uncoated Insulating Glass Units:** Provide manufacturer's standard units complying with the following requirements:
 - 1. Exterior Pane: Clear float glass.
 - Grade: Tempered.
 - 2. Interior Pane of Glass: Clear float glass.
 - Grade: Tempered.

2.06 GLAZING SEALANTS

- A. General:** Comply with recommendations of sealant and glass manufacturers for selection of glazing sealants which have performance characteristics suitable for applications indicated and conditions at time of installation.
- B. Compatibility:** Select sealants with proven compatibility with surfaces contacted in the installation and under service conditions indicated, as demonstrated by testing and field experience.
- C. Colors:** Provide color of exposed sealants indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors.
- D. 2-Part Polysulfide Glazing Sealant:** Polysulfide elastomeric sealant complying with FS TT-S-00227, Class A, Type 2; and with ASTM C 920, Type M, Grade NS, Class 25, Use G and, as applicable to use indicated, Uses A and O.
- E. Acrylic Glazing Sealant:** Acrylic terpolymer or polypropenate solvent-based thermo-plastic 1-part sealant complying with FS TT-S-00230, Class B, Type II; and with ASTM C 920, Type S, Grade NS, Class 12-1/2, Use G and, as applicable to use indicated, Uses A and O.
- F. Preformed Butyl-Polyisobutylene Glazing Tape:** Blend of butyl- polyisobutylene rubber with a solids content of 100%, in extruded tape form, complying with AAMA 807.1, packaged on rolls with a release paper on side, with or without continuous spacer rod as recommended by manufacturers of tape and glass for application indicated.
- G. Available Products:** Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
 - 1. 2-Part Polysulfide Glazing Sealants:**
 - a. Sonolastic Two-Part; Sonneborn Building Products Div., Rexnord Chemical Products, Inc.
 - b. Chem-Calk 100; Woodmont Products, Inc.
 - 2. Acrylic Glazing Sealants:**

-
- a. Mono; Tremco.
 - b. Chem-Calk 800; Woodmont Products, Inc.

3. Preformed Butyl-Polyisobutylene Glazing Tape:

- a. Tremco Polyshim Tape; Tremco.
- b. Tremco 440 Tape; Tremco.
- c. SST 800 Tape; Tremco.
- d. Chem-Tape 40; Woodmont Products, Inc.

2.07 GLAZING GASKETS

A. Cellular Elastomeric Preformed Gaskets: Extruded or molded closed cell, integral-skinned neoprene of profile and hardness required to maintain watertight seal; complying with ASTM C 509, Type II; black.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

- **Manufacturers of Preformed Gaskets:**

- 1. D. S. Brown Co.
- 2. Maloney Precision Products Co.
- 3. Tremco.

2.08 MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide materials with proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.

C. Setting Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.

D. Spacers: Neoprene, EPDM or silicone blocks, or continuous extrusions, as required for compatibility with glazing sealant, of size, shape and hardness recommended by glass and sealant manufacturers for application indicated.

E. Edge Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealant, of size and hardness required to limit lateral movement (side-walking) of glass.

F. Compressible Filler Rods: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 5-10 psi compression strength for 25% deflection.

PART 3 - EXECUTION

3.01 INSPECTION

Require glazier to inspect work of glass framing erector for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners; for presence and functioning of weep system; for existence of minimum required face or edge clearances; and for effective sealing of joinery. Obtain Glazier's written report listing conditions detrimental to performance of glazing work. Do not allow glazing work to proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

Clean glazing channels and other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

3.03 GLAZING, GENERAL

- A. **Comply with combined printed recommendations** of glass manufacturers, of manufacturers of sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those of referenced glazing standards.
- B. **Glazing channel dimensions** as indicated in details are intended to provide for necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by job conditions at time of installation.
- C. **Protect glass from edge damage** during handling and installation; 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 with flares or bevels along one horizontal edge which would occur in vicinity of setting blocks so that these are located at top of opening. Remove from project and dispose of glass units with edge damage or other imperfections of kind that, when installed, weakens glass and impairs performance and appearance.
- D. **Apply primers to joint surfaces** where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

3.04 GLAZING

- A. **Install setting blocks** of proper size in sill rabbet, located one quarter of glass width from each corner, but no closer than 6", unless otherwise required. Set blocks in thin course of sealant which is acceptable for heel bead use.
- B. **Provide spacers** inside and out, of correct size and spacing to preserve required face clearances, for glass sizes larger than 50 united inches, except where gaskets or glazing tapes with continuous spacer rods are used for glazing. Provide 1/8" minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.
- C. **Provide edge blocking** to comply with requirements of referenced glazing standard, except where otherwise required by glass unit manufacturer.
- D. **Set units of glass** in each series with uniformity of pattern, draw, bow and similar characteristics.
- E. **Provide compressible filler rods** or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep

systems and from adhering to joints back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.

- F. **Force sealants into glazing channels** to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.
- G. **Tool exposed surfaces** of sealants to provide a substantial "wash" way from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.
- H. **Where wedge-shaped gaskets are driven** into one side of channel to presurize sealant or gasket on opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when installation is subjected to movement.
- I. **Miter cut wedge-shaped gaskets** at corners and install gaskets in manner recommended by gasket manufacturer to prevent pull away at corners; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.05 PROTECTION AND CLEANING

- A. **Protect exterior glass from breakage** immediately upon installation by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass. Remove nonpermanent labels and clean surfaces.
- B. **Protect glass from contact with contaminating substances** resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove immediately by method recommended by glass manufacturer.
- C. **Examine glass surfaces** adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less often than once a month, for build-up of dirt, scum, alkali deposits, or staining. When examination reveals presence of these forms of residue, remove by method recommended by glass manufacturer.
- D. **Remove and replace glass** which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.
- E. **Wash glass** on both faces not more than 4 days prior to date scheduled for inspections intended to establish date of substantial completion in each area of project. Wash glass by method recommended by glass manufacturer.

END OF SECTION 088000

SECTION 093010 - CERAMIC TILE (Unglazed Ceramic Mosaic Tile)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. **Definition:** Tile includes ceramic surfacing units made from clay or other ceramic materials.
- B. **Extent** of tile work is indicated on drawings and schedules.
- C. **Types** of tile work in this section include the following:
 - 1. Unglazed ceramic mosaic tile.
- D. **Sealing expansion and other joints** in tile work with elastomeric joint sealers is work of this section.

1.03 QUALITY ASSURANCE

Source of Materials: Provide materials obtained from one source for each type and color of tile, grout, and setting materials.

1.04 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical information and installation instructions for materials required, except bulk materials.
- B. **Samples for Initial Selection Purposes:** Submit manufacturer's color charts consisting of actual tiles or sections of tile showing full range of colors, textures and patterns available for each type of tile indicated. Include samples of grout and accessories involving color selection.
- C. **Sample for Verification Purposes:** Submit the following:
 - 1. Samples for each type of tile and for each color and texture required, not less than 12" square, on plywood or hardboard backing and grouted.
 - 2. Full size samples for each type of trim, accessory and for each color.

1.05 PRODUCT HANDLING

Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Prevent damage or contamination to materials by water, freezing, foreign matter or other causes.

1.06 PROJECT CONDITIONS

- A. **Maintain environmental conditions** and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.
- B. **Vent temporary heaters** to exterior to prevent damage to tile work from carbon dioxide buildup.

-
- C. Maintain temperatures** at not less than 50°F (10°C) in tiled areas during installation and for 7 days after completion, unless higher temperatures required by referenced installation standard or manufacturer's instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

A. Unglazed Ceramic Mosaic Tile:

1. American Olean
2. Daltile
3. Winburn Tile

B. Commercial Portland Cement Grout:

1. American Olean
2. Custom Building Products
3. L & M Surco Mfg. Co., Inc.
4. The Upco Company.

C. Chemical-Resistant Joint Sealants:

1. Atlas Minerals and Chemical Co.
2. Pennwalt Corporation
3. Aqua Mix, Inc.

D. Tile Cleaners:

1. Hillyard Chemical Co.
2. L & M Surco Mfg. Co., Inc.
3. Aqua Mix, Inc.

2.02 PRODUCTS, GENERAL

- A. ANSI Standard for Ceramic Tile:** Comply with ANSI A137.1 "American National Standard Specifications for Ceramic Tile" for types and grades of tile indicated.
- B.** Furnish tile complying with "Standard Grade" requirements unless otherwise indicated.
- C. Colors, Textures and Patterns:** For tile and other products requiring selection of colors, surface textures or other appearance characteristics, provide products to match characteristics indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standards.
- D. Slip Resistance:** All tile shall meet ADA Requirements for slip resistance.
- E.** Provide tile trim and accessories which match color and finish of adjoining flat tile.

2.03 TILE PRODUCTS

- A. Unglazed Ceramic Mosaic Tile:** Provide factory mounted flat tile complying with the following requirements:
1. **Color:** Selected from American Olean price groups 1-3.
 2. **Wearing Surface:** 3"x3" Slip-resistant tile.
 3. **Nominal Thickness:** 1/4".
 4. **Face:** Plain, with square edges.
- B. Trim Units:** Provide tile trim units to match characteristics of adjoining flat tile and to comply with following requirements:
1. **Size:** As indicated, coordinated with sizes and coursing of adjoining flat tile, where applicable.
 2. **Shapes:** As follows, selected from manufacturer's standard shapes:
 3. **Base for Portland Cement Mortar Installation:** Coved.
 4. **External Corners for Thinset Installations:** Surface bullnose.
 5. **Internal Corners:** Field-butt square corners, except use internal cove and cap angle pieces designed to member with stretcher shapes.

2.04 SETTING MATERIALS

- A. Portland Cement Mortar Installation Materials:** Provide materials to comply with ANSI A108.1 as required for installation method designated, unless otherwise indicated.
- B. Thinset Portland Cement Mortar:** Where thinset portland cement mortar applications are indicated, use the following unless otherwise required:
4. Latex-portland cement mortar, ANSI A118.4.

2.05 GROUTING MATERIALS

Epoxy Grout: ANSI A118.3, TCA Formula AAR-II, product of TCA licensee.

2.06 MISCELLANEOUS MATERIALS

- A. Two-Component Sealants:** ASTM C 920, Type M, Grade P, Class 25, use T (for use in joints subject to pedestrian traffic).
- B. For** chemical resistant floors, use chemical- resistant sealants compatible with resin members and grouts as approved by resin manufacturers.
- C. Tile Cleaner:** Product specifically acceptable to manufacturer of tile and grout manufacturer for application indicated and as recommended by National Tile Promotion Federation, 112 North Alfred St., Alexandria, VA 22134 or Ceramic Tile Institute, 700 N. Virgil Ave., Los Angeles, CA 90029.

PART 3 - EXECUTION

3.01 INSPECTION

Examine surfaces to receive tile work and conditions under which tile will be installed. Do not proceed with tile work until surfaces and conditions comply with requirements indicated in referenced tile installation standard.

3.02 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standard:** Comply with applicable parts of ANSI 108 series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile".
- B. TCA Installation Guidelines:** TCA "Handbook for Ceramic Tile Installation"; comply with TCA installation methods indicated or, if not otherwise indicated, as applicable to installation conditions shown.
- C. Extend** tile work into recesses and under or behind equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disrupting pattern or joint alignments.
- D. Accurately** form intersections and returns. Pre-form 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 that plates, collars, or covers overlap tile.
- E. Jointing Pattern:** Unless otherwise shown, lay tile in grid pattern. Align joints when adjoining tiles on floor, base, walls and trim are same size. Layout 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 shown.
- F.** For the mounted in sheets make joints between tile sheets same width as joints within tile sheets so that extent of each sheet is not apparent in finished work.
- G. Expansion Joints:** Locate expansion joints and other sealant filled joints, including control, contraction and isolation joints, where indicated, or if not indicated, at spacings and locations recommended in TCA "Handbook for Ceramic Tile Installation", and approved by Architect.
- H.** Prepare joints and apply sealants to comply with requirements of referenced standards and sealant manufacturer.
- I.** Grout tile to comply with referenced installation standards, using grout materials indicated.

3.03 FLOOR INSTALLATION METHODS

- A. Ceramic Mosaic Tile:** Install tile to comply with requirements indicated below for setting bed method, TCA installation method related to type of subfloor construction, and grout type:
- B. Portland Cement Mortar:** ANSI A108.1.
TCA F112-94
- C. Bond Coat:** Portland paste on plastic bed; or thin-set portland cement on cured bed, ANSI A108.5; at Contractor's option.
 - 1. TCA F115-95

D. **Grout:** Epoxy Grout per AMSI A108.6

3.04 CLEANING AND PROTECTION

- A. **Cleaning:** Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
- B. Unglazed tile may be cleaned with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but no sooner than 14 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.
- C. **Remove temporary wax coating** from quarry tile, using methods recommended by manufacturer's of tile and grout.
- D. **Finished Tile Work:** Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.
- E. **Protection:** 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.
- F. Prohibit foot and wheel traffic from using tiled floors for at least 7 days after grouting is completed.
- G. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION 093010

SECTION 095100 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.01 DESCRIPTION OF WORK:

- A. **Extent** of each type of acoustical ceiling is shown and scheduled on drawings.
- B. **Types** of acoustical ceilings specified in this section include the following:
 - Acoustical panel ceilings, exposed suspension.

1.02 QUALITY ASSURANCE:

- A. **Fire Performance Characteristics:** Provide acoustical ceiling components that are identical to those tested for the following fire performance characteristics, according to ASTM test method indicated, by UL or other testing and inspecting agency acceptable to authorities having jurisdiction. Identify acoustical ceiling components with appropriate marking of applicable testing and inspecting agency.
- B. Require UL Certification for Load Compliance per ASTM C635 for Quality Assurance.
- C. **Surface Burning Characteristics:** As follows, tested per ASTM E 84.
 - 1. **Flame Spread:** 25 or less.
 - 2. **Smoke Developed:** 50 or less.
- D. **Coordination of Work:** Coordinate layout and installation of acoustical ceiling units and suspension system components with other work supported by or penetrating through, ceilings, including light fixtures, HVAC equipment, fire-suppression system components (if any), and partition system (if any).

1.03 SUBMITTALS:

- A. **Product Data:** Manufacturer's product specifications and installation instructions for each acoustical ceiling material required, and for each suspension system, including certified laboratory test reports and other data as required to show compliance with these specifications.
- B. Include manufacturer's recommendations for cleaning and refinishing acoustical units, including precautions against materials and methods which may be detrimental to finishes and acoustical performances.

1.04 SAMPLES:

- A. Set of 6" x 4" square samples for each acoustical unit required, showing full range of exposed color and texture to be expected in completed work.
- B. Set of 12" long samples of each exposed runner and molding.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. **Deliver acoustical ceiling units** 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 or other causes.
- B. **Before installing acoustical ceiling units**, permit them to reach room temperature and a stabilized moisture content.
- C. **Handle acoustical ceiling units** carefully to avoid chipping edges or damaging units in any way.

1.06 PROJECT CONDITIONS:

Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

PART 2 - PRODUCTS

2.01 ACOUSTICAL CEILING UNITS, GENERAL:

- A. **Standard for Acoustical Ceiling Units:** Provide manufacturer's standard units of configuration indicated which are prepared for mounting method designated and which comply with FS SS-S-118 requirements, including those indicated by reference to type, form, pattern, grade (NRC or NIC' as applicable), light reflectance coefficient (LR), edge detail, and joint detail (if any).
- B. **Mounting Method for Measuring NRC:** No. 7 (mechanically mounted on special metal support), FS SS-S-118; or Type E-400 mounting as per ASTM 795.
- C. **Sound Attenuation Performance:** Provide acoustical ceiling units with ratings for ceiling sound transmission class (STC) of range indicated as determined according to AMA 1-II "Ceiling Sound Transmission Test by Two-Room Method" with ceilings continuous at partitions and supported by a metal suspension system of type appropriate for ceiling unit of configuration indicated (concealed for tile, exposed for panels).
- D. **Colors, Textures, and Patterns:** Provide products to match appearance characteristics indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors, surface textures, and patterns available for acoustical ceiling units and exposed metal suspension system members of quality designated.

2.02 ACOUSTICAL PANELS:

- A. Type I: Armstrong Fine Fissured #1729 square edge with Humiguard Plus Performance. 24"x 48"x 5/8" UL Classified NRC .55 CAV 35. Light Reflectance 84%. Manufacturer's 10-year warranty from sagging or warping.
- B. Type II: Armstrong Ceramaguard #605 with Humiguard Max Performance. 24" x 24 x 5/8" and "24" x 48" x 5/8". UL Classified NRC.10 CAC 40. Light reflectance 80%. Scrubbable factory applied vinyl plastic paint. Manufacturer's 10-year warranty from sagging or warping. Provide hold down clips for all Type II ceilings.

2.03 METAL SUSPENSION SYSTEMS, GENERAL:

- A. Standard for Metal Suspension Systems:** Provide hot dipped galvanized metal suspension systems of type, structural classification and finish indicated which comply with applicable ASTM C 635 requirements.
- B. Finishes and Colors:** Provide manufacturer's standard finish for type of system indicated, unless otherwise required. For exposed suspension members and accessories with painted finish, provide color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's full range of standard colors.
- C. Attachment Devices:** Size for 5 times design load indicated in ASTM C 635, Table 1, Direct Hung.
- D. Hanger Wire:** Galvanized carbon steel wire, ASTM A 641, soft temper, prestretched, Class 1 coating, sized so that stress at 3- times hanger design load (ASTM C 635, Table 1, Direct Hung), will be less than yield stress of wire, but provide not less than 12 gage.
- E. Edge Moldings and Trim:** Metal of types and profiles indicated or, if not indicated, provide manufacturer's standard molding for edges and penetrations of ceiling which fits with type of edge detail and suspension system indicated.
- F. Hold-Down Clips for Non-Fire-Rated Ceilings:** For exterior ceilings and for interior ceilings composed at lay-in panels weighing less than 1 lb. per sq. ft., provide hold-down clips spaced 2'-0" o.c. on all cross tees.
- G. Available Manufacturers:** Subject to compliance with requirements, manufacturers offering suspension systems which may be incorporated in the work include, but are not limited to, the following:
- 1. Manufacturers of Steel Exposed Suspension Systems:**
 - Same as acoustical unit manufacturer.
 1. Chicago Metallic Corp.
 2. Donn Corp.
 3. Armstrong World Industries
 - 2. Manufacturers of Moldings and Trim:**
 1. Fry Reglet Corp.
 2. Technical Ceiling Systems, Inc.
 3. Donn Corp.
- H. Exposed Metal Direct-Hung Suspension Systems:**
- I. Non-Fire-Rated Double Web Steel Suspension System:**
- J. Prelude XL 15/16" exposed tee grid system with Humiguard Plus Performance.**
- K. Structural Classification:** Intermediate-duty system.
- L. Finish:** Painted, white.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. **Coordination:** Furnish layouts for inserts, clips, or other supports required to be installed by other trades for support of acoustical ceilings.
- B. Furnish concrete inserts, steel deck hanger clips and similar devices to other trades for installation well in advance of time needed for coordination of other work.
- C. **Measure each ceiling area** and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half width units at borders, and comply with reflected ceiling plans wherever possible.

3.02 INSTALLATION:

- A. **General:** Install materials in accordance with manufacturer's printed instructions, and to comply with governing regulations, fire-resistance rating requirements as indicated, and industry standards applicable to work.
- B. **Arrange acoustical units** and orient directionally-patterned units (if any) in manner shown by reflected ceiling plans.
- C. **Install tile** with pattern running in one direction.
- D. **Install suspension systems** to comply with ASTM C 636, with hangers supported only from building structural members. Locate hangers not less than 6" from each end and spaced 4'-0" along each carrying channel or direct-hung under, unless otherwise indicated, leveling to tolerance of 1/8" in 12'-0".
- E. **Secure wire hangers** by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail with age or elevated temperatures.
- F. **Install hangers plumb** and free from contact with insulation or other objects within ceiling plenum which are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, counter splaying or other equally effective means.
- G. **Install edge moldings** of type indicated at perimeter of acoustical ceiling area and at locations where necessary to conceal edges of acoustical units.
- H. **Screw-attach moldings** to substrate at intervals not over 16" o.c. and not more than 3" from ends, leveling with ceiling suspension system to tolerance of 1/8" in 12'-0". Miter corners accurately and connect securely.
- I. **Install acoustical panels** in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.
- J. **Install hold-down clips** in areas indicated, and in areas where required by governing regulations or for fire- resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.

3.03 ADJUST AND CLEAN:

Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

3.04 EXTRA STOCK:

- A. Deliver stock of maintenance material to Owner. Furnish maintenance material matching products installed, packaged with protective covering for storage and identified with appropriate labels.
- B. Acoustical Ceiling Units:** Furnish quantity of full size units equal to 2.0% of amount installed.

END OF SECTION 095100

SECTION 09650 - RESILIENT FLOORING

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

DESCRIPTION OF WORK:

Extent of resilient flooring and accessories is shown on drawings and in schedules.

QUALITY ASSURANCE:

Manufacturer: Provide each type of resilient flooring and accessories as produced by a single manufacturer, including recommended primers, adhesives, sealants and leveling compounds. Wherever possible, provide required resilient flooring and accessories produced by a single manufacturer.

Fire Test Performance: Unless otherwise indicated, provide resilient flooring having the following classifications or properties when tested in accordance with the standard fire tests referenced below:

Critical Radiant Flux: Not less than the following rating as per ASTM E 648:

0.45 watts per sq. cm.

Flame Spread: Not more than 75 as per ASTM E 84.

Smoke Developed: Not more than 450 as per ASTM E 662.

Smoke Density: Not more than 450 as per NFPA 258.

SUBMITTALS:

Product Data: Submit 2 copies of manufacturer's technical data and installation instructions for each type of resilient flooring and accessory.

Samples: Submit, for verification purposes, samples of each type, color and pattern of resilient flooring, including accessories, required indicating full range of color and pattern variation. Provide full size tile units, and 2-1/2" long sections of resilient flooring accessories.

For initial selection of colors and patterns submit, prior to above, samples in form of actual sections of resilient flooring, including accessories, showing full range of colors and patterns available, for each type of resilient flooring required.

Certification for Fire Test Performance: Submit manufacturer's certification that resilient flooring furnished for areas indicated complies with required fire test performance and has been tested and meets indicated requirements.

Maintenance Instructions: Submit 2 copies of manufacturer's recommended maintenance practices for each type of resilient flooring and accessory required.

Replacement Material: After completion of work, deliver to project site replacement materials from same manufactured lot as materials installed and as follows:

Tile flooring, not less than one box for each 50 boxes or fraction thereof, for each type, size and color installed.

JOB CONDITIONS:

Maintain minimum temperature of 65 degrees F (18 degrees C) in spaces to receive resilient flooring for at least 48 hours prior to installation, during installation and for not less than 48 hours after installation. Store resilient flooring materials in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 55 degrees F (13 degrees C) in areas where work is completed.

Install resilient flooring and accessories after other finishing operations, including painting, have been completed. Do not install resilient flooring over concrete slabs until the latter have been cured and are sufficiently dry to achieve bond with adhesive as determined by manufacturer's recommended bond and moisture test.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Vinyl Composition Tile:

Armstrong World Industries, Inc., or equal
Mannington, or equal

Wall Base:

Armstrong World Industries, Inc.
Flexco Div., Textile Rubber Co., Inc.
Johnsonite.

MATERIALS:

Colors and Patterns: As shown or scheduled, or as selected by Architect from manufacturer's standards.

Tile Flooring:

Vinyl Composition Tile: FS SS-T-312, Type IV; 12" x 12", unless otherwise indicated, and as follows:

ASTM F 1066 Class 2 – through pattern
Composition 1 - asbestos free.
Gage: 1/8"

Accessories:

Wall Base:

- A. ASTM F 1861.
 - 1. Armstrong World Industries, Inc.;
 - 2. Johnsonite;
 - 3. Roppe Corporation.

- B. Type (Material Requirement): TP (rubber, thermoplastic).

- C. Group (Manufacturing Method): II (layered).
- D. Style: Cover (with top set toe)
- E. Minimum Thickness: 0.125 inch (3.2mm).
- F. Height: 4 inches (102 mm).
- G. Lengths: Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length.
- H. Outside Corners: Premolded
- I. Inside Corners: Premolded
- J. Surface: Smooth.

Resilient Edge Strips: 1/8" thick, homogeneous vinyl or rubber composition, tapered or bullnose edges, color to match flooring, or as selected by Architect from standard colors available, not less than 1" wide.

Adhesives (Cements): Waterproof, stabilized type was recommended by flooring manufacturer to suit material and substrate conditions.

Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer.

Leveling Compound: Latex type as recommended by flooring manufacturer.

PART 3 - EXECUTION

PREPARATION:

Broom clean or vacuum surfaces to be covered and inspect sub- floor. Start of flooring installation indicates acceptance of subfloor conditions and full responsibility for completed work.

Use leveling compound as recommended by flooring manufacturer for filling small cracks and depressions in subfloors.

Perform bond and moisture tests on concrete slabs to determine that concrete surfaces are sufficiently cured, dried and ready to receive flooring.

Apply concrete slab primer, if recommended by flooring manufacturer, prior to application of adhesive. Apply in compliance with manufacturer's directions.

INSTALLATION:

General:

Install flooring using method indicated in strict compliance with manufacturer's recommendations. Extend flooring into toe spaces, door reveals and into closets and similar openings.

Maintain reference markers, holes or openings that are in place or plainly marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other non-permanent marking device.

Tightly cement flooring to subbase without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, or other surface imperfections. Hand roll flooring at perimeter of each covered area to assure adhesion.

Tile Floors:

Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room area are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters. Lay tile square to room axis, unless otherwise shown.

Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged if so numbered. Cut tile neatly around all fixtures. Broken, cracked, chipped or deformed tiles are not acceptable.

Lay tile with grain running in one direction.

Adhere tile flooring to substrates using full spread of adhesive applied in compliance with flooring manufacturer's directions.

Accessories:

Apply wall base to walls, columns, pilasters, casework and other permanent fixtures in rooms or areas where base is required. Install base in lengths as long as practicable, with preformed corner units. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.

On masonry surfaces, or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.

Place resilient edge strips tightly butted to flooring and secure with adhesive. Install edging strips at edges of flooring which would otherwise be exposed.

CLEANING AND PROTECTION:

Remove any excess adhesive or other surface blemishes, using neutral type cleaners as recommended by flooring manufacturer. Protect installed flooring with heavy Kraft paper or other covering.

Finishing: After completion of project and just prior to final inspection of work, thoroughly clean floors and accessories. Apply polish and buff with type of polish, number of coats and buffing procedures in compliance with flooring manufacturer's instructions.

END OF SECTION 09650

SECTION 099000 – PAINTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of painting work is indicated on drawings and schedules, and as herein specified.
- B. Work includes painting and finishing of interior and exterior exposed items and surfaces throughout project, except as otherwise indicated.
- Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatment specified under other sections of work.
- C. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- D. Surfaces to be painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect will select these from standard colors or finishes available.
- Following categories of work are not included as part of field-applied finish work.
- E. Pre-Finished Items: unless otherwise indicated, do not include painting when factory-finishing or installer- finishing is specified for such items as (but not limited to) metal toilet enclosures, pre-finished partition systems, acoustic materials and finished mechanical and electrical equipment, including light fixtures, switchgear and distribution cabinets.
- F. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, foundation spaces, furred areas, utility tunnels, pipe spaces, duct shafts and elevator shafts.
- G. Finished Metal Surfaces: Unless otherwise indicated, metal surfaces of anodized aluminum, stainless steel, chromium plate, copper, bronze and similar finished materials will not require finish painting.
- H. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts will not require finish painting.
- Following categories of work are included under other sections of these specifications:

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- I. Shop Priming: Unless otherwise specified, shop priming of ferrous metal items is included under various sections for structural steel, metal fabrications, hollow metal work and similar items.
- Unless otherwise specified, shop priming of fabricated components such as architectural woodwork, wood casework and shop- fabricated or factory-built mechanical and electrical equipment or accessories is included under other sections of these specifications.
- J. Mechanical and Electrical Work: Painting of mechanical and electrical work is specified in Divisions 15 and 16, respectively.
- Do not paint over any code-required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

1.3 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.
- B. Coordination of Work: Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical information including paint label analysis and application instructions for each material proposed for use.
- B. Samples: Prior to beginning work, Architect will furnish color chips for surfaces to be painted. Use representative colors when preparing samples for review. Submit samples for Architect's review of color and texture only. Provide a listing of material and application for each coat of each finish sample.
- C. On actual wood surfaces, provide two (2) 4" x 8" samples of natural and stained wood finish. Label and identify each as to location and application.
- D. On concrete masonry, provide two (2) 4-inch square samples of masonry for each type of finish and color, defining filler, prime and finish coat.

1.5 DELIVERY AND STORAGE

- A. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material.
 2. Fed. Spec. number, if applicable.

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3. Manufacturer's stock number and date of manufacturer.
 4. Manufacturer's name.
 5. Contents by volume, for major pigment and vehicle constituents.
 6. Thinning instructions.
 7. Application instructions.
 8. Color name and number.
- B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage of paint in a clean condition, free of foreign materials and residue.
- Protect from freezing where necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.6 JOB CONDITIONS

- A. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50°F (10°C) and 90°F (32°C), unless otherwise permitted by paint manufacturer's printed instructions.
- B. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45°F (7°C) and 95°F (35°C), unless otherwise permitted by paint manufacturer's printed instructions.
- C. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted by paint manufacturer's printed instructions.
- Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products, which may be incorporated in the work, include, but are not limited to, the following:

1. PPG Industries, Pittsburgh Paints
2. Porter Paints
3. Sherwin Williams

2.2 MATERIALS

- A. Material Quality: Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade produce will not be acceptable.
- B. Proprietary names used to designate colors or materials are not intended to imply that products of named manufacturers are required to exclusion of equivalent products of other manufacturers.
- C. Federal Specifications establish minimum acceptable quality for paint materials. Provide written certification from paint manufacturer that materials provided meet or exceed these minimums.
- D. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.
- E. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non-volatile (dry-film) of paint by weight.
 - This limitation is extended to interior surfaces and those exterior surfaces, such as stairs, decks, porches, railings, windows, and doors, which are readily accessible to children under seven years of age.

PART 3 – EXECUTION

3.1 INSPECTION

- A. Applicator must examine areas and conditions under which painting work is to be applied and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Applicator.
- B. Starting of painting work will be construed as Applicator's acceptance of surfaces and conditions within any particular area.
- C. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

3.2 SURFACE PREPARATION

- A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition.
 - 1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
 - 2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied

protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.

3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
- B. Cementitious Materials: Prepare Cementitious surfaces of concrete, concrete block, cement plaster and cement-asbestos board to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze.
1. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning if finish paint, correct this condition before application of paint. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
 2. Clean concrete floor surfaces, scheduled to be painted, with a commercial solution of muriatic acid, or other etching cleaner. Flush floor with clean water to neutralize acid, and allow to dry before painting.
- C. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer, before application of priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
1. Prime, stain, or seal wood required to be job-painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood, including cabinets, counters, cases, paneling.
 2. When transparent finish is required, use spar varnish for back-priming.
 3. Seal tops, bottoms, and cut-outs of unprimed wood doors with a heavy coat of varnish or equivalent sealer immediately upon delivery to job.
- D. Ferrous Metals: Clean ferrous surfaces, which are not galvanized or shop-coated, of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning.
- E. Touch-up shop-applied prime coats wherever damaged or bare, where required by other sections of these specifications. Clean and touch-up with same type shop primer.
- F. Galvanized Surfaces: Clean free of oil and surface contaminants with non-petroleum based solvent.

3.3 MATERIALS PREPARATION

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

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- C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film, and if necessary, strain material before using.

3.4 APPLICATION

- A. General: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Provide finish coats, which are compatible with prime paints used.
 2. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 3. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
 4. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.
 5. Paint backsides of access panels, and removable or hinged covers to match exposed surfaces.
 6. Finish exterior doors on tops, bottoms and side edges same as exterior faces, unless otherwise indicated.
 7. Sand lightly between each succeeding enamel or varnish coat.
 8. Omit first coat (primer) on metal surfaces, which have been shop-primed and touch-up painted, unless otherwise indicated.
- B. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
- Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure and application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- C. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as indicated or, if not indicated, as recommended by coating manufacturer.
- D. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to those items exposed in mechanical equipment rooms and in occupied spaces.
- E. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others.

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- Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.
- F. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth 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.
- G. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.
- Provide satin finish for final coats, unless otherwise indicated.
- H. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.5 CLEAN-UP AND PROTECTION

- A. Clean-Up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.
- Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.
- B. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.
- C. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.
- D. At completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

3.6 EXTERIOR PAINT SCHEDULE

General: Provide the following paint systems for the various substrates, as indicated.

3.7 CONCRETE MASONRY UNITS:

All exterior split faced concrete masonry units shall receive a weather-protective coating.

- A. Primer: 1 coat Luxon Block Surfacer A24W200 with minimum D.F.T. of 8 mil.
- B. First and Second Finish Coat: Luxon XP Waterproofing System A24 with a minimum D.F.T. 6.4-8.3 mils / coat.
1. Sherwin Williams - Luxon XP A24

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2. Benjamin Moore & Co. -Moorlastic 055
 3. Duron Paints & Wallcovering -MaxFlex Performance

3.8 GENERAL PAINTED WOOD

- A. Latex Gloss Finish: 2 finish coats over primer with total dry film thickness not less than 3.5 mils.
- B. Prime Coat:
 1. PPG Speedhide Wood Primer 6-809
 2. Porter STA Kill 194
 3. SWA 100 Exterior Latex Wood Primer, B42W41
- C. First and Second Finish Coat (Oil Finish):
 1. PPG Manor Hall 52-110
 2. Porter Acri Pro 100 6775
 3. SWA 100 Exterior Latex Gloss, A8 Series

3.9 FERROUS METAL

- A. Gloss Alkyd Enamel: 2 finish coats over primer.
- B. Primer Coat (Oil Finish):
 1. PPG Multiprime 90-689
 2. Porter U-Prime 286
 3. S.W. Kem Kromik Universal Primer, B50Z
- C. First and Second Coat Oil System:
 1. PPG Industrial Enamel 7-282
 2. Porter Industrial Enamel 2749
 3. S.W. Industrial Enamel B54

3.10 ZINC-COATED METAL

- A. High Gloss Alkyd Enamel: 2 finish coats over primer.
- B. Prime Coat:
 1. PPG Pittech DTM 90-712
 2. Porter DTM Primer 215
 3. S.W. Galvite HS Metal Primer, B50WZ30

C. First and Second Coat Oil System:

1. PPG Industrial Enamel 7-282
2. Porter Industrial Enamel 2749
3. S.W. Industrial Enamel B54

3.11 INTERIOR PAINT SCHEDULE

General: Provide the following paint systems for the various substrates, as indicated.

3.12 CONCRETE MASONRY UNITS

- A. High Build Semi-Gloss Polyamide Epoxy Coating: 2 coats over filled surface with total dry film thickness not less than 3.5 mils, excluding filler coat.
- B. Filler Coat: Block Filler. Apply filler coat at a rate to ensure complete coverage with pores filled.
1. PPG Speedhide Latex Block Filer 6-7
 2. Porter Promaster 2000 Latex Block Filler 6223
 3. S.W. PrepRite Latex Block Filler B25W25
- C. Epoxy Finish:
1. PPG Aquapon High Build High Performance Coating
 2. Porter
 3. S.W. ProMar

3.13 GYPSUM DRYWALL SYSTEMS

- A. Primer Coat:
1. PPG Speedhide High Build 6-4
 2. Porter Max Prime 567
 3. S.W. Preprite 200 Wall Primer, B28W200
- B. First & Second Coat:
1. PPG Speedhide 6-411 Eggshell
 2. Porter Promaster 2000 6129 Eggshell
 3. S.W. ProMar 200 Latex Eggshell, B20-220

3.14 GYPSUM DRYWALL SYSTEMS (Interior of Restrooms)

- A. Primer Coat:
1. PPG Speedhide 6-2
 2. Porter Promaster 2000 PP867

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3. S.W. Preprite 200 Latex Primer B28W200
- B. First & Second Coat:
1. PPG Manor Hall Interior Pearl Alkyd 28-110
 2. Porter Promaster 2000 Alkyd Satin Enamel PP129
 3. S.W. ProMar Alkyd Eg-Shell Enamel B33WZ1101

3.15 FERROUS METAL

- A. Semi-Gloss Enamel Finish: 2 coats over primer, with total dry film thickness not less than 2.5 mils.
- B. Prime Coat:
1. PPG Speedhide Int./Ext. Rust Primer 6-208
 2. Porter Glyptex Rust Inhibitive 296
 3. S.W. Kem Kromik Metal Primer, B50Z
- C. First & Second Coat Oil:
1. PPG Speedhide Speedhide S/G 6-1110
 2. Porter Promaster 2000 S/G 149
 3. S.W. Promar 200 Alkyd S/9 Enamel, B34-200.

3.16 ZINC-COATED METAL

- A. Semi-Gloss Finish: 2 coats over primer, with total dry film thickness not less than 2.5 mils.
- B. Prime Coat:
1. PPG Pitt-Tech DTM Primer Finish 90-line
 2. Porter DTM Primer Finish 215
 3. S.W. Galvite H.S. Metal Primer, B50WZ30
- C. Oil First & Second Coats:
1. PPG Speedhide Speedhide S/G 6-1110
 2. Porter Promaster 2000 Promaster S/G 149
 3. S.W. Promar 200 Alkyd S/9 Enamel, B34-200

END OF SECTION 099000-PAINTING

SECTION 099600

PAINTING – WATER WORKS

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

- A. This specification covers preparation of surfaces, performance and completion of painting of all surfaces as required by the drawings and as specified herein.
- B. All Materials delivered to job site shall be in original sealed and labeled containers of the paint manufacture.

1.02 ENVIRONMENTAL CONDITIONS

- A. Coatings shall be applied during good painting weather. Air and surface temperatures shall be within limits prescribed by the manufacture for the coating being applied and work areas shall be reasonably free of airborne dust at the time of application and while coating is drying.

1.03 ENVIRONMENTAL REGULATIONS

- A. All materials specified herein meet the current VOC Regulations and National AIM Regulations in effect. Shop applied materials to meet current HAPS requirements.
- B. All products in contact with potable water must be certified by ANSI/NSF to Standard 61.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials specified herein are manufactured by the TNEMEC Co., Inc., North Kansas City, Missouri (local contact 615-333-1000). These products are specified to establish standards of quality and are approved for use on this project.
- B. Equivalent materials of other manufacturers may be substituted on approval of the engineer. Requests for substitution shall include Manufacturer's literature for each product giving the name, generic type, descriptive information and evidence of satisfactory past performance. Submittals shall include the following performance data as certified by a qualified testing laboratory:

ASTM B117 - Method of Salt Spray (Fog) Testing

ASTM D149 - Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials of Commercial Power Frequencies

ASTM D3359 - Method for Measuring Adhesion by Test Tape
ASTM D3363 - Method for Film Hardness by Pencil Test
ASTM D4060 - Method for Abrasion Resistance of Organic coatings by the Taber Abraser
ASTM D4541 - Method for Pull-Off Strength of Coats Using Portable Adhesion Testers
ASTM 4585 - Practice for Testing the Water Resistance of Coatings Using Controlled Condensation
ASTM G53 - Practice for Operating Light- and Water- Exposure of nonmetallic Materials
AWWA D102 - Standard for Painting Steel Water Storage Tanks
SSPC-SP6 - Commercial Blast Cleaning
SSPC-SP10 - Near White Blast Cleaning

- C. Bidders desiring to use coatings other than those specified shall submit their proposal in writing to the engineer at least ten (10) days prior to the bid opening. Substitutions which decrease the film thickness, the number of coats applied, change the generic type of coating, or fail to meet the performance criteria of the specified materials will not be approved. Prime and finish coats of all surfaces shall be furnished by the same manufacturer.
- D. Colors, where not specified, shall be as selected by the engineer. All colors shall be certified lead free.
- E. Materials supplied by other manufacturers may be considered for substitution if the following prevailing conditions exist:
1. Performance criteria of the specified materials are exceeded by the submitted alternate materials as listed in paragraph 2.01 and detailed on the technical data sheets of each specified product.
 2. The submittal must compare the performance criteria of the specified material with that of the submitted material and be documented in a side by side manner for the Engineer\Owner to review.
 3. Substitute materials must be for complete systems and not individual products combined with the specified materials and the performance criteria for all products within a system must meet or exceed the specified materials.
 4. Only one alternate submittal will be received for this specification and must be accompanied by a detailed statement of the sum to be added or deducted from the base bid should alternate materials be accepted.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Materials shall be mixed, thinned and applied according to the manufacturer's printed instructions.

3.02 SURFACE PREPARATION

- A. Prepare surfaces in accordance with coating system's specifications. Touch up welds, burned and abraded areas with specified primer before applying field coats.
- B. Allow each coat to dry thoroughly before applying next coat.
- C. Finish coats shall be uniform in color and sheen without streaks, laps, runs, sags or missed areas. Primer and finish coats shall be furnished from the same Manufacturer to ensure compatibility.

3.03 ACCEPTANCE OF WORK

- A. All Surface Preparation and repairs shall be approved by the engineer/owner before primer is applied.
- B. Request acceptance of each coat before applying next coat.
- C. Correct work that is not acceptable and request re-inspection.

3.04 SYSTEM INSPECTION AND TESTING

- A. After application of each coating in the specified system and its surface has cured, measure its thickness with a properly calibrated Nordson Microtest Dry Film Thickness Gauge, or equivalent. Follow standard method for measurement of dry paint thickness with magnetic gauges as outlined in Society of Protective Coatings Specification SSPC-PA2
- B. Make as many determinations as needed to ensure the specified thickness values in each typical area. To all surfaces having less dry film thickness than specified, apply additional coat(s) at no extra cost to Owner to bring thickness up to specifications.
- C. Structural metals in immersion service that receive a protective coating system shall be checked with a non-destructive holiday detector that shall not exceed 67 1/2 volts. All pinholes or defects shall be repaired in accordance with manufacturer's printed recommendations and then retested.

- D. Masonry, drywall, or other non-metallic surfaces shall be continuously checked with wet-film thickness gauges during application to ensure proper dry film thickness will be attained. Also, square feet coverage needs to be monitored to verify proper coverage rates.
- E. Painting contractor shall permit Owner's Representative and/or paint & coating manufacturer (as requested by owner) to inspect his work for conformance to this specification. Owner reserves the right to reject all work that does not comply with this specification.

3.05 CLEANUP

- A. Remove and dispose of all rubbish or other unsightly material, in a legal manner, leaving the premises in a clean condition.

3.06 PAINTING SCHEDULE

- A. Steel - Structural, Tanks, Pipes and Equipment
 - 1. Exterior, Non-Immersion
Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: 1074U\1075U-Color Endura-Shield II at 2.0 - 3.0 mils DFT.
 - 2. Immersion, Potable or Non-Potable Water
Surface Preparation: SSPC-SP10 Near-White Blast Cleaning with a minimum 1.5 mil anchor profile.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
* Use Series N(L)140 Pota-Pox Plus in Potable Water
 - 3. Severe Vapor Phase and Liquid Fluctuation Level, Non-Potable water with high levels of Hydrogen Sulfide and abrasion.
Surface Preparation: SSPC-SP5/NACE 1 White Metal Blast Cleaning with minimum 3.0 mil anchor profile.
1st Coat: 435 PERMA-SHIELD ® at 15.0 - 20.0 mils DFT.
2nd Coat: 435 PERMA-SHIELD ® at 15.0 - 20.0 mils DFT.
* May be applied in one coat at 30.0 to 40.0 mils DFT
 - 4. Immersion or Hydrogen Sulfide Exposure
Surface Preparation: SSPC-SP10/NACE 2 Near White Blast Cleaning with minimum 2.0 mils anchor profile.
1st Coat: 446 Perma-Shield at 7.0 - 10.0 mils DFT.
2nd Coat: 446 Perma-Shield at 7.0 - 10.0 mils DFT.
 - 5. Interior, Non-Immersion
Surface Preparation: SSPC-SP6 Commercial Blast Cleaning with a minimum 1.5 mil anchor profile.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.

6. Metal Anchorage for Buried Piping
Surface Preparation: Shop Primed Materials - Clean and Dry or SSPC-SP3 Power Tool Clean.
1st Coat: 46-465 H.B. Tnemecol at 8.0 -12.0 mils DFT.
7. Miscellaneous Castings, Including Manhole Rings and Covers
Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
1st Coat: 46H-413 Hi-Build Tneme-Tar at 12.0 - 16.0 mils DFT.
8. Factory Primed
Field Surface Preparation: Surface shall be clean and dry.
Barrier Coat as Required: 1-1216 Omnithane at 2.5 - 3.5 mils DFT.
* check compatibility of shop primer.
Intermediate Coat: N69(L) Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
Interior Finish Coat: N69(L)-Color Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
Exterior Finish Coat: 1074/1075-Color Endura-Shield at 2.0 - 3.0 mils DFT.

B. Galvanized Metal

1. Exterior, Non-Immersion
Surface Preparation: Prepare in accordance with ASTM D6386.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
2nd Coat: 1074U\1075U-Color Endura-Shield at 2.0 - 3.0 mils DFT.
2. Interior, Non-Immersion
Surface Preparation: Prepare in accordance with ASTM D6386.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
3. Immersion
Surface Preparation: Prepare in accordance with ASTM D6386.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 2.0 - 3.0 mils DFT.
* Use Series N(L)140 Pota-Pox Plus in Potable Water

C. Mill Coated Steel Pipe

1. Exterior of Pipe, Non-Immersion
Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
Surface shall be clean and dry.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT
2nd Coat: 1074U\1075U-Color Endura-Shield at 2.0 -3.0 mils DFT.
2. Immersion, Potable or Non-Potable Water
Surface Preparation: SSPC-SP10 Near-White Blast Cleaning.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
* Use Series N(L)140 Pota-Pox Plus in Potable Water

D. Ductile or Cast Iron: Pipe and Miscellaneous Fabrications

1. Exterior, Non-Immersion
Surface Preparation: Surface shall be clean and dry. Remove Black Coating in accordance with NAPF 500-03-04.
1st Coat: N(L)69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: 1074U/1075U-Color Endura Shield at 2.0 - 3.0 mils DFT.
2. Interior, Non-Immersion
Surface Preparation: Surface shall be clean and dry. Remove Black Coating in accordance with NAPF 500-03-04.
1st Coat: : N(L)69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
3. Immersion, Potable or Non-Potable Water
Surface Preparation: Surface shall be clean and dry. Remove Black Coating in accordance with NAPF 500-03-04.
1st Coat: N(L)69-1255 Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
* Use Series N140 Pota-Pox Plus in Potable Water
4. Severe Vapor Phase and Liquid Fluctuation Level, Non-Potable water with high levels of Hydrogen Sulfide and abrasion.
Surface Preparation: NAPF 500-03-04.
1st Coat: 435 PERMA-SHIELD ® at 15.0 - 20.0 mils DFT.
2nd Coat: 435 PERMA-SHIELD ® at 15.0 - 20.0 mils DFT.
* May be applied in one coat at 30.0 to 40.0 mils DFT
5. Immersion or Hydrogen Sulfide Exposure
Surface Preparation: NAPF 500-03-04.
1st Coat: 446 Perma-Shield at 7.0 - 10.0 mils DFT.
2nd Coat: 446 Perma-Shield at 7.0 - 10.0 mils DFT.
6. Below Ground
Surface Preparation: Contact Tnemec Representative
Primer: (Optional) Series N69 Hi-Build Epoxoline, 3.0 to 5.0 mils DFT
Finish Coat: Series 46H-413 Hi-Build Tneme-Tar, 14.0 to 20.0 mils DFT

E. Concrete, Dense Masonry

1. Exterior, Non-Immersion
Surface Preparation: Surface shall be clean and dry.
One Coat: 180/181-Color W.B Tneme-Crete at 8.0 - 10.0 mils DFT.
2. Interior, Abrasion resistant
Surface Preparation: Surface shall be clean and dry. Stone rub to remove loose and small particles from surface. ICRI CSP 3-5
1st Coat: 104-Color HS Epoxy at 6.0 - 8.0 mils DFT .
2nd Coat: 104-Color HS Epoxy at 6.0 - 8.0 mils DFT.

3. Interior, exposed to high levels of Hydrogen Sulfide and Sulfuric Acid Condensate.
 Surface Preparation: SSPC-SP13/NACE 6, ICRI CSP 5 or greater
 Surfacer: 218 MortarClad
 1st Coat : 436 Perma- Shield FR at 50.0 to 125.0 mils DFT. Can be applied in one or two coats.
4. Fluoride Room, Floor & Walls
 Surface Preparation: Abrasive Blast or equivalent to remove laitance, form release agents, curing compounds, sealers and other contaminants provide profile NACE 6/SSPC-SP13, ICRI CSP 5. Perform “Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride” (ASTM F 1869).
 Moisture content not to exceed three pounds per 1,000 square feet in a 24 hour period.
 Surfacer: Tnemec 215 Surfacing Epoxy to fill all bug holes and concrete imperfections as required.
 Primer Coat: Tnemec 251SC –Beige ChemBloc at 6.0 to 8.0 mils DFT.
 Finish Coat: Tnemec 252SC- Gray ChemBloc at 8.0 to 12.0 mils DFT.
5. Chemical Storage, Containment Areas (Floor, Trench, Tank Pad, and 3'6" Band on Walls).
 Surface Preparation: Abrasive Blast or equivalent to remove laitance, form release agents, curing compounds, sealers and other contaminants to provide profile NACE 6/SSPC-SP13, ICRI CSP 5. Perform “Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride” (ASTM F 1869).
 Moisture content not to exceed three pounds per 1,000 square feet in a 24 hour period.
 Cant: 239SC Chembloc mortar (aggregate filled) - 1” x 1” cant to all inside 90 degree angles.
 Surfacer/Parge: Tnemec 218 MortarClad at 1/16” to 1/8” inch thickness to fill all bug holes and concrete imperfections as required. For more deteriorated substrates greater than 1/4” use Tnemec 217 Mortarcrete.
 Primer: Tnemec 201 Epoxoprime at 4.0 to 12.0 mils DFT.
 Base Coat: Tnemec 239SC ChemBloc at 8.0 to 12.0 mils DFT.
 Mat: Tnemec 211-0215 fiberglass reinforcing mat – lay into wet 239SC basecoat.
 Saturant Coat: Tnemec 239SC Chembloc at 8.0 to 12.0 mils DFT.
 Finish Coat: Tnemec 282 Tneme-Glaze at 6.0 to 8.0 mils DFT.

6. Immersion or Non-Immersion, Dense Masonry – Clearwell, wetwells and secondary containment
 Surface Preparation: Pressure Blast to achieve an open Capillary substrate.
 1st Coat: Apply XYPEX Concentrate at 1.5 pounds per square yard.
 2nd Coat: Apply XYPEX Modified at 1.5 pounds per square yard.
 Admix C-1000/ C-500 may be used at the batch plant as an admix in lieu of coatings.
 7. Interior, pipe gallery walls - Clear:
 Surface Preparation: Rub seams and irregular areas
 1st Coat: Chemprobe Series 660 Prima-A-Pell 200.
 2nd Coat: Chemprobe Series 660 Prima-A-Pell 200.
 8. Interior: pipe gallery walls - Colored
 Surface Preparation: Surface shall be clean and dry.
 1st Coat: 104-Color HS Epoxy at 6.0 – 8.0 mils DFT
 2nd Coat: 104-Color HS Epoxy at 6.0 - 8.0 mils DFT.
 9. Immersion: Potable or Non-Potable Water
 Surface Preparation: Brush-Off Blast.
 Filler Coat (As Required): Fill flush all bug holes and voids with TNEMEC 215 Epoxy Surfacer.
 1st Coat: 104-Color HS Epoxy at 6.0 - 10.0 mils DFT.
 2nd Coat: 104-Color H.S. Epoxy at 6.0 - 10.0 mils DFT.
 * Use Series N(L)140 Pota-Pox Plus in Potable Water
- F. Porous Masonry - CMU
1. Exterior
 Surface Preparation: Surface shall be clean and dry. Stone rub to remove loose and small particles from surface.
 1st Coat: 156-Color Enviro-Crete at 6.0 - 8.0 mils DFT.
 2nd Coat: 156-Color Enviro-Crete at 6.0 - 8.0 mils DFT.
 Note: Split face block requires TNEMEC 130 Envirofill.
 2. Interior
 Surface Preparation: Surface shall be clean and dry. Stone rub to remove loose and small particles from surface.
 1st Coat: 104-Color HS Epoxy at 80- 100 sq. ft. gal.
 2nd Coat: 104-Color HS Epoxy at 6.0 - 8.0 mils DFT.
 3. Exterior: Clear Sealer and/or Stain
 Surface Preparation: Surface to be sound, dry and free of cracks, oils efflorescence, paint or other contaminants.
 Sealer Coat: Apply TNEMEC Prima-Pell H₂O at 125 to 150 Sq. ft./gal.
- G. Concrete Floors
1. Interior
 - a. Pipe Gallery, Mechanical Rooms - Clear
 Surface Preparation: See Product Data Sheet
 2 coats: 629 CT Densifyer 201 at 300 to 350 sq. ft. per gallon.
 - b. Pipe Gallery, Mechanical Rooms – Colored
 Surface Preparation: Acid Etch or Brush-Off Blast. ICRI CSP 1-3

1st Coat: 205-ColorTerra-Tread FC at 3.0 - 5.0 mils DFT.
2nd Coat: 205-ColorTerra-Tread FC at 3.0 - 5.0 mils DFT.
3rd Coat: 290/291-Color CRU at 2.0 – 3.0 mils DFT. Non-skid with 211 Glass beads as required.

- c. Decorative - Lab area, Shower and Bathroom areas
Surface Preparation: SSPC-SP13/NACE 6, ICRI CSP 3 – 5.
1st Coat: 222-Color DECO-Tread double broadcast.
Total thickness 1/8 inch.
2nd Coat: 284 DECO-Clear at 6.0 to 12.0 mils DFT.
3rd Coat: 284 DECO-Clear at 6.0 to 12.0 mils DFT.

H. Concrete Structures.

1. Below Grade
Surface Preparation: Brush-off Blast.
One Coat: 46H-413 Hi-Build Tneme-Tar at 12.0 - 16.0 mils DFT.

I. Plaster and Wallboard

1. Interior
Surface Preparation: Surface shall be clean and dry.
1st Coat: Series 51 PVA Sealer DFT 1.0 - 2.0 mils.
2nd Coat: 1028/1029-Color Enduratone at 2.0 - 3.0 mils DFT.
3rd Coat: 1028/1029-Color Enduratone at 2.0 - 3.0 mils DFT.
2. Interior- Moderate Abuse
Surface Preparation: Surface shall be clean and dry.
1st Coat: Series 51 PVA Sealer DFT 1.0 - 2.0 mils.
2nd Coat: 113-Color H.B. Tneme Tuffcoat at 4.0 - 6.0 mils DFT.
3rd Coat: 113-Color H.B. Tneme Tuffcoat at 4.0 - 6.0 mils DFT.
3. Interior – Heavy Abuse
Base Coat: Series 273 Stranlok at 8.0 to 12.0 mils DFT.
Glass Mat: embed 273 mat while wet.
Saturant Coat: Series 273 Stranlok at 6.0 to 8.0 mils DFT.
Finish: Series 280-Color Tneme-Glaze, DFT 6.0 to 8.0 mils

J. Wood

1. Interior or Exterior
Surface Preparation: Surface shall be clean and dry
1st Coat: 151 Elasto Grip FC at 180-400 sq. ft. per gallon..
2nd Coat: TNEMEC 1028/1029-Color ENDURATONE® at 2.0 - 3.0 mils DFT.
3rd. Coat: TNEMEC 1028/1029-Color ENDURATONE® at 2.0 - 3.0 mils DFT.

K. Insulated Pipe

1. Interior
Surface Preparation: Surface shall be clean and dry
1st Coat: 6-Color Tneme-Cryl at 2.0 - 3.0 mils DFT.
2nd Coat: 1028/1029-Color Tneme-Cryl at 2.0 - 3.0 mils DFT.
- L. PVC Pipe
1. Interior
Surface Preparation: Surface shall be lightly sanded and be clean and dry.
One Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
- M. Non-Ferrous Metals
1. Interior
Surface Preparation: SSPC-SP1 Solvent Cleaning and lightly scarify.
One Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
 2. Exterior
Surface Preparation: SSPC-SP1 Solvent Cleaning and lightly scarify.
1st Coat: N69-Color Hi-Build Epoxoline II at 4.0 - 6.0 mils DFT.
2nd Coat: 1074U/1075U-Color Endura Shield at 2.0 – 3.0- mils DFT.
- N. Brick
1. Exterior Sealer

Surface Preparation: Surface to be sound, dry and free of cracks, oils, efflorescence, paint or other contaminates.
Sealer Coat: Apply TNEMEC Prima-Pell H₂O at 125 to 150 Sq. ft./gal.
- O. Metal Doors and Frames
1. Interior or Exterior
Surface Preparation: Surface shall be clean and dry. Lightly scarify shop primed surface and ensure compatibility with topcoat.
1st Coat: TNEMEC 1028/1029-Color ENDURATONE® at 2.0 - 3.0 mils DFT.
2nd Coat: TNEMEC 1028/1029-Color ENDURATONE® at 2.0 - 3.0 mils DFT.

3.06 COLOR CODE FOR PROCESSING EQUIPMENT

1. Prior to beginning work verify colors for new equipment with Owner.

System - OSHA:

	GENERIC COLOR	COLOR IDENTIFICATION
WATER		
Raw Water	olive green	110GN Clover
Settled or Clarified Water	aqua	10GN Aqua Sky
Finished or Potable Water	Dark Blue	11SF Safety Blue
Reclaimed Water	Purple	16SF Rec Water Purple
WASTEWATER		
Sewage Plant Effluent	day*	07RD Terra Cotta
Backwash Waste	light brown	68BR Twine
Sludge	dark brown	84BR Weathered Bark
Sewer (Sanitary or Other)	dark gray	34GR Deep Space
CHEMICAL		
Alum or Primary Coagulant	orange	04SF Safety Orange
Ammonia	white	11WH White
Carbon Slurry	black	35GR Black
Caustic	yellow with green band	02SF Safety Yellow with 09SF Safety Green
Chlorine (Gas and Solution)	yellow	02SF Safety Yellow
Fluoride	light blue with red band	25BL Fountain blue with 06SF Safety Red
Lime Slurry	light green	37GN Irish Spring
Ozone	yellow with orange band	02SF Safety Yellow with 04SF Safety Orange
Phosphate Compounds	light green with red band	37GN Irish Spring with 06SF Safety Red
Polymers or Coagulant Aids	orange with green band	04SF Safety Orange with 09SF Safety Green
Potassium Permanganate	violet	14SF Safety Purple
Soda Ash	light green with orange band	37GN Irish Spring with 04SFSafety Orange
Sulfuric Acid	yellow with red band	02SF Safety Yellow with 06SF Safety Red
Sulfur Dioxide	light green with yellow band	37GN Irish Spring with 02SF Safety Yellow
OTHER		

	GENERIC COLOR	COLOR IDENTIFICATION
Compressed Air	dark green	91GN Balsam
Gas Tile	red	28RD Monterrey
Other Lines	light gray	32GR Light Gray
Hoists/trolleys	yellow*	02SF Safety Yellow
Fire Protection	red*	06SF Safety Red

* These generic colors are not part of the Recommended Standards for Water Works.

END OF SECTION

Section 101550 - Toilet Compartments (Plastic Laminate)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes toilet compartments and screens as follows:

1. Type: Plastic laminate on HD particleboard.
2. Compartment Style: Overhead braced and floor anchored. Urinal screen ceiling brace.
3. Screen Style: Floor and ceiling anchored.

B. Related sections include the following:

- Division 10 "Toilet and Bath Accessories" for toilet paper holders, grab bars, purse shelves, and similar accessories.

1.03 SUBMITTALS

A. **Product Data:** For each type and style of toilet compartment and screen specified. Include details of construction relative to materials, fabrication, and installation. Include details of anchors, hardware, and fastenings.

B. **Shop Drawings:** For fabrication and installation of toilet compartment and screen assemblies. Include plans, elevations, sections, details, and attachments to other work.

C. Show locations of reinforcement and cutouts for compartment-mounted toilet accessories.

D. **Samples for Verification:** Of each compartment or screen color and finish required, prepared on 6-inch (150-mm) square samples of same thickness and material indicated for work.

1.04 PROJECT CONDITIONS

Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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. All American Metal Corp.
2. Ampco Products, Inc.

3. Bobrick Washroom Equipment, Inc.
4. Capitol Partitions, Inc.
5. Global Partitions, Inc.
6. Metpar Corp.

2.02 MATERIALS

- A. General:** Provide materials that have been selected for surface flatness and smoothness. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections on finished units are unacceptable.
- B. Plastic Laminate:** NEMA LD 3, GP-50, 0.05-INCH (1.27-mm) nominal thickness, color and pattern as follows:
- C. Color and Pattern:** One color and pattern in each room as selected by Architect from manufacturer's full range of colors and patterns.
- D. Core Material and Plastic Laminate:** ANSI 208.1, Type M-2 particleboard with 45-lb (20.4kg) density in thickness required to provide minimum nominal thickness for components as follows:
1. Doors, Panels, and Screens: 1 inch (25 mm).
 2. Doors, Panels, and Screens: 7/8 inch (22mm).
 3. Pilasters: 1 inch (25 mm).
- E. Pilaster Shoes and Sleeves (Caps):** ASTM A 666, Type 302 or 304 stainless steel, not less than 0.0312 inch (0.8 mm) thick and 3 inches (75 mm) high, finished to match hardware.
- F. Stirrup Brackets:** Manufacturer's standard ear or U-brackets for attaching panels and screens to walls and pilasters of the following material:
- **Material:** Stainless steel.
- G. Full-Height (Continuous) Brackets:** Manufacturer's standard design for attaching panels and screens to walls and pilasters of the following material:
- **Material:** Stainless steel.
- H. Hardware and Accessories:** Manufacturer's standard design, heavy-duty operating hardware and accessories of the following material:
- **Material:** Stainless steel.
- I. Overhead Bracing:** Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile in manufacturer's standard finish.
- J. Heat-Sink Strip:** Manufacturer's standard continuous, extruded-aluminum strip in manufacturer's standard finish.
- K. Anchorages and Fasteners:** Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads.

Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.03 FABRICATION

- A. **General:** Provide standard doors, panels, screens, and pilasters fabricated for compartment system. Provide units with cutouts and drilled holes to receive compartment-mounted hardware, accessories, and grab bars, as indicated.
- B. Provide internal reinforcement in metal units for compartment-mounted hardware, accessories, and grab bars, as indicated.
- C. **Floor-and-Ceiling-Anchored Compartments:** Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
- D. Provide metal-faced screens with integral full-height flanges for attachment to wall.
- E. **Floor-and-Ceiling-Anchored Screens:** Provide pilasters and panels of same construction and finish as toilet compartments. Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
- F. **Doors:** Unless otherwise indicated, provide 24-inch (610-mm) wide in-swinging doors for standard toilet compartments and 36-inch (914-mm) wide out-swinging doors with a minimum 32-inch (813-mm) wide clear opening for compartments indicated to be handicapped accessible.
- G. **Hinges:** Manufacturer's standard self-closing type that can be adjusted to hold door open at any angle up to 90 degrees.
- H. **Latch and Keeper:** Recessed latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be handicapped accessible.
- I. **Latch and Keeper:** Manufacturer's standard surface-mounted latch unit with combination rubber-faced door strike and keeper designed for emergency access. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be handicapped accessible.
- J. **Coat Hook:** Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
- K. **Door Bumper:** Manufacturer's standard rubber-tipped bumpers at out-swinging doors or entrance screen doors.
- L. **Door Pull:** Manufacturer's standard unit that complies with accessibility requirements of authorities having jurisdiction at out-swinging doors. Provide units on both sides of doors at compartments indicated to be handicapped accessible.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. **General:** Comply with manufacturer's written installation instructions. Install units rigid, straight, plumb, and level. Provide clearances of not more than 1/2 inch (13 mm) between pilasters and panels and not more than 1 inch (25 mm) between panels and walls. Secure units in position with manufacturer's recommended anchoring devices.
- B. Secure panels to walls and panels with not less than 2 stirrup brackets attached near top and bottom of panel. Locate wall brackets so holes for wall anchors occur in masonry or tile joints. Align brackets at pilasters with brackets at walls. **Floor-and-Ceiling-Anchored Compartments:** Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.
- C. **Screens:** Attach with anchoring devices according to manufacturer's written instructions and to suit supporting structure. Set units level and plumb to resist lateral impact.

3.02 ADJUSTING AND CLEANING

- A. **Hardware Adjustment:** Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and swing doors in entrance screens to return to fully closed position.
- B. Provide final protection and maintain conditions that ensure toilet compartments and screens are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 101550

SECTION 105220 FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

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

1.02 SUMMARY:

A. This Section includes the following:

1. Fire extinguishers.
2. Fire extinguisher cabinets.

B. **Related Sections:** The following sections contain requirements that relate to this section:

C. **Division 15 Section "Fire Protection"** for fire protection systems.

1.03 SUBMITTALS:

A. **General:** Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. **Product data** for each type of product specified. For fire extinguisher 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 form of manufacturer's color charts showing full range of colors available for those units with factory-applied color finishes.

1.04 QUALITY ASSURANCE:

A. **Single-Source Responsibility:** Obtain fire extinguishers and cabinets from one source from a single manufacturer.

B. **UL-Listed Products:** Fire extinguishers UL-listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher.

C. **FM-Listed Products:** Fire extinguishers approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher and carry appropriate FM marking.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

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

TLM Associates, Inc.

1

Section 105220 Fire Extinguishers, Cabinets,
and Accessories

1. Allenco.
2. Ansul Fire Protection, Wormald US Inc.
3. Badger-Powhatan.
4. Bobrick Washroom Equipment, Inc.
5. J. L. Industries.
6. Larsen's Manufacturing Co.
7. Modern Metal Products by Muckle.
8. Potter-Roemer, Inc.
9. Samson Metal Products, Inc.
10. Walter Kidde, Division of Kidde, Inc.
11. Watrous Inc.

2.02 FIRE EXTINGUISHERS:

- A. **General:** Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by Architect from manufacturer's standard, which comply with requirements of governing authorities.
- B. **Abbreviations** indicated below identify extinguisher types related to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.
- C. **Multipurpose Dry Chemical Type:** UL-rated 4-A:60-B:C, 10-lb. nominal capacity, in enameled steel container.

2.03 FIRE EXTINGUISHER CABINETS:

- A. **General:** Provide fire extinguisher cabinets where indicated, of suitable size for housing fire extinguishers of types and capacities indicated.
- B. **Construction:** Manufacturer's standard enameled steel box, with trim, frame, door, and hardware to suite cabinet type, trim style, and door style indicated. Weld all joints and grind smooth. Miter and weld perimeter door frames.
- C. **Cabinet Type:** Suitable for mounting conditions indicated, of the following types:
- D. **Surface-Mounted:** Cabinet box (tub) fully exposed and mounted directly on wall.

2.04 DOOR MATERIAL AND CONSTRUCTION:

- A. **Manufacturer's standard door construction,** of material indicated, coordinated with cabinet types and trim styles selected.
- B. **Enameled Steel:** Manufacturer's standard finish, hollow steel door construction with tubular stiles and rails.
- C. **Door Glazing:** Tempered float glass complying with ASTM C 1048, Type I, Quality q3, Class as follows:
 - Clear glass, Class 1 (transparent).
- D. Identify fire extinguisher in cabinet with lettering spelling "FIRE EXTINGUISHER" applied to door. Provide lettering to comply with requirements indicated for letter style, color, size,

spacing, and location or, if not otherwise indicated, as selected by Architect from manufacturer's standard arrangements.

E. Application Process: Silk screen.

F. 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 door pull, exposed or concealed, and friction latch. Provide concealed or continuous-type hinge permitting door to open 180 deg.

2.05 FINISHES FOR FIRE EXTINGUISHER CABINETS, GENERAL:

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Protect mechanical finishes on exposed surfaces from damage by application of strippable, temporary protective covering prior to shipment.

2.06 STEEL FIRE EXTINGUISHER CABINET FINISHES:

A. Surface Preparation: Solvent-clean surfaces in compliance with SSPS-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 in compliance with SSPC-SP 5 (White Metal Blast Cleaning) or SSPC-SP 8 (Pickling).

B. Baked Enamel Finish: Immediately after cleaning and pretreatment, apply manufacturer's standard 2-coat baked enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's instructions for application and baking to achieve a minimum dry film thickness of 2.0 mils.

C. Color and Gloss: As indicated by reference to manufacturer's standard color and gloss designations.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items included in this section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.

B. Securely fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb, to comply with manufacturer's instructions.

C. Where exact location of surface-mounted cabinets and bracket-mounted fire extinguishers is not indicated, locate as directed by Architect.

END OF SECTION 105220

SECTION 108000 –TOILET ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK:

A. Extent of each type of toilet accessory is indicated on drawings and schedules.

B. Types of toilet accessories required include the following:

- Paper Towel Dispensers.

C. Mirrors are specified in Section, "Mirror Units".

D. Toilet Partitions are specified in section "Toilet Partitions".

1.03 QUALITY ASSURANCE:

A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

B. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

C. Products: Provide products of same manufacturer for each type of accessory unit and for units exposed in same areas, unless otherwise acceptable to Architect.

1.04 SUBMITTALS:

A. Product Data: Submit manufacturer's technical data and installation instructions for each toilet accessory.

B. Setting Drawings: Provide setting drawings, templates, instructions, and directions for installation of anchorage devices in other work.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering toilet accessories which may be incorporated in the work include, but are not limited to, the following:

1. American Dispenser Co., Inc.
2. Bobrick Washroom Equip., Inc.
3. Bradley Corp.
4. McKinney/Kidde, Inc.
5. The Charles Parker Co.
6. Watrous, Inc.

2.02 MATERIALS, GENERAL:

- A. **Stainless Steel:** AISI Type 302/304, with polished No. 4 finish, 22 gage minimum, unless otherwise indicated.
- B. **Galvanized Steel Mounting Devices:** ASTM A 386, hot-dip galvanized after fabrication.
- C. **Fasteners:** Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed.

2.03 FABRICATION:

- A. **General:** Stamped names or labels on exposed faces of toilet accessory units are not permitted, except where otherwise indicated; inobtrusive labels on surfaces not exposed to view are acceptable. Where locks are required for a particular type of toilet accessory, provide same keying throughout project. Furnish two keys for each lock.
- 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. **Paper Towel Dispensers**
- D. **Surface-Mounted Towel Dispensers:** Fabricate of stainless steel with hinged front equipped with tumbler lockset. Provide pierced slots at sides as refill indicator.
- E. **Capacity:** Not less than either 300 C-fold or 400 Multifold paper towels without need for special adaptors.

PART 3 - EXECUTION

3.01 INSTALLATION:

Install toilet accessory units in accordance with manufacturers' instructions, using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated.

3.02 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 after removing labels and protective coatings.

END OF SECTION 108000

SECTION 108100 - MIRROR UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK:

- A. **Extent** of mirror units is indicated on drawings.
- B. **Types** of mirror units required include the following:
 - Stainless steel framed mirrors.
- C. **Toilet accessories** are specified elsewhere in Division 10.

1.03 QUALITY ASSURANCE:

General: Provide mirror units produced by single manufacturer for entire project.

1.04 SUBMITTALS:

- A. **Product Data:** Submit manufacturer's technical data, detail drawings, and installation instructions for mirror units.
- B. **Schedule:** Submit schedule indicating mirror types, quantities, sizes and installation locations for each mirror to be provided for project.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering mirror units which may be incorporated in the work include, but are not limited to, the following:

1. American Dispenser Co., Inc.
2. Bobrick Washroom Equipment, Inc.
3. Bradley Corp.
4. McKinney/Kidde, Inc.
5. The Charles Parker Co., Inc.
6. Watrous, Inc.

2.02 MATERIALS:

- A. **Mirror Glass:** 1/4" thick, Type I, Class 1, Quality q2, conforming to FS DD-G-451, with silvering, copper coating, and protective organic coating complying with FS DD-M-411.

B. Stainless Steel Framing: AISI Type 302/304, with polished No. 4 finish.

2.03 FABRICATION:

A. General:

B. Edge Protection: Fabricate frames for glass mirrors to accommodate wood, felt, plastic, or other glass edge protection material.

C. Backing: Provide mirror backing and support system which will permit rigid, tamperproof glass installation and prevent accumulation of moisture, as follows:

D. Galvanized steel backing sheet, not less than 22 gage and full mirror size, and non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.

E. Hangers: Provide system of mounting mirror units which will permit rigid, tamperproof and theftproof installation, as follows:

- Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring special tool to remove.

F. Stainless Steel Framed Mirrors:

G. Heavy-Duty Type: Fabricate frame with angle shapes of not less than 18 gage, with square corners mitered, welded, and ground smooth.

PART 3 - EXECUTION

3.01 INSTALLATION:

Secure mirrors to walls in tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square at locations indicated, in accordance with manufacturer's instructions for type of substrate involved.

3.02 ADJUST AND CLEAN:

Clean exposed surfaces of mirror units in compliance with manufacturer's recommendations.

END OF SECTION 108100

PART 1 – GENERAL

1.01 DESCRIPTION OF THE SYSTEM

- A. The ACTIFLO® Process is a high performance compact clarification system using microsand enhanced flocculation and settling. A coagulant is added to the raw water in the influent pipe and enters the pre-coagulation tank, followed by the coagulation tank, for micro-flocculation. The coagulated water then enters a third tank called the maturation tank, where the microsand and flocculant aid polymer is added. The microsand provides a large contact area for floc attachment and acts as a ballast, thereby accelerating the settling of the flocs. The flocculant aid polymer binds the destabilized suspended solids to the microsand particles by forming polymer bridges. In the maturation tank, the high efficiency mixing zone created by the use of a draft tube allows the microsand/sludge flocs to agglomerate and grow into high-density flocs known as microsand ballasted flocs. In the fourth tank, the settling tank, the microsand ballasted flocs settle quickly to the bottom of the tank. The efficiency of settling is further increased by the use of the lamella tubes. The sludge/microsand mixture is collected at the bottom of the settling tank, below the lamella tubes. This sludge/microsand mixture is then continuously pumped to hydrocyclones where the sludge is separated from the microsand by the centrifugal forces generated in the hydrocyclone. The recovered microsand is continuously recycled to the maturation tank, and the separated sludge is continuously discharged.

1.02 OPERATING CONDITIONS

Site Reference	Monroe County, KY
Type of application	Drinking Water
Type of Installation	(X) Indoor () Outdoor
Model Number	ACP2-45
Number of trains	One (1)
Design Flow per train (continuous operation)	2.0 MGD
Design Surface Loading Rate in settling zone	31.1 gpm/sf
Maximum Daily Flow per train (hydraulic capacity)	3.0 MGD
Number of recirculation lines per train	Two (2)
Flow per recirculation line	42 gpm

1.03 DESIGN REQUIREMENTS

- A. The ACTIFLO® process shall be capable of thorough coagulant mixing, microsand and polymer injection and mixing, floc maturation, settling, and removal. Final water clarification will take place via lamella settling tubes. Microsand is separated from the sludge/microsand mixture via continuous recirculation through the hydrocyclone(s). The microsand is continuously re-injected into the ACTIFLO® Process and the sludge is continuously discharged.
- B. The system shall be capable of initiating operation and reaching 65% of specified process performance within 1 to 2 hydraulic retention times when operated at design flow rate.
- C. The system shall be capable of continuously operating at surface loading rates of 31.1 gpm/sf at design flow rate for drinking water types of treatment.

- D. Only those processes making use of microsand ballasted flocculation, operating in the manner described above, will be considered.

1.04 ACTIFLO® SUPPLIER SCOPE OF WORK

- A. Krüger, Inc. is responsible for process design and equipment sizing, selection and procurement required for the ACTIFLO® system. The system will be designed and supplied in accordance with the Specifications as described herein. Krüger, Inc. scope of work does not include any engineering, selection, procurement, installation, or operation of any equipment, materials or other services not specifically defined in this Specification.
- B. Engineering will be in accordance with the project Plans and Specifications. Krüger, Inc. will provide all necessary design, installation and operating information for equipment within its stated scope of supply. Krüger, Inc. is not responsible for the design, selection, installation, operation or maintenance of any materials, equipment or services supplied by others.
- C. Krüger, Inc. will provide process engineering and design support for the system as follows:
 - 1. Dimensional Layout
 - 2. Installation Details
 - 3. Start-Up and Operation Instructions
 - 4. Electrical and Controls Diagram(s)
 - 5. Parts and Spare Parts List(s)
 - 6. Operation and Maintenance Manual
- D. Field Services

Krüger, Inc. will provide the services necessary to start-up, test, and operate the system as follows:
 - 1. Advice during installation
 - 2. Equipment check-out and start-up assistance
 - 3. Operator training
 - 4. Follow-up site visits
 - 5.

1.05 QUALITY ASSURANCE

- A. American National Standards Institute (ANSI)
- B. American Welding Society
- C. National Electric Manufacturer's Association (NEMA)
- D. National Electric Code (NEC)
- E. Standard Methods for the Examination of Water and Wastewater
- F. Institute of Electrical and Electronics Engineers (IEEE)

1.06 SUBMITTALS

- A. The Supplier shall furnish to the Contractor for review, six copies of each submittal. The term "submittal" as used herein shall be understood to include installation drawings, catalog sheets and data sheets. Unless otherwise required, said submittals shall be submitted to the Contractor, at a time sufficiently early to allow review of same by the

Contractor. The Contractor shall furnish the Engineer the submittals in compliance with the Project Specifications.

- B. Copies of all materials required establishing compliance with the specifications shall be submitted in accordance with the provisions of the contract documents. Submittals shall include at least the following:
1. Installation drawings showing important details of construction, dimensions, and field erection as required.
 2. Descriptive literature, bulletins, and/or catalogs of the equipment.
 3. Data on the characteristics, features, and performance of the equipment.
 4. Electrical Schematics, panel layouts, field wiring diagrams, instrumentation sheets, and product data sheets for all electrical equipment being supplied by the ACTIFLO® manufacturer.
 5. The weight of all equipment including the weight of the single largest item.
 6. Complete motor drive data.

1.07 OPERATION AND MAINTENANCE

- A. Operation and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cut sheets, drawings, equipment lists, descriptions, and other information that is required to instruct operation and maintenance personnel unfamiliar with such equipment.
- B. A factory trained representative with complete knowledge of the proper system operation and maintenance shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance of the system and equipment. The instruction shall be conducted in conjunction with the inspection of installation and start-up assistance as provided under Part 3. If there are difficulties in operation of equipment due to contractor's work, additional services shall be provided by supplier at standard supplier rates. The Supplier shall be provided with a minimum of 3-weeks' notice prior to the date personnel are requested to be on site.

1.08 PRODUCT HANDLING

- A. Equipment, including spares will be shipped by the ACTIFLO® Supplier or the Supplier's vendor when the equipment is ready and available for shipment. The Contractor will be responsible for receiving, unloading and properly storing the equipment in accordance with Supplier's instructions. Promptly upon the arrival of any equipment components at the job site or first shipping destination, the Contractor will prepare a Supplier's receiving report and submit a copy thereof to the Supplier. The receiving report is to note equipment receipt and all evidence of damage in transit, if any. Confirmation of inspection will be no later than 10 days after receipt of delivery.
- B. Equipment surfaces shall be properly protected to prevent rust, corrosion and damage. Precautions shall be taken to prevent carbon steel contamination of all stainless steel components.
- C. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.09 WARRANTY

- A. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from acceptance, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

1.10 PATENTS

- A. The Supplier shall assume all costs of patent fees or licenses for equipment or processes, and shall safeguard and save harmless the Owner and their agents from damages, judgments, claims and expenses arising from license fees or claimed infringements or any letters of patent or patent right, or because of royalty or fee for the use of any equipment or process, structural feature or arrangement of any of the component parts of the installation; and the price stipulated for all such patent fees, licenses, or other costs pertaining thereto.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Krüger Inc., of Cary, NC.
- B. Experience of Equipment Manufacturers:

1. The sand ballasted flocculation equipment supplier shall be furnished by a manufacturer who has at least twelve (15) years of experience in the United States in the design and commissioning of sand ballasted flocculation systems.
2. The sand ballasted flocculation equipment supplier shall have at least ten (15) commissioned drinking water installations of similar applications in the United States that have been in operation for at least ten (10) years.
3. The sand ballasted flocculation equipment supplier's system must have been approved by the Commonwealth of Kentucky Department For Environmental Protection for previous surface water clarification projects.

2.02 GENERAL

- A. The equipment covered by these Specifications is intended to be standard process equipment of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on Kruger's drawings.
- B. All parts shall be so designed and proportioned as to have liberal strength and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustment.
- C. The nameplate ratings for the motors shall not be exceeded, nor shall the design service factor be reduced when its piece of equipment is operating at any point on its characteristic curve.
- D. The location, size, and type of all piping shall be as shown on the Drawings, or as required by the equipment, if size not shown.
- E. For corrosion control, all fabricated steel parts will be coated per the manufacturers' standard

2.03 PACKAGE PLANT – GENERAL

- A. The **ACTIFLO**® shall be supplied as a shop fabricated, skid mounted system, complete with flanged inlet and outlet connections. Unit is assembled as much as possible in the factory prior to shipment. Please refer to Section CONTRACTOR'S INSTALLATION TASKS for further details.
- B. The package plant system shall be supplied with grating to permit access to the top of the unit. Grating shall be provided to cover the pre-coagulation, coagulation and flocculation tanks.
- C. The package plant system shall be supplied with handrails around the grating area. One access opening adjacent to the ladder (by others) shall be provided.
- D. The package plant shall be sized and configured according to the Kruger-supplied drawings.
- E. Approximate operating weights are as follows:

ACP2-45 tank:

(Tank Assembly Weight; Dry) 22,000 lbs
(Full of Water) 115,000 lbs

2.04 COAGULANT DISPERSION DEVICE – INLINE MECHANICAL MIXER

- A. An inline mechanical mixer shall be supplied for coagulant dispersion prior to the flow entering the ACTIFLO® system.
- B. Service Conditions
1. A quantity of one (1) pipeline-mounted mixer is required. The mixer shall be designed to meet the following requirements:

Velocity Gradient	TBD	sec ⁻¹
Flow Range (Min, Design, Max)	0.5, 2.0, 3.0	gpm
Max Pressure Drop at Design Flow	TBD	psi
Nominal Pipe Diameter	12	inches
Pipe Length	TBD	inches
Process Fluid	Drinking Water	
No. of Injection Ports	Two (2)	
Injection Fluids	Alum	
Pipe Material	Epoxy Coated A36 Carbon Steel	
Baffle Material	316 Stainless Steel	
Seal Type	Single Mechanical, Dry Running	
Material of Wetted Parts	316 Stainless Steel	

- C. Materials
1. Design for long, continuous, and uninterrupted service; easy adjustment or replacement of parts; minimum ¼-in. thickness, steel members; minimum ½-in. diameter, structural bolts.
 2. Structural steel in accordance with ASTM A36.
 3. Iron castings in accordance with ASTM A48.
 4. Provide Type 316 stainless steel for fasteners and wetted parts of mixers. Stainless steel-clad or type 304 stainless steel shafts are not acceptable.
- D. Pipeline Mounted Flash Mixers
1. Mixer Body :
 - a. Mixer body shall be supplied as a pipe section with both ends flanged. It shall contain a vertical flange mounted mixer. The pipe body shall have an integral mounting flange for connection to the mixer drive. The vertical flange opening shall be large enough for removal of the mixer as a complete unit with exception of the mixing blades when bolted to a central hub. The mixer body shall incorporate a lower vertical flange for stabilizing bearing housing where required. All flanges shall be fabricated per standards for ANSI 150#.

- b. Where required by the drawings, the mixer body shall be supplied with four (4) mounting feet designed to support the complete unit.
- c. Gaskets shall be supplied for all bolted flange connections.
- d. Mixer body shall incorporate a dual flow straightening baffle arrangement. One baffle shall be located upstream and one baffle located downstream of the mixing impellers. Baffles shall be of the above specified material.
- e. Chemical feed ports shall be located on the side of the mixer body. Number of ports shall be as listed above. Chemical feed ports shall include an assembly to remove chemical solution lines without taking the mixer out of service.

2. Mixer Drive

- a. The drive's minimum service factor, based upon motor nameplate horsepower, will be 1.5. Upon request, mixer supplier must submit rating calculations with approval drawings.
- b. The mixer drive shall be designed with a shaft and bearing system suitable for the loadings imposed by the application. All designs shall be based upon the hydraulic loadings experienced in this specific mixing application.
- c. All components of each drive shall be designed, manufactured and assembled in full compliance with all applicable AGMA requirements.
- d. All drive bearings shall be large capacity, double shielded, heavy duty ball bearings. All bearings within the drive shall have minimum AFBMA L-10 lives of 100,000 hours when operating at full motor nameplate horsepower at design speed. Mixer supplier must submit bearing life calculations, with approval drawings. Bearing calculations must be based upon hydraulic loadings as seen in this specific mixing application.
- e. Thermal rating of the gear reducer must exceed design mechanical rating. No external cooling devices are allowed.

3. Impellers:

- a. Impeller type and number of blades shall be as recommended by the mixer manufacturer for a suitable process result.
- b. Impellers shall be removable and attach to the shaft by means of a dual set screw arrangement or a removable hook key and set screw arrangement.
- c. The maximum stress in any impeller component shall not exceed 12,000 psi under maximum operating loads
- d. The shaft-impeller system design shall be such that its operating speed shall not fall within 25% above or below its first lateral critical speed. The use of stabilizing rings or fins will not influence this limitation.

4. Impeller Shaft and Support Bushing:

- a. The agitator shaft shall be of the above specified grade of material. The shaft shall be designed such that the maximum stress shall not exceed 9,000 psi under maximum operating loads.
- b. Where required for seal integrity, shaft support bushing shall be located below the flange connection at the bottom of the pipe. Bushings shall be constructed of glass filled Teflon material. The bushing assembly shall include a shaft wear sleeve, and the complete bushing housing shall be removable for maintenance service without disturbing the mixer.

5. Drive Motors:

- a. The electric motor driver shall be commercially available standard NEMA C-Face, TEFC, premium efficient, and severe duty rated.
- b. Insulation shall be Class F, limited to Class B temperature rise at 40°C ambient at 1.0 service factor.
- c. Service factor shall be 1.15 on sine wave power and 1.0 on inverter power.
- d. Rating: 230/460 Volt/3 Phase/60 Hertz.
- e. L-10 Bearing Life: 100,000 hrs. at full load and speed.
- f. Maximum speed of 1800 rpm.

6. Seal Assembly

- a. Mixer shall be supplied with seal assembly as described above.
- b. Stuffing box or mechanical seal assembly shall be supplied as necessary for proper sealing of the mixer shaft opening.
- c. Seal assembly shall be designed for the maximum pressure in the pipe.

7. Guards

- a. Supply rotating shafts above platform level with guards conforming to OSHA Requirements.

E. Manufacturers

1. The inline mechanical mixers shall be supplied by Philadelphia Mixing Solutions, or equal.

2.05 PRE-COAGULATION, COAGULATION AND MATURATION TANK MIXERS

- A. Each mixer assembly shall consist of a heavy-duty speed reducer, premium efficient electric motor, baseplate, solid agitator shaft, and mixing impellers. Mechanical details of each component shall be as follows:

1. The mixer gear drive must be built in accordance with the current AGMA Standards. The AGMA calculated drive HP rating shall be stamped on the drive nameplate. Drive

housings shall be of high quality close grained cast iron, or fabricated steel, stress relieved and reinforced, and shall be provided with lifting lugs. Each unit shall be provided with an integral or separate baseplate.

2. Gearing must be vertical parallel shaft all helical gears or helical spiral bevel to ensure the highest efficiency coupled with the convenience of mounting and maintenance (worm gearing is not acceptable). Helical gears shall be a minimum AGMA Quality 10 per AGMA standard 390.03. Spiral/bevel sets shall be a minimum AGMA Quality 8, matched and lapped. The gears shall be grease-lubricated or lubricated from a common oil bath. Mixers with gears lubricated from a common oil bath shall be supplied with a minimum 12” pedestal base for ease of assembly of the agitator shaft and to facilitate draining of the oil from the gear drive. The full load operating noise levels of the mixer drives shall not exceed 85 dBA at 3 feet from any part of the drive assembly.
3. The mixer gear drive shall be designed with an output shaft system suitable for the loadings imposed by the specific duty. The drive’s minimum AGMA service factor shall be 1.5 and based upon motor nameplate horsepower. The service factor shall be based on AGMA Standard 6010-F97 for 24 hour per day moderate shock application. Service factors based on uniform load and motor bhp will not be accepted. Agitator gear drive coupled to impeller shaft must be designed, manufactured, and tested by the mixer supplier. Furnishing second party gear drives will not be allowed.
4. All drive bearings shall be of the antifriction type, ball or roller bearings. All bearings within the drive, including output shaft bearings, shall have minimum AFBMA B-10 lives of 50,000 hours when operating at full motor nameplate horsepower at design speed.
5. Each drive must have an effective lubrication of rotating elements without leakage down the output shaft. Output shaft bearings may be grease lubricated. Output shaft bearing seals shall be dry-well type. Lip seals shall only be permitted for grease lubricated gear drives.
6. The electric motor drivers shall have a 1.15 service factor and TEFC/TENV enclosure with class F insulation and class B temperature rise above 40 deg C ambient. The motors shall be squirrel cage induction motors for operation on 3 phase, 60 hertz, 230/460 volt current with synchronous speed of 1800 RPM or less. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. Maturation mixer motors are to be used with AC inverters that shall meet NEMA MG1, part 31 for variable torque, 10:1 turndown operation. The motor shall be connected to the input shaft with a flexible coupling and shall be pilot mounted with a NEMA C face flange; for mixers with grease-lubricated gear drives, the motor shall be connected directly to gear reducer without using a flexible coupling. Integral mounted motors without flexible coupling attachments shall not be accepted. IEC or other non-NEMA motor flanges will not be accepted. All motors shall be designed constructed and tested in accordance with applicable IEEE, NEA, and ANSI, standards.
7. The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged or integral coupling.
8. The agitator shaft shall be of solid 304 stainless steel construction. The shaft shall be designed such that the combined (Mohrs circle) maximum shear stress shall not exceed 9,000 psi under maximum operating loads for stainless steel. It shall be of overhung

design for use in complete coverage (liquid levels at least one impeller diameter above the impeller height). The use of underwater steady bearings is not permitted. The mixer shaft shall have a maximum operating speed of 0.75 times the natural frequency of the shaft and impeller assembly without the use of stabilizing ring and lower shaft bearing. The pre-coagulation and coagulation tank agitator shafts shall have extended keyways to allow the impeller to be placed 0.75D to 1.0D off of the tank bottom.

9. Pre-coagulation and coagulation tank mixer impellers shall be a low-shear, axial-flow, hydrofoil-type impeller, and the maturation tank mixer impeller shall be a low-solidity, draft tube-type impeller. Impellers shall be constructed of 304 stainless steel or other approved material as recommended by the mixer manufacturer. Impellers shall be of bolted construction and shall be connected to the agitator shaft with a hook key for maximum security. The maximum stress in any impeller component shall not exceed 11,000 psi under maximum operating loads.
10. Upon installation each unit shall be run to demonstrate its ability to operate without overloading, jamming, or excessive vibration during normal operation.
11. All non-wetted parts will be shipped with manufacturer's standard factory paint, suitable for use as a finish coat. All touch-up and additional coats are to be applied in the field by the contractor. Wetted parts, of 304 or 316 stainless steel, will not be painted.
12. The mixers shall be manufactured by Philadelphia Mixing Solutions, or equal.

2.06 MATURATION TANK DRAFT TUBE

- A. A draft tube shall be provided for the maturation tank for increased mixing efficiency.
 - a. The draft tube shall be constructed of 304 stainless steel, or other approved material as recommended by the mixer manufacturer, and shall be sized by the ACTIFLO[®] Supplier.
 - b. The draft tube will be supported by legs anchored to the bottom of the maturation tank.
 - c. The draft tube manufacturer shall provide support leg interfaces and side baffle connections plates.
 - d. The draft tube shall be manufactured by ACTIFLO supplier (Kruger).

2.07 MICROSAND PUMPS

- A. General
 1. Pumps to be provided under this Contract shall have purpose and duties as described in the project specifications and shall comply with the following general specifications unless stated otherwise.
 2. The pumps shall be designed so that they:
 - a. Operate at the best possible efficiency over the operating range based on the application and pump model selection.
 - b. Are capable of continuous operation at all times.

- c. Shall have a continuously falling head/capacity characteristic curve from no flow to maximum flow conditions to ensure satisfactory parallel operation.
3. The supplier shall supply all standard performance curves of the pumps showing head/flowrate, horsepower, efficiency and net positive suction head requirements over the full operating range.
4. A complete arrangement drawing of each pump shall be provided by the supplier showing overall dimensions and stating the weight of the combined pump, motor and base.
5. The impellers shall be statically balanced to ensure freedom from vibration. Shafts and other rotating components shall be statically balanced or machined, depending on pump model.
6. Pumps shall be driven by V-belts and sheaves to obtain the required pump speed. Provision shall be made for adjusting belt tension. A fully enclosed, steel belt guard shall be provided in compliance with OSHA requirements.

B. Pump Arrangement/Construction

1. Casings shall be cast iron radially split type, for easy maintenance, fitted with field replaceable abrasion resistant rubber liners pressure molded to the backing plate and secured to the casing externally by heavy-duty studs and nuts. Rubber liners shall extend through casing nozzles to form natural gaskets between flanges and piping. Flanges shall be solid type, flat-face weld neck flanges.
2. The impeller shall be abrasion resistant rubber, pressure molded to a ductile iron/steel support skeleton OR shall be a recessed type (open vane) consisting of rubber-lined construction, depending on the application. Determination of impeller type shall be made by the ACTIFLO® system supplier. Impeller to be screwed to the shaft with heavy duty threads running in opposite direction to the shaft rotation for maximum security.
3. The pump shall be fitted with a flushless mechanical seal. The mechanical seal shall be suitable for sand slurry service. An external seal water flush is not required but a drip pan, with suitable drain piping connection is required.
4. All bearings to be heavy-duty anti-friction type completely enclosed in an oil-lubricated cast iron cartridge assembly or lubricated by grease depending on pump model.
5. All pumps and motors shall be provided with necessary lugs, eyebolts, or other suitable attachments for lifting.
6. The microsand pumps shall include a sub-base which shall provide for ease of pump removal from the field.
7. The electric motor shall be sized to be non-overloading at the design operating point on the pump performance curve with a minimum service factor of 1.15. Motor enclosure shall be TEFC with class F insulation and class B temperature rise above 40 deg C ambient. Motors shall be 3 phase, 60 Hertz, 460 volt power. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. All motors shall comply with

manufacturers standard design, construction and testing procedures as define by applicable IEEE, NEMA, and ANSI standards.

8. Pumps shall be shipped with the manufacturer's standard paint, suitable for use as a finish coat. All touch-up and additional coats are to be applied in the field by the contractor.

C. Manufacturers

1. The microsand pumps shall be manufactured by McLanahan Corp., or equal.

2.08 SLUDGE/SAND GEAR DRIVE AND SCRAPER ASSEMBLY

A. General

1. The sludge scraper mechanism shall be suitable for installation in the settling tank with a floor slope sufficient for sludge removal determined by the manufacturer. The total load of the scraper mechanism shall be supported from the walkway spanning the top of the settling tank.
2. Each scraper shall comprise a complete assembly including center drive assembly, overload alarm, torque indication device, sludge collector arms and necessary anchorage parts.
3. The overall mechanism shall be designed for a torque capacity determined when the full volume of sand in the system is collected at the bottom of the settler.
4. The vertical shaft shall be fabricated of schedule 40, HDG ASTM A53 steel pipe flanged at its upper end for mounting to the drive unit and attachments at its lower end for the rake arms. The center scraper shall be attached to the center shaft and shall extend into the sludge discharge cone. No submerged steady bearing shall be permitted.
5. The rake arms shall be fabricated of HDG ASTM A36 steel and designed to move the solids to the discharge cone.
6. The final output shaft from the gearbox shall be designed to operate with a maximum output speed of 0.50 rpm at full motor speed.
7. The discharge cone scraper shall be fabricated of HDG ASTM A36 steel attached directly to the center shaft.
8. Design and manufacturing standards: All calculations of gear and bearing life shall be made in accordance with the latest AGMA and AFBMA standards. Welding fabrication and design are in accordance with the latest AWS standards. Power train calculations of all components are available upon request in accordance with specification details listed above.

B. Center Drive Mechanism

1. The drive mechanism shall consist of an electric motor, a primary reduction unit, and a final reduction unit. All components are directly coupled, eliminating chains and V-belts. The drive unit output torque shall be limited by a torque overload protection device. All lubrication shall be of the totally enclosed oil bath and grease design

2. Primary Reduction Unit

- a. The primary reduction unit shall be mounted on top of the final gear reducer with direct shaft coupling
 1. The primary reduction unit shall use helical gearing and be permanently grease lubricated.
 2. The primary reduction unit shall transmit torque to input shaft of the intermediate gear reducer through a shear pin.
 3. The L_{10} life of the primary gearbox bearings shall be in excess of 100,000 hours at continuous torque rating of the drive unit.

3. Final Reduction Unit

- a. The final reduction unit shall be a planetary gearbox.
- b. The final reduction unit shall be permanently lubricated.

4. Electric Motor

- a. The electric motor shall have a minimum service factor of 1.15. Motor enclosure shall be TEFC with class F insulation and class B temperature rise above 40 deg C ambient. Motors shall be 3 phase, 60 Hertz, 460 volt power. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. All motors shall comply with manufacturer's standard design, construction and testing procedures as defined by applicable IEEE, NEMA, and ANSI standards.

5. Torque Indication and Overload Protection

- a. The torque overload protection device shall be attached to the primary reduction unit, and activated by the torque reaction of the primary reduction unit.
- b. The torque load of the drive unit shall be indicated on a stainless steel 6 inch diameter torque gauge in ft-lbs.
- c. The overload protection device shall have two switches, which may independently energize an alarm circuit and motor cutoff circuit when the load of the mechanism reaches the customer specified torque settings.
- d. The switches shall be enclosed in a NEMA 4X housing.
- e. In addition to alarm and cutoff, the drive unit is also protected by a shear pin.

C. Manufacturer

- a. The sludge drive gearbox shall be manufactured by DBS; the sludge rake assembly shall be designed and fabricated by the ACTIFLO® Supplier.

2.09 HYDROCYCLONES

- A. The hydrocyclones shall be sized by the ACTIFLO® Supplier. The underflow of the hydrocyclones shall be gravity fed to the maturation tank for reuse of the clean microsand. The overflow of the hydrocyclone shall be sent by gravity flow to the sludge handling facility. Materials shall be food-grade or non-food grade urethane depending on the application.
- B. The ACTIFLO supplier shall supply a 304 stainless steel stand to support each hydrocyclone. The hydrocyclone and stand shall be installed by the Contractor.

2.10 LAMELLA SETTLING EQUIPMENT

- A. Lamella shall have an incline at 60 degrees from the horizontal. Lamella shall be sufficiently supported underneath by an AISI 304/304L stainless steel support structure.
- B. The total required surface area of lamella equipment in each settling tank shall be equal to the square footage required to produce the design surface loading rate.

2.11 EFFLUENT COLLECTION SYSTEM

- A. Clarified water shall be collected by means of square notched collection troughs. Each trough shall discharge to a common effluent launder.
 - 1. Collection troughs shall be rectangular shaped and fabricated from AISI 304/304L stainless steel. The troughs shall be sized by the ACTIFLO® Supplier.

2.12 STILLING BAFFLES

- A. Stilling baffles shall be utilized at the Maturation Tank weir wall to induce laminar flow.
 - 1. The Stilling Baffles shall be constructed of 304 stainless steel sheet. The baffles shall be sized and designed by the ACTIFLO® Supplier.

2.13 VALVES

- A. PVC Isolation Valves
 - 1. All PVC isolation valves shall be the true-union type ball valve as manufactured by Hayward, Inc. or equal. Valves shall be supplied with socket ends, plastic actuating lever, PVC body, and EPDM O-Rings.
- B. Eccentric Plug Valves
 - 1. For applications with a system pH above 5.0, all eccentric plug valves shall be industrial resilient seated type with ANSI class 125/150 flat face through bolting flanges. Plug valves shall be provided with cast iron wafer type bodies, acrylonitrile-butadiene packing, neoprene resilient seat material, manual lever or hand wheel actuated. Plug valves shall be PEC plug valves as manufactured by DeZurik or equal.

2. Each pre-coagulation and maturation tank shall include a flanged drain equipped with an eccentric plug valve.
3. Each recirculation circuit shall be equipped with an eccentric plug valve on the suction side of the microsand recirculation pump.

C. Ball Valves

1. All ball valves shall be industrial type, regular port design with carbon steel body and stainless steel trim. End connections should be NPT, butt weld, or flanged per ANSI standard, and as specified on the plans. All welded end valves shall be of the 3-Piece design for ease of maintenance. Flanged end valves may be of two piece or unibody design. Instrument isolation valves shall be threaded end unibody design. All valve seats shall be reinforced Teflon. Valves should be supplied with lever operators unless otherwise specified. Valves shall be as manufactured by Velan or equal.

D. Raw Water Inlet Valve

1. The raw water valve shall be butterfly valve model 31-119 as manufactured by Bray. The valve shall be industrial resilient seated type with ANSI class 125/150 flanges. Butterfly valves shall be provided with cast iron bodies, EPDM seats, ductile iron Nylon coated disc and stainless steel shaft. The actuator shall be electric Series 70 On/Off and shall be equipped with auxiliary, SPDT dry contact limit switches and mechanical torque limiting system.

E. Settling Tank Partial Drain Valve

1. The settling tank shall include a drain located below the level of the lamellas to partially empty the settling area to clean the lamellas. The port shall be a flanged drain equipped with a butterfly valve as manufactured by Bray Series 31-119 or equal. The valve shall be industrial resilient seated type with ANSI class 125/150 flanges. It shall be provided with cast iron bodies, EPDM seats, ductile iron Nylon coated disc and stainless steel shaft and hand wheel or lever actuators.

2.14 SYSTEM CONTROLS

A. Pre-Wiring

All ACTIFLO® mounted equipment, valves, and instruments will require conduit and wiring from equipment specific NEMA 4X junction box mounted near the equipment to a main NEMA 4X junction box. This will be the responsibility of the installing contractor.

In the case where the Sand Recirculation Pumps are not mounted to the Kruger supplied skid, the installing contractor shall be responsible for providing conduit and wiring from the main junction box to each sand pump and pressure transmitter.

The installing contractor shall be responsible for providing conduit and wiring from the common junction box on the Kruger supplied skid to the main PLC. All terminal blocks in the main junction box shall be labeled to correspond with the terminal blocks in the main PLC.

B. ACTIFLO® System Control Panel

1. The PLC based control panel(s) will be supplied to monitor and control the ACTIFLO® process. All panels are required to be installed **INDOORS ONLY**. Each control panel, will be completely assembled, tested and programmed for the required functionality. Each U.L. labeled panel will be designed according to the scope of supply listed in the ACTIFLO® Scope of Supply.
2. The PLC Control Panel will include the necessary input/output plus 20% spare I/O. All I/O will be wired to field terminations and include surge arresting and isolation as required.
3. The Instrumentation and Controls submittals will contain the following drawings:
 - Panel layout drawings and I/O layout per I/O card (per the ACTIFLO® Scope of Supply)
 - Panel power distribution drawing (internal to the panel only)
 - Loop wiring diagrams
 - These loops will detail the ACTIFLO® equipment and the necessary controls for the ACTIFLO® equipment.
 - Systems outside of the ACTIFLO® scope will only show terminal connections details to the ACTIFLO® Control Panel.
4. The Instrumentation and Controls submittals will not have any of the following drawings:
 - P&ID's
 - One-line power diagrams
 - Installation details of the panels
5. Unless specifically set forth in the ACTIFLO® Scope of Supply, this offer does not include:
 - Interconnecting wiring and/or conduit
 - UPS backup
 - VFDs
 - Fiber optic cable
 - Fiber optic cable termination
 - Installation labor/supervision
 - Motor control equipment
 - Power distribution equipment
 - Motor starters, contactors, reversing contactors
 - Local control panels
 - Sample pumps
 - Junction boxes
 - Samplers
 - Instrument and other mounting stands
 - Mounting hardware and supports for float switches
 - Intrinsically safe relays & intrinsically safe relays panels
 - Computer furniture
 - Sun shields
 - Primary flow measurement devices (such as parshall flumes)
 - Instrument winterization
 - Air conditioners or heaters
 - Field mounted surge arrestors (power and signal)
 - Instrument mounting hardware
 - Piping, if needed, from the process to any remote mounted transmitters

- Local disconnects

2.15 PROCESS INSTRUMENTATION

A. Turbidity/TSS Monitoring

1. The suspended solids and turbidity analyzer shall consist of a self-cleaning PVC or stainless steel immersion or insertion probe with 33' (10m) cable, microprocessor-controlled interface module and power supply. The connections between the turbidimeter and interface unit will include plug & play connections.
2. The analyzer shall measure turbidity or suspended solids or both dependent on the probe selected. The probe has a self-cleaning system preventing erroneous values and maintenance problems caused by gas bubbles and sludge particles, requiring almost no maintenance. Measurements are accurate, continuous, and completely independent of color.
3. The analyzer operates with a user-selected measurement range of 0.001 to 1000 NTU for turbidity, and 0.001 to 50.0 g/L for suspended solids. An operating temperature of 32 to 104 °F for the probe and -4 to 104 °F for the interface module. Response time is less than 1 second and is user-adjustable up to 5 minutes. The accuracy is less than 1% of reading or ± 0.001 NTU, whichever is greater for turbidity and less than 5% of reading for suspended solids. Repeatability for turbidity is less than 1% of reading, and less than 3% for suspended solids reading.
4. The turbidimeter(s) shall be Hach Solitax with SC200 controller, or equal.
5. One turbidimeter will be supplied for monitoring influent turbidity, and one turbidimeter will be supplied for monitoring effluent turbidity.

B. pH Monitoring

1. pH Sensor
 - a. The pH or ORP sensor shall be of Differential Electrode Technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling-resistant characteristics.
 - b. The sensor shall have a hex-shaped body to facilitate mounting, and shall be constructed of PEEK® material for exceptional chemical resistance and mechanical strength. This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together.
 - c. The sensor shall be capable of the following installation styles:
 1. Convertible body style featuring 1-inch NPT threads on both ends to mount into a standard 1-inch pipe tee, into a Hach adapter pipe for union mounting with a standard 1-1/2 inch tee, or onto the end of a pipe for immersion into a vessel.
 2. Insertion body style featuring 1-inch NPT threads only on the cable end to mount into a Hach ball valve hardware assembly, enabling the sensor to be inserted into or retracted from the process without stopping the process flow.
 - d. The built-in electronics of the sensor shall be completely encapsulated for protection from moisture and humidity.

- e. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 m (328 ft.) with standard cabling and up to 1000 m (3280 ft.) with a termination box.
- f. The sensor signal shall have an integral temperature sensor. The pH sensor shall automatically compensate measured values for changes in process temperature.
- g. The sensor shall have a measuring range for pH of 0.00 to 14.00.
- h. The sensor shall be Hach Company Model pHD sc or pHD.

2. pH Controller

- a. The controller shall be a microprocessor based instrument.
- b. The enclosure shall be 1/2 DIN format, NEMA4X rated for wall, pole and panel mounting.
- c. The controller shall be available in either 100–240 Vac 50/60 Hz or 24 Vdc power supply versions.
- d. The controller shall offer two analog 0/4-20 mA output signals with independent PID control functions and optional additional 4-20 mA outputs.
- e. The controller shall have single channel and dual channel options.
- f. The controller shall have options for MODBUS RS232, MODBUS RS485, Profibus DPV1, and HART 7.2 communication.
- g. The display contrast shall be adjustable.
- h. The controller shall have 2 Data logs, 128 kb each. The logged data shall be downloadable on a SD card in XML format.
- i. The controller shall be Hach Company sc200 Universal Controller.

C. Flow Meter

- 1. The magnetic flowmeter shall be free of obstructions and operate by means of pulsed DC coil excitation. The flow tube shall be constructed of 304 stainless steel, with a Polyurethane liner, 316 stainless steel electrodes, and ANSI Class 150 steel flanges. Stainless steel grounding electrodes shall be built into the flow tube. The flow tube shall be equipped with a hard rubber liner. The flowmeter will be installed in a straight run of pipe with inlet run greater than or equal to five (5) times the flowmeter pipe diameter, and the outlet run greater than or equal to two (2) times the flowmeter pipe diameter.
- 2. The flow tube shall be able to withstand accidental submergence of 10 feet for 72 hours. For flow tubes installed below grade, a submersible kit shall be supplied so that the flow tube can withstand 30 feet of continuous submergence. The external surface of the flow tube shall be protected by corrosion resistant two-component epoxy paint.
- 3. . The signal converter shall be either integrally mounted on the flow tube or remotely mounted from the flow tube. It shall be powered by 110V; 60 Hz power and provide both a 4 – 20 mA flow rate signal and a scaled 0 – 1000 Hz pulse output for remote totalization.
- 4. The converter shall have a liquid crystal backlit display with 2 X 16 character alphanumeric to indicate flow rate, total flow, field settings and error codes. In addition, the converter shall provide integral empty pipe cutoff, low flow cutoff, limit switches, two totalizes for both forward and reverse flow. Local operation with 3 pushbuttons (- ,+ , E). Quick Setup menus for straightforward commissioning.
- 5. The accuracy of the magnetic flowmeter shall be 0.5% of rate for all flows above 6-ft/sec velocity. The magnetic flowmeter shall be Endress & Hauser Pro Mag 50W.

6. One flowmeter per train will be supplied for monitoring raw water flowrate.

D. Pressure Transmitter

1. For use in measuring the discharge pressure of the Sand recirculation pump. The transmitter shall convert the sensed pressure to an analog 4 to 20 mA electrical signal that will interface with the PLC.
2. The pressure transmitter shall measure pressure in the range of 1.5 ~ 60 PSI. The pressure transmitter shall have a measuring range capable of 1.5 ~ 600 PSI.
3. The pressure transmitter shall have a ceramic flush mounted diaphragm.
4. The pressure transmitter will have 1.5" process connection. The process connection shall be threaded ANSI MNPT 316L. The sensor seal shall be FKM Viton. The pressure transmitter connection shall not require a manifold or additional seal.
5. The pressure transmitter shall be capable of measuring process conditions of -40°F to 257° and capable of operating in an ambient temperature of -40°F to 185°F. The unit shall be able to handle a max overpressure of 900PSI.
6. Supply voltage shall be 11.5 to 45 VDC for non-hazardous areas and 11.5 to 30VDC for hazardous areas. The unit shall be loop powered.
7. The pressure transmitter shall be available with 4-20mA output or 4-20mA with superposed HART protocol. The type of output shall be selected at the time of product configuration based on field requirements.
8. The pressure transmitter will have 1.5" process connection. The process connection shall be threaded ANSI MNPT 316L. The sensor seal shall be FKM Viton. The pressure transmitter connection shall not require a manifold or additional seal.
9. Local display shall be plug-in liquid crystal display (LCD). The display will indicate corresponding pressure with a 4-digit display and bar graph. The display can be rotated in 90° increments.
10. Operating elements will be located under the local display that allow calibrating of lower range value (zero), upper range value (span) and dip switch for dampening on/off.
11. The pressure transmitter housing shall be die cast aluminum with powder protective coating. The transmitter will be equipped with a ½" NPT connection for electrical wiring.
12. The pressure transmitter shall be Endress & Hauser Cerabar M PMC71.
13. One pressure transmitter will be supplied per microsand recirculation pump for monitoring discharge pressure.

E. Level Switch

1. The settling tank shall be equipped with a level float switch to generate an alarm signal as the water level in the settling tank reaches an excessive level.

2. The level switch shall not contain mercury and shall be Anchor Scientific GSE20NO.

2.16 DRYPOLYMER PROCESSING SYSTEM

A. Dry Preparation System

1. The module shall be sized for usage of up to 0.7 pounds per hour at a 0.3 percent solution, aged for at least 1 hour.
2. The automatic polymer preparation/dilution system shall be an integrated equipment package capable of automatically preparing a homogenous polymer solution. The system shall be an automatically controlled, sequentially batching unit consisting of a high shear, first stage wetting system, a mix tank with a low shear mixer, and an aging tank. The system shall continuously supply the resulting polymer solution to one or more devices designed to automatically meter, dilute and feed stock polymer solution to point of use.
3. The Polymer Preparation System shall have the capability to automatically prepare dry polymers. The entire system shall be an integrated package pre-piped, pre-wired, skid mounted system to the most practical extent for shipping. This configuration shall provide for a complete polymer preparation system occupying the smallest possible space.
4. The system storage hopper should have a minimum capacity of 2 cu. ft. and will be constructed of 304 SS or carbon steel. The storage hopper shall include a low level switch for monitoring polymer supply levels. Low level conditions will include a visual alarm in the control panel.
5. The dry feeder will include either a dissimilar speed, double concentric auger metering mechanism to condition the material to a consistent bulk density and fill the auger from a full 360 degrees, or an integral flexible hopper to prevent powder bridging. The screw feeder will be constructed of 316 SS. The feeder will include a 304 SS discharge spout and should include provisions for preventing moisture contact with the dry powder. The feeder shall be driven by a totally enclosed variable speed motor, with the motor controller mounted inside the panel. The feeder shall be controlled by an adjustable timer accessed through the touchscreen display
6. The wetting system shall incorporate a mixing action with sufficient means for ensuring complete wetting of each polymer particle. No restrictive orifices should be utilized and the wetting system should incorporate a containment reservoir to prevent spillage in the event of an overflow condition. In the event of a containment reservoir overflow, the system shall signal an alarm and immediately shutdown. Wetting system shall include a clear synthetic cover to allow for visual inspection. All surfaces that come into contact with the wetted polymer shall be constructed of 304 SS. Means for transporting the wetted polymer to the mixing tank should be attached directly to the outlet of the wetting chamber. Means for preventing backflow of polymer solution should also be incorporated.
7. The system to include dedicated mixing and aging tanks. Mixing and aging tanks to be constructed of 304 SS. Mixing tanks to be located above aging tank to reduce floor space and arrangement must include means for accessing tank internals. Tanks accessories to include mixing tank transfer valve, level transmitters, and drain valves.

Aging tank shall include an outlet valve and labyrinth baffles to promote a plug flow pattern within the tank to optimize polymer detention. Open-top tanks will not be acceptable. The mixing tank shall have a capacity of 50 gallons, and the aging tank shall have a capacity of 100 gallons to provide at least 1 hour aging time when feeding 0.3 percent solution at the maximum dry polymer usage

8. The mixing tank will be provided with a mechanical mixer suited with hydro-foil type impeller capable of operation at varying tank levels. Impeller and shaft to be constructed with 304 or 316 Stainless steel. Shaft to be coupled with integral gear reducer.
9. The water supply line shall be sweated copper and shall include pressure reducing valve, pressure switch with high and low contacts, solenoid valve, pressure gauge and visual flow meter. Water supply shall be 25 gpm filtered water at 15 psig.
10. Package system to include pre-mounted and pre-wired NEMA 4X control panel including Allen-Bradley PLC with Ethernet and 10" color touchscreen operator interface. Control Panel shall automatically operate the entire preparation system and components thereof. The panel shall also include a main disconnect and an emergency stop push-button. PLC program shall include interlocks to prevent feeding of dry polymer unless water is being supplied to the wetting chamber and all motors are operational. Interlocks shall trigger a visual alarm. Should the system experience a loss of power, the PLC shall remember where in the sequence of operation the polymer preparation system was interrupted and continue from that point when power is restored and system restarted. Control panel shall include motor starters and necessary wiring to respective motors to the greatest extent possible. System power requirements shall be 230 volt, 60 Hertz, 3 phase. Transformers, if required, shall be provided to step voltage down from 230 volts to 115 volts.
11. The color touchscreen operator interface shall provide the following capabilities at a minimum:
 - "Process" screen, showing on/open status of all components during system operation.
 - Continuous level displays for both the mixing and aging tanks.
 - Resettable batch counter.
 - Alarm acknowledge and reset buttons.
 - Password protection.
 - "Alarm" screen showing all possible alarms, noting which alarms are currently present.
 - Alarm 'history' screen.
 - "Timers" screen, allowing the operator to set feeder, mixer, and emulsion pump timers, in addition to various system delay timers.
 - "Switches" screen, including H/O/A switches for all major components.
 - Local/Remote capability.
 - "Levels" screen, allowing the operator to set mixing and aging tank control and alarm levels.
12. System to be manufactured by VWS , Acrison, Enpro or equivalent as supplied by Kruger.

2.17 POLYMER METERING PUMPS

GENERAL

A. Acceptable Manufacturers

The dilute polymer feed skid system described in this section shall contain progressing cavity pumps as manufactured by Moyno or Seepex Pumps. For another manufacturer to be determined acceptable for providing progressing cavity pumps on this project, it must supply references of five separate, substantially similar installations with contact names and phone numbers. Referenced installations must be for the same chemicals required in this specification and have been in satisfactory operation for a minimum of 2 years.

B. The dilute polymer feed skid shall be self-contained and designed to feed required concentrations of polymer. Each polymer feed skid shall include (1) or (2) single stage progressing cavity pumps. The progressing cavity pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller to be provided by the skid or pump manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.

C. Dual Pump Chemical Metering Skid:

1. The polymer feed skid shall be constructed of heavy duty corrosion resistant material with adequate supports for all equipment and piping. Forklift truck cut outs to be provided. Each progressing cavity pump shall be mounted onto an individual baseplate as a pump unit. Each pump unit shall contain a single stage progressing cavity pump with independently mounted gear reducer and NEMA motor. Each pump unit shall be shimmed, aligned, and built independently of the structural skid.
2. Polymer feed pump system piping shall include: one (1) Y-Strainer in the suction header piping in duty/standby configuration with one (1) common calibration column, one (1) high pressure cut off switch per pump, one (1) pressure gauge per pump, two (2) check valves, one (1) dilution water line, all required piping, valves, supports, and flushing ports. All piping shall include isolation valves and unions for all serviceable components. Pump skid dilution water line shall contain one (1) solenoid valve, one (1) throttle valve, one (1) rotameter, one (1) pressure gauge, two (2) ball valves, one (1) static mixer with diluted polymer discharge connection mounted on the vertical back panel.
3. All piping shall be schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.

D. Chemical Metering Pump:

1. Pump Type: Positive displacement progressing cavity pump. Pump shall be capable of handling high viscosity polymer.
2. Provide manual speed adjustment, 0-100%, in 1% increments.
 - a. Provide ability to adjust speed while pump is operating.
3. Drive:
 - a. Variable Speed Motor with Controller
 - b. TEFC/TENV Enclosure

4. Materials
 - a. Housing: Cast Iron or 316 Stainless Steel
 - b. Bearings: Grease Lubricated Roller Type
 - c. PTFE Packing or Mechanical Seal
 - d. Rotor and Drive Train: Chrome Plated hardened Alloy or 316 Stainless Steel
 - e. Stator: 70 dM Nitrile or Viton
5. The pumps shall have the following Remote Control Outputs (To Kruger PLC):
 - a. Dry contact for Auto Status
 - b. Dry contact for Run Status
 - c. Dry contact Fail Status
6. The pumps shall have the following Remote Control Inputs (From Kruger PLC):
 - a. Dry contact for Start/Stop Command
 - b. Dry contact for Speed Command

ACCESSORIES

A. Calibration Cylinders:

1. Calibration cylinders shall be provided and installed in the chemical supply piping. The cylinder shall be vented back to the chemical supply. The calibration cylinder shall be sized for a **30 second draw down** at maximum pumping rate.
2. Materials
 - a. Cylinder Body: Clear PVC
 - b. End Caps: PVC

B. Pressure Switches:

1. Provide an in-line adjustable Pressure Switch on the discharge side of each pump. The switch shall be wired to the local control panel and stop pump and dilution water on increasing pressure threshold.
2. Materials:
 - a. Body: Brass
 - b. Diaphragm: Buna
 - c. Sized to match line size

C. Check Valves:

1. Provide in-line vertically mounted check valve on discharge side of each pump and dilution water line.
2. Materials:
 - a. Body: PVC
 - b. Seals: FPM or Viton or EPDM
 - c. Sized to match line size

D. Controls:

1. Each skid shall be provided with a single wall or skid mounted control panel for both pumps or shall be provided with a skid-mounted termination box and controller unit.
2. Provide main disconnect mounted in local control panel or as integral part of controller unit.
3. Utilize common terminal strip for electrical connections.
 - a. Provide terminals for single 120V 1 phase input or 460V 3 phase input.
4. All internal skid wiring to be terminated in NEMA 4X control panel or NEMA 4X terminal box located on skid prior to shipment. Required external power sources and control connections to be provided by installing contractor.
5. Provide a hand/off/auto selector switch mounted on the control panel or terminal box.
 - a. Provide auxiliary contact for remote indication of hand/off/auto selection
6. Provide Running, Fail, and High Pressure Alarm indicating lights for each pump.
7. In Hand, motor speed adjustments shall take place via panel-mounted speed adjustment knob or controller unit keypad.
8. In Auto, the pump shall be frequency adjusted by 4-20 mA flow signal through a controller provided by the skid or pump manufacturer.
9. All required skid functionality should take place via local control panel or controller unit and junction box. This includes, but is not limited to, pump protection instrumentation and dilution water control while pump is in both automatic and hand operation.
10. All enclosures shall be rated NEMA 4X with all switches, indicator lights, and knobs mounted on the termination box or local panel door.

E. Pump Design Criteria

Type of application	Drinking Water
No. Pumps Required	1 duty + 1 standby
Pump Capacity Range (gph)	28.0
Pump Discharge Pressure @ Capacity (psi)	85
Polymer Dosage Range (mg/L)	0.1-1.0
Prepared Polymer Concentration (%)	0.3
Secondary Dilution Water Capacity (gph)	140

2.18 COAGULANT

METERING

PUMPS

GENERAL

A. Acceptable Manufacturers

The chemical metering pump skid systems of this section shall be manufactured by ProMinent Fluid Controls or Grundfos Group. For another manufacturer to be determined acceptable for providing diaphragm chemical metering skids on this project, it must supply references of five separate, substantially similar installations with contact names and phone numbers. Referenced installations must be for the same chemicals required in this specification and have been in satisfactory operation for a minimum of 2 years.

B. The chemical metering skid shall be self-contained and designed to feed required amounts of Coagulant. Each chemical metering skid shall include (2) simplex head chemical metering pumps. The metering pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller provided by the skid or pump manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.

C. Dual Pump Chemical Metering Skid:

1. The chemical metering skid shall be constructed of fusion welded, black uv-protected polypropylene sheets with adequate supports for all equipment and piping. Forklift truck cut outs to be provided. The base will have a metal mounting plate and a polypropylene top plate.
2. Chemical metering pump system piping shall include: one (1) Y-Strainer for coagulant feed located in the suction header piping, (1) pressure relief valve per pump, one (1) check valve per pump, one (1) pulsation dampener per pump, one (1) pressure gauge with diaphragm seal per pump, one (1) back pressure valve per pump, one (1) calibration cylinder per pump and all required piping, valves, supports, and flushing ports. All piping shall include isolation valves and unions for all serviceable components.
3. All piping shall be schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.

D. Chemical Metering Pump:

1. Pump Type: Positive displacement solenoid/mechanically/hydraulically actuated simplex head diaphragm pump. Suction and discharge strokes shall be controlled by single ball check valves. Check valves must be interchangeable.
2. Provide manual stroke length adjustment, 0-100%, in 1% increments.
 - a. Provide ability to adjust stroke while pump is operating.
 - b. For microprocessor driven pumps, stroke length may be adjusted automatically by the microprocessor.
3. Drive:
 - a. Variable Speed Motor with Controller
 - b. TEFC/TENV Enclosure
4. Materials
 - a. Diaphragm: Steel Core, Nylon Reinforced Teflon Faced EPDM
 - b. Valve Ball: Aluminum Oxide Ceramic
 - c. Valve Body: PVDF (Kynar)/PVC
 - a. Check Valve Seal: PTFE/PVC
 - b. Other Wetted Parts: PVDF/PVC
 - c. Reciprocating Shaft: Steel
 - d. Housing: Cast Aluminum inner housing with either Glass-filled Luranyl or Acrylic Resin coated outer housing.
6. The pumps shall have the following Remote Control Outputs (To Kruger PLC):
 - a. Dry contact for L-O-R position
 - b. Dry contact for Run Status
 - c. Dry contact for Fail Status
7. The pumps shall have the following Remote Control Inputs (From Kruger PLC):
 - a. Dry contact for Start/Stop Command
 - b. Dry contact for Speed Command

ACCESSORIES

A. Calibration Cylinders:

1. Calibration cylinders shall be provided and installed in the chemical supply piping.
The cylinder shall be vented back to the chemical supply. The calibration cylinder shall be sized for a 1-minute draw down at maximum pumping rate.
 2. Materials
 - a. Cylinder Body: Clear PVC
 - b. End Caps: PVC
- B. Check Valves:
1. Provide in-line vertically mounted check valve on discharge side of each pump
 2. Materials:
 - a. Body: PVC
 - b. Seals: FPM or Viton or EPDM
 - c. Sized to match line size
- C. Pulsation Dampener (as required):
1. Type: Bladder/bellows type dampener with dry side precharged with air. Pressure gauge on dry side of bladder/bellows provides indication of precharge pressure. Unit can be disassembled for removal and replacement of bladder/bellows. Valve on dry side allows for air recharge after servicing. The pulsation dampener shall be sized per the manufacturer's recommendations.
 2. Materials
 - a. Body: PVC
 - b. Bladder: Viton
- D. Pressure Relief Valve:
1. Provide in-line pressure relief valve on the discharge side of each pump head. The relief side of the valve shall be plumbed to the supply side of each metering pump.
 2. Materials:
 - a. Body: PVC
 - b. Diaphragm: Teflon-faced EPDM
 - c. Sized to match line size
 - d. Relief Pressure: 0 to 150 PSI adjustable, factory set at 70 PSI
- E. Backpressure Valves:
1. Provide in-line backpressure valve on discharge pipe side of each pump.
 2. Materials:
 - a. Body: PVC
 - b. Diaphragm: Teflon faced EPDM
 - c. Sized to match line size
 - d. Backpressure Provided: 0 to 150 PSI adjustable, factory set at 60 PSI
- F. Controls:
1. Each pump will be shall be provided with an integral micro processor

G. Pump Design Criteria

Type of application	Drinking Water
No. Pumps Required	1 Duty + 1 Standby
Pump Capacity Range (gph)	1.3-13.0
Pump Discharge Pressure @ Capacity (psi)	145
Coagulant Dosage Range (mg/L)	10-100
Coagulant Type	Alum
Coagulant Specific Gravity	1.34
Coagulant Percent Active (%)	48.5

2.19 FILTER AID METERING PUMPS

GENERAL

A. Acceptable Manufacturers

The chemical metering pump skid systems of this section shall be manufactured by ProMinent Fluid Controls or Grundfos Group. For another manufacturer to be determined acceptable for providing diaphragm chemical metering skids on this project, it must supply references of five separate, substantially similar installations with contact names and phone numbers. Referenced installations must be for the same chemicals required in this specification and have been in satisfactory operation for a minimum of 2 years.

B. The chemical metering skid shall be self-contained and designed to feed required amounts of Coagulant. Each chemical metering skid shall include (2) simplex head chemical metering pumps. The metering pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller provided by the skid or pump manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.

C. Dual Pump Chemical Metering Skid:

1. The chemical metering skid shall be constructed of fusion welded, black uv-protected polypropylene sheets with adequate supports for all equipment and piping. Forklift truck cut outs to be provided. The base will have a metal mounting plate and a polypropylene top plate.
2. Chemical metering pump system piping shall include: one (1) Y-Strainer for coagulant feed located in the suction header piping, (1) pressure relief valve per pump, one (1) check valve per pump, one (1) pulsation dampener per pump, one (1) pressure gauge with diaphragm seal per pump, one (1) back pressure valve per pump, one (1) calibration cylinder per pump and all required piping, valves, supports, and flushing ports. All piping shall include isolation valves and unions for all serviceable components.
3. All piping shall be schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.

D. Chemical Metering Pump:

3. Pump Type: Positive displacement mechanically actuated simplex head diaphragm pump. Suction and discharge strokes shall be controlled by single ball check valves. Check valves must be interchangeable.
4. Provide manual stroke length adjustment, 0-100%, in 1% increments.
 - c. Provide ability to adjust stroke while pump is operating.
 - d. For microprocessor driven pumps, stroke length may be adjusted automatically by the microprocessor.
3. Drive:
 - a. Variable Speed Motor with Controller
 - b. TEFC/TENV Enclosure
5. Materials
 - a. Diaphragm: Steel Core, Nylon Reinforced Teflon Faced EPDM
 - b. Valve Ball: Aluminum Oxide Ceramic
 - c. Valve Body: PVDF (Kynar)/PVC
 - e. Check Valve Seal: PTFE/PVC
 - f. Other Wetted Parts: PVDF/PVC
 - g. Reciprocating Shaft: Steel
 - h. Housing: Cast Aluminum inner housing with either Glass-filled Luranyl or Acrylic Resin coated outer housing.
8. The pumps shall have the following Remote Control Outputs (To Kruger PLC):
 - d. Dry contact for Run Status
 - e. Dry contact for Fail Status
9. The pumps shall have the following Remote Control Inputs (From Kruger PLC):
 - c. Dry contact for Start/Stop Command
 - d. Dry contact for Speed Command

ACCESSORIES

- A. Calibration Cylinders:
 3. Calibration cylinders shall be provided and installed in the chemical supply piping. The cylinder shall be vented back to the chemical supply. The calibration cylinder shall be sized for a 1-minute draw down at maximum pumping rate.
 4. Materials
 - c. Cylinder Body: Clear PVC
 - d. End Caps: PVC
- B. Check Valves:
 3. Provide in-line vertically mounted check valve on discharge side of each pump
 4. Materials:
 - a. Body: PVC
 - b. Seals: FPM or Viton or EPDM
 - c. Sized to match line size
- C. Pulsation Dampener (as required):

3. Type: Bladder/bellows type dampener with dry side precharged with air. Pressure gauge on dry side of bladder/bellows provides indication of precharge pressure. Unit can be disassembled for removal and replacement of bladder/bellows. Valve on dry side allows for air recharge after servicing. The pulsation dampener shall be sized per the manufacturer's recommendations.
4. Materials
 - c. Body: PVC
 - d. Bladder: Viton

D. Pressure Relief Valve:

3. Provide in-line pressure relief valve on the discharge side of each pump head. The relief side of the valve shall be plumbed to the supply side of each metering pump.
4. Materials:
 - e. Body: PVC
 - f. Diaphragm: Teflon-faced EPDM
 - g. Sized to match line size
 - h. Relief Pressure: 0 to 150 PSI adjustable, factory set at 70 PSI

E. Backpressure Valves:

3. Provide in-line backpressure valve on discharge pipe side of each pump.
4. Materials:
 - a. Body: PVC
 - b. Diaphragm: Teflon faced EPDM
 - c. Sized to match line size
 - d. Backpressure Provided: 0 to 150 PSI adjustable, factory set at 60 PSI

F. Controls:

1. Each skid shall be provided with a skid mounted control panel for both pumps, or shall be provided with a skid-mounted termination box with number of power receptacles matching number of pumps.
2. Provide main disconnect mounted in control panel (not applicable for skids with terminal box designs.)
3. Utilize common terminal strip for electrical connections.
 - a. Provide terminals for single 120V 1 phase input.
4. All internal skid wiring to be terminated in NEMA 4X control panel or NEMA 4X terminal box prior to shipment. Required external power sources and control connections to be provided by installing contractor.
5. Provide a hand/off/auto selector switch mounted on the control panel. For microprocessor driven pumps, hand/off/auto selection is via pump keypad.
 - a. Provide auxiliary contact for remote indication of hand/off/auto selection.
6. Provide Running and Fail indicating lights for each pump.
7. In Hand, the pump stroke frequency shall be manually adjusted with a manual stroke adjustment potentiometer. For microprocessor driven pumps, stroke adjustment may take place via pump keypad, or may be adjusted automatically by the microprocessor.
8. In Auto, the pump shall be frequency adjusted by 4-20 mA signal through a controller provided by the skid or pump manufacturer.
9. In hand, motor speed adjustments shall take place via the local panel or motor controller keypad or pump keypad for microprocessor driven pumps.

10. All enclosures shall be rated NEMA 4X fiberglass. When applicable all switches shall be mounted on enclosure door.

G. Pump Design Criteria

Type of application	Drinking Water
No. Pumps Required	1 Duty + 1 Standby
Pump Capacity Range (gph)	0.1-1.3
Pump Discharge Pressure @ Capacity (psi)	230
Coagulant Dosage Range (mg/L)	1.0-10.0
Coagulant Type	Alum
Coagulant Specific Gravity	1.34
Coagulant Percent Active (%)	48.5

2.20 MICROSAND

A. General

Microsand for the ACTIFLO® system shall be Manley Bros. of Troy Grove, IL or Standard Sand & Silica Co. of Davenport, FL, or equal. The microsand should have an effective size of 80-160 microns, depending on the application, a uniformity coefficient of <1.7 and shall contain 95 to 99% pure silica sand.

The ACTIFLO® Supplier will provide 6 tons of microsand for system start-up.

2.21 RECIRCULATION CIRCUIT PIPING

- A. The microsand recirculation circuit piping (from settling tank pit to hydrocyclone inlet) shall be a combination of Sch 10 304 stainless steel pipe with rubber lined flexible hose segments and shall be supplied by the ACTIFLO Supplier. The Contractor is responsible for installing the microsand recirculation piping that is required to ship loose.

2.22 GRATING (FRP MOULDED)

- A. The ACTIFLO Supplier will provide grating for ACTIFLO System per the ACTIFLO system supplier drawings and specifications below.
- B. FRP MOLDED GRATING shall be Fibergrate or approved equal.
- C. All mechanical grating clips shall be 304 SS and spaced at maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.
- D. Grating shall be manufactured with non-slip surface, integrally applied grit to the top of each bar providing maximum slip resistance.
- E. Color shall be standard Grey 'GR-10' or approved substitute.
- F. Depth: 1-1/2" with a tolerance of plus or minus 1/16".
- G. Mesh Configuration: 1-1/2" x 1-1/2" with a tolerance of plus or minus 1/16" mesh center to center.
- H. Load/Deflection: Grating shall be designed for a uniform load of 100 psf or concentrated load of 300 lb. Deflection is not to exceed 0.375" or L/D = 120, whichever is less. Grating clear span shall not exceed 42".
- I. Layout: Each grating section shall be readily removable, except where indicated on drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.)

shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable. Each section of grating shall not exceed ~60lbs.

- J. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.
- K. Installation: Fabricator shall install gratings in accordance with ACTIFLO system supplier assembly drawings. Fasten grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products, provide adequate ventilation.

2.23 HANDRAILS

- A. The ACTIFLO Supplier will provide handrails for ACTIFLO System per the ACTIFLO system supplier drawings and specifications below.
 - 1. Handrails:
 - i. Handrails shall be provided at the perimeter of the ACTIFLO tank.
 - ii. One point of entry/egress shall be provided with 30" min width, and the location shall be per the ACTIFLO system supplier drawings.
 - iii. Handrails shall be welded ASTM A500 steel 1-1/2" square tube with welded ASTM A36 steel kick plate and Hot Dipped Galvanized (HDG) finish.
 - iv. Handrails shall be 42" above top of grating.
 - v. All connection hardware shall be 18-8 (304) stainless steel.

2.24 POLYMER

- A. General

Polymer for the ACTIFLO[®] system shall be Hydrex brand, as supplied by Kruger Inc. Based on the application, the ACTIFLO[®] supplier shall determine the polymer type, as it relates to charge, charge density, and molecular weight.

For drinking water and tertiary wastewater applications the ACTIFLO[®] Supplier will provide 150 lbs quantity of the appropriate polymer for system start-up.

2.25 PACKAGE PLANT CONSTRUCTION MATERIAL

- A. MATERIALS

- 1. The ACTIFLO[®] ACP Package Plant materials of construction shall be as follows:

Package Plant Tank	:	ASTM A36 steel plate, angles and members
Supports and beams	:	ASTM A36 steel plate, angles and members
Flanges	:	ASTM A105, ANSI 150
Collecting Trough	:	AISI 304/304L
Mixer shafts	:	AISI 304/304L
Mixer blades	:	AISI 304/304L
Handrails	:	Hot Dip Galvanized ASTM A36 square tubing
Grating	:	Fiberglass Reinforced Plastic

Mobile Ladder or Stairs : Coated Carbon Steel
 Assembly Hardware : 18-8 Stainless Steel

Sludge Scraper

Drive Shaft : Hot Dip Galvanized, SCH 40, ASTM A53 pipe
 Rake Arms : Hot Dip Galvanized, ASTM A36 members
 Discharge Cone Scraper : Hot Dip Galvanized, ASTM A36 plates

B. PAINTING

1. All carbon steel parts shall be painted, except the parts specifically defined as Hot Dip Galvanized. All 304 Stainless Steel or Aluminum shall be shipped bare. The painting shall be according to the following procedure:

a. Clean surfaces in accordance with SSPS-SP1.

b. For Submerged Steel in Potable Water (Tank Interior):

Surface Prep: in strict accordance with SSPC-SP10/NACE 2 (profile: 2.0-2.5mils)

Dry surface in accordance with ASTM-D-4263.

Total DFT(mils) = 11.0-15.5

i. Prime Coat: Tnemec-Omnithane® Series 1
 Color: 1216 Grayish-Green
 DFT(mils): 3.0-3.5

ii. Intermediate Coat: Tnemec-Pota-Pox® PlusSeries N140F
 Color: 11WH Fast Cure White
 DFT(mils): 4.0-6.0

iii. Top Coat: Tnemec-Pota-Pox® PlusSeries N140F
 Color: 11WH Fast Cure White
 DFT(mils): 4.0-6.0

c. For Non-Submerged Steel (Tank Exterior):

Surface Prep: in strict accordance with SSPC-SP6/NACE 3 (profile: 1.0-2.0mils)

Dry surface in accordance with ASTM-D-4263.

Total DFT(mils) = 9.5-13.0

i. Prime Coat: Tnemec-Omnithane® Series 1
 Color: 1216 Grayish-Green
 DFT(mils): 3.0-3.5

ii. Intermediate Coat: Tnemec-Pota-Pox® PlusSeries N140F
 Color: 11WH Fast Cure White
 DFT(mils): 4.0-6.0

iii. Top Coat: Tnemec Endura-Shield II Series 1075
 Color: 11 SF True Blue/ Safety Blue
 DFT(mils): 2.5-3.5

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the Supplier’s instruction and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil

and grease for initial operation. The grades of oil and grease shall be in accordance with the Supplier's recommendations.

- B. All equipment, components, piping and appurtenances shall be installed true to alignment rigidly supported. Any damage caused by the negligence of the Contractor to the above items shall be repaired or replaced by the Contractor to its original condition.
- C. The equipment and accessories shall be installed in accordance with the supplier's instruction and located as shown on the Drawings to form a complete workable system.
- D. Interconnecting piping supplied by the Contractor shall be hydrostatically tested by the Contractor.

3.02 CONTRACTOR'S INSTALLATION TASKS

- A. The ACTIFLO® Package Plants are factory assembled as much as possible. However, for freight purposes or general practical reasons, the installation of some items needs to be completed on site by the contractor, per I. Krüger Inc. installation manual. Field installation includes, but is not limited to:

- Handrails
- Instrumentation
- Mixers
- Scraper drive
- Hydrocyclone Support Assembly
- Polymer Distributor Piping (Polymer Header)
- Recirculation pump (ACP2-45 to ACP2-75)
- Field Wiring (See Section 2.14 for additional details)
- Equipment Reconnection

Following installation, any touch up painting that may be required is the responsibility of the contractor. Touch up paint supplied by I. Krüger Inc.

- 1. Anchors and Leveling: Prior to installing the equipment, the contractor shall properly level and anchor the unit. The leveling system and anchors are not part of **I. Krüger Inc.** supply. Approximate gross shipping weights are as follows:

ACP2-45 tank:	(Tank Assembly Weight; Dry) 22,000 lbs (Full of Water) 115,000 lbs
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- 2. Mixers: The mixers are delivered separately. The shafts are already assembled to the gearbox. The contractor must assemble the impellers on the shafts at job site. Positioning of the impeller must be performed at the indicated position on the shaft. For the maturation tank, the draft tube assembly is pre-mounted in the tank. Motors are factory wired from motor to disconnect and from disconnect to termination box. For shipping purposes, motors are disconnected and the contractor shall reconnect in the field.
- 3. Recirculation pump: **ACP2-45 to ACP2-75:** The contractor shall install the pumps and drive belts. Recirculation pump piping is shipped loose and must be field assembled by the contractor.

4. Hydrocyclone: The hydrocyclones are factory installed on their support. For shipping purposes hydrocyclones and support are shipped loose and the contractor shall re-install on the tank. The contractor shall also connect the hydrocyclone to the recirculation line supplied with the recirculation pump arrangement.
5. Sludge scraper: The scraper drive is delivered separately and must be installed by the contractor. The scraper mechanism is factory installed and shall be braced for shipping. The bracing shall be removed by the contractor prior to start-up. Motors are factory wired from motor to disconnect and from disconnect to termination box. For shipping purposes, motors are disconnected and the contractor shall reconnect in the field.
6. Handrails: The contractor shall assemble the handrails in place. All the handrails are supplied complete with the required hardware. Access/Entry location shall be coordinated prior to submittal and should be based on the ACTIFLO System Supplier drawings and verified prior to manufacturing.
7. Mobile Ladder/Stairs: The contractor shall supply a Mobile Ladder or Stairs to provide access to the Actiflo System entry location.
8. Valves: The following valves, if supplied, shall be installed, wired and connected:
 - Raw water inlet automatic electric valve.
 - Coagulation and Maturation tank drain valves (Manual valves, wiring not required)
 - Settling Tank partial drain valve (Manual valve, wiring not required)
9. The following instruments are shipped separately. The wiring, connection, conduit, and installation are by others.
 - Raw Water Turbidimeter
 - Raw Water Flowmeter
 - Raw Water pH meter
 - Pressure Transmitter (ACP2-45 to ACP2-75)
 - LSHH Level Switch
10. The following instruments are pre-wired, pre-connected and pre-mounted in the factory on a support. For the purposes of shipping, these instruments and supports will be removed and the contractor shall reinstall the instruments in the field.
 - Influent Magnetic Flow Meter
 - Sand Pump Magnetic Flow Meter
 - Coagulation/Effluent pH meter
 - Effluent Turbidimeter
11. ACTIFLO® Control Panel: PLC Panel is shipped loose and shall be installed by contractor. All conduit and wiring from the termination box on the **I. Krüger Inc** supplied Package plant to the ACTIFLO® Control Panel is to be supplied and installed by the contractor.
12. Coagulant feed skid: The contractor shall do the electrical and control connections between skid's junction box and the ACTIFLO® control panel. The wiring is not supplied by **I. Krüger Inc**. The contractor shall supply and install the coagulant skid inlet and outlet piping.

13. Polymer preparation and feed skid: The contractor shall do the electrical and control connections between skid's junction box and the **ACTIFLO®** control panel. The wiring is not supplied by **I. Krüger Inc.** The contractor shall also supply and install the transport water and the make-up water piping. The contractor shall supply and install the polymer skid inlet and outlet piping.
14. Filter Aid feed skid: The contractor shall do the electrical and control connections between skid's junction box and the **ACTIFLO®** control panel. The wiring is not supplied by **I. Krüger Inc.** The contractor shall supply and install the coagulant skid inlet and outlet piping.
15. Supply and install all bulk storage tanks, pads, and supports including the concrete pad required for the **ACTIFLO®** system.
16. Supply and installation of all foundations, embedded or underground piping, conduits and drains.
17. Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment, and materials provided by I. Krüger Inc.
18. Labor and material for winterizing the **ACTIFLO®** System; insulating/heat tracing any tanks, piping, or tubing subjected to freezing temperatures, and water heaters when polymer solution make-up water is expected to fall below 55 °F. Polymer solution make-up water should be potable.
19. Provide all labor, materials, supplies and utilities as required for start-up, and performance testing including laboratory facilities, analytical work and chemicals.
20. Provide all chemicals, lubricants, glycol, oils, or grease and other supplies required for equipment start-up or plant operation.
21. The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the **ACTIFLO®** Supplier.
22. Supply and install all sunshields and/or additional enclosures as needed when installing **ACTIFLO®** equipment and instrumentation outdoors.
23. All other necessary equipment and services not otherwise listed as specifically supplied by the **ACTIFLO®** Supplier.

3.03 SUPPLIER'S SERVICES

- A. Preliminary field testing, inspection, and checkout of the entire **ACTIFLO®** system, following installation, shall be performed by a qualified representative of both the Supplier and Contractor. Tests shall be conducted to demonstrate to the Engineer that all system components furnished by the **ACTIFLO®** Supplier are fully operational, that all connecting piping is leak-proof and properly anchored, and that the entire system furnished by the **ACTIFLO®** Supplier is ready for continuous safe operation. The purpose of the checkout shall be to ensure that each individual system component has been correctly installed, shall operate in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation.

- B. When all preceding equipment tests have been satisfactorily performed and when water is available and can be suitably handled through the ACTIFLO® system, the ACTIFLO® system shall be started. The Supplier's representative shall supervise the Owner's operating personnel during the start-up period. Start-up operations shall be continued until it is satisfactorily demonstrated that the equipment is suitable for continuous on-line service.

- C. During the start-up period the process performance shall be evaluated for a minimum period of 2 eight-hour days. The owner shall provide for any necessary sampling and analysis during the testing period. Should the system meet satisfactory process performance requirements (or as required by the contract documents), the performance of the system shall be deemed successful and the ACTIFLO® system supplier shall be relieved of any further process performance obligations. In the event that the system does not meet satisfactory process performance requirements (or required by the contract documents), the 2-day test period shall be repeated.

- END OF SECTION -

PART 1. GENERAL

1.1. GENERAL INFORMATION

- A. The contractor shall install two (2) **DUSENFLO**[®] Package Plant Filter(s) as manufactured by **Kruger, Inc.**, the same manufacturer as the ACTIFLO System.
- B. Each **DUSENFLO**[®] Package Plant Filter shall filter water received through its inlet pipe. The **DUSENFLO**[®] Package Plant Filter shall consist of a rectangular steel tank with flanged inlet connection, distribution trough, filtering media, nozzle flow distribution system, filtered water compartment, flanged outlet, flanged water backwash connection, flanged air backwash connection, backwash water outlet and pre-filtration outlet.

1.2. OPERATING CONDITIONS

Site Reference	Monroe County, KY
Type of application	Drinking Water
Type of installation	Indoor
DUSENFLO [®] Model	DUS 500
Number of unit	Two (2)
Design Flow per unit	1.0 MGD
Design Rate in filtering zone	3.1 gpm/sf
Filter Type	Dual Media

1.3. SYSTEM DESCRIPTION

- A. The **DUSENFLO**[®] Process is a high performance, compact Filter system using various types of filtering media. The **DUSENFLO**[®] is specially designed to operate with the **ACTIFLO**[®] High Rate Clarifier System. The water enters the unit through the inlet and falls in a distribution trough. The water then overflows from this through in the filter compartment, on top of the filtering media. In the filter compartment, the water penetrates the filtering media and exits the media zone through flow distributing nozzles mounted on the false floor. The circulation through the filtering media and the nozzles is pushed by the pressure head on top of the filtering media. The false floor isolates the filtered water from the media zone. Once in the filtered water compartment, the water is evacuated from the filter through the outlet connection.
- B. The backwash process takes place when required. The inlet water to the **DUSENFLO**[®] is closed upstream from the unit and the water level in the tank is progressively reduced as the filtered water outlet drains the basin. Once the water level is lowered, the filtered water valve is closed and the backwash water system is activated. Once the air backwash cycle is completed, the air backwash system is stopped and the filter is left to rest for a short period of time. Then, the backwash water outlet is opened, the backwash water valve is opened and the water backwash system is activated. During the water backwash period, the water elevates in tank and eventually overflows back in the distribution trough. The backwash water outlet is located at the end of the distribution trough, opposite from the normal inlet of the unit. Once the backwash procedure is completed, the backwash water system is stopped, the backwash water inlet valve and the backwash water outlet valve are

closed. The inlet water is then reintroduced in the filter and the filtered water bypass valve is opened, sending the pre-filtered water to waste for a period of 10 minutes. Past this period, the bypass valve is closed, the outlet water valve is opened, restoring normal operation.

1.4. QUALITY ASSURANCE

A. The equipment and process supply shall conform to the latest version of the following codes and regulations:

- American Society of Mechanical Engineers(ASME)
- Canadian Standards Association(CSA)
- Standard Methods for the Examination of Water and Wastewater
- National Electric Manufacturer’s Association(NEMA)
- National Electric Code(NEC)
- Institute of Electrical and Electronics Engineers.....(IEEE)
- Electrical Equipment Manufacturers Association of Canada(EEMAC)
- American Gear Manufacturers Association.....(AGMA)
- American Society for Testing and Materials(ASTM)
- American National Standard Institute.....(ANSI)

1.5. SUBMITTALS

A. Submittals shall include at least the following information and documents:

1. Dimension layouts showing important details of construction, dimensions and anchor bolt locations.
2. Descriptive literature, bulletins and/or catalogs of the equipment.
3. Data on the characteristics, features and performance of the equipment.
4. Electrical Schematics, panel layouts, field wiring diagrams, instrumentation sheets and product data sheets for all electrical equipment.
5. The weight of all equipment including the weight of the single largest item.
6. A complete bill of materials for all equipment.
7. Complete motor drive data.

1.6. OPERATION AND MAINTENANCE

A. All Operation and Maintenance shall be performed in accordance with the information and manuals supplied by **Kruger, Inc.** The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, and other information that is required to instruct operation and maintenance personnel unfamiliar with such equipment.

PART 2. PRODUCTS

2.1. GENERAL

A. The **DUSENFLO®** System shall be supplied as a completely functional, shop fabricated and tested system, complete with flanged connections.

2.2. DUSENFLO® PACKAGE PLANT TANK

- A. The **DUSENFLO®** DUS Tank shall consist of a completely welded steel tank that includes two compartments. The inlet pipe shall access the frontal upper filtering media compartment. The water overflow on the media from a distribution trough. The other compartment is located below the false floor fitted with the flow distributing nozzles.
- B. The water accesses the filtered water compartment through the nozzles.
- C. The filtered water outlet is located in the filtered water compartment.
- D. The backwash connections are located as follows: the air and water backwash connections are in the filtered media zone. The backwash water outlet is located in the media zone, connected to the distribution trough and opposite from the filter's main inlet.
- E. The tank shall be sized and configured as per supplied drawings.

2.3. DISTRIBUTION TROUGH

- A. The distribution trough shall be a stainless steel element fabricated to help the flow distribution in the filter. The same trough also serves as an overflow point for the backwash water leading afterwards to the backwash outlet.
- B. The distribution trough spans across the filter length and is attached to the tank at the inlet and outlet ends. The raw water enters the trough through the inlet flange and falls in the trough itself. The water shall overflow from the trough uniformly all along the length of the trough, thus bringing a good flow distribution on the filter. The other end of the trough is supported at the tail end of the filter tank and connects there with the backwash water outlet.

2.4. FILTER MEDIA

- A. The filtering bed is made of two layers of media. The anthracite layer removes larger particles while the sand layer retains finer particles.
- B. The top layer shall be made of 460 mm thick of anthracite with an effective diameter of 1,3 to 1,5 mm and an uniformity coefficient of less than 1,5.
- C. The bottom layer of sand shall be 300 mm thick of 0,45 to 0,55 mm diameter grain with a uniformity coefficient of less than 1,5.

2.5. NOZZLES

- A. The **DUSENFLO®** flow distributing nozzles shall be fabricated of Polypropylene. They are mounted on the false floor and help to distribute the flow evenly on the filter system.
- B. The nozzles are removable.

2.6. FALSE FLOOR

- A. The false floor is a perforated steel plate designed to accept the flow distributing nozzles, support the media and the unfiltered water and insure that the filtered water zone is not contaminated by short circuiting water. For this reason, the false floor is sealed on the tank sides and well supported from the tank bottom.
- B. The plate also serves as a support for the filtering media.
- C. The plate is supported on the sides by angles welded on the tank sides. The contact of the plate with the side angles is sealed.
- D. If the false floor requires more than one plate, the various plates are sealed together.

2.7. AIR SCOUR BLOWER

- A. The backwash of the filter media shall be done first with using air and then with water.
- B. The air scour blower shall have enough capacity to backwash the filter at a rate of 24.5 gpm/sf.
- C. The motor shall be constant speed, TEFC, 575 V / 3 Ø / 60 Hz.
- D. The air scour blower and motor shall be painted with the manufacturer's standard paint.
- E. The air scour blower will be equipped with a plugging indicating element, a silencer filter, a safety valve, a check valve and flexible connectors.
- F. Shelter is not included.

PART 3. VALVES

3.1. BUTTERFLY VALVE

- A. Butterfly valve shall be as manufactured by Bray Series 31. The valve shall be industrial resilient seated type with ANSI class 125/150 flanges. Butterfly valves shall be provided with cast iron bodies, EPDM seats, ductile iron Nylon coated disc and stainless steel shaft.
- B. Automatic valve shall be equipped with pneumatic double-action quarter-turn actuator as manufactured by Bray Series 92. The compressed air for operation shall be at 80 PSIG.
- C. For modulating valve, electro-pneumatic actuator with 4-20 mA input signal shall be provided as manufactured by Bray Series 6A.

- D. Automatic valve shall be equipped with electric quarter-turn actuator as manufactured by Bray Series 70.

PART 4. INSTRUMENTATION

4.1. LOW RANGE TURBIDITY MONITORING

- A. Low range turbidimeter(s) shall be provided for installation in the **DUSENFLO®** effluent stream. The unit is located on the filtered water piping.
- B. The turbidity monitor shall include at least one turbidimeter and one interface unit. The system shall be capable of functioning as a single sensor system and also be easily expanded up to two turbidimeters per interface unit. Connections between the turbidimeter and interface unit will include plug & play connections.
- C. Turbidimeter shall measure turbidity in the range of 0.001-100 NTU and be a microprocessor-based, continuous-reading, on-line nephelometric instrument meeting all design and performance criteria specified by USEPA method 180.1.
- D. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells. Optical components shall be mounted in a sealed head assembly that can be removed easily without disturbing sample flow.
- E. The turbidimeter body shall be constructed of corrosion-resistant polystyrene, and shall include an internal bubble removal system.
- F. Accuracy shall be $\pm 2\%$ of reading or $\pm 0,015$ NTU (whichever is greater) from 0 to 40 NTU; $\pm 5\%$ of reading from 40 to 100 NTU. Displayed resolution shall be 0,0001 NTU from 0 to 9,9999 NTU; 0,001 NTU from 10,000 to 99,999 NTU and repeatability shall be better than $\pm 1,0\%$ of reading or $\pm 0,002$ NTU (whichever is greater).
- G. The interface unit shall allow operators to control sensor and interface functions with user-friendly, menu-driven software, and shall provide data logging of measurement data from up to two turbidimeters for 15 minutes, 1 hour, 24 hours, 30 days, or 180 days.
- H. The interface unit will also have a built-in data logger with the storage capacity to store data on 15-minute intervals for up to 6 months.
- I. Each turbidimeter shall be HACH Solitax or equal.

4.2. FLOW MONITORING

- A. Magnetic flowmeter shall be provided for installation for each **DUSENFLO®** effluent and backwash streams.
- B. Magnetic flowmeter shall be obstructionless and operate by means of pulsed DC coil excitation. Flow tube shall be constructed of 304SS, with a hard rubber liner,

Hastelloy-C electrodes, and ANSI Class 150 flanges. 316SS grounding rings shall be built into flow tube.

- C. Signal converter shall be either integrally mounted on flow tube or remotely mounted up to 300 m from tube. It shall be powered by 110V, 60 Hz single phase current and provide both a 4-20 mA rate signal and a scaled 0-10 kHz pulse output for remote total addition.
- D. Accuracy of magnetic flowmeter shall be $\pm 0,5\%$ of reading for all flows above 0,396 m/s (1,3 ft/sec) velocity.
- E. Magnetic flowmeter shall be as manufactured by Endress & Hauser.

4.3. ULTRASONIC LEVEL MONITOR

- A. Ultrasonic water level monitor shall constantly detect level over fixed level filter. This signal shall be compiled to regulate opening of filtered water modulating valve at outlet of unit.
- B. Ultrasonic Level Monitor shall be manufactured by Endress & Hauser.

4.4. DIFFERENTIAL PRESSURE TRANSMITTER

- A. Differential pressure transmitter shall detect headloss through filtering media of unit. Measured headloss shall be used to start backwash sequence of unit.
- B. Instrument shall be manufactured by Endress & Hauser.

4.5. LEVEL SENSOR

- A. The Filter shall have one level sensor to generate an alarm signal as the water level in the filter reaches an excessive level.
- B. The level sensor shall be a float switch manufactured by Anchor Scientific.

PART 5. NOT USED

PART 6. CONSTRUCTION MATERIAL

6.1. MATERIALS

- A. The **DUSENFLO®** DUS Package Plant materials of construction shall be as follows:

Package Plant Tank	:	CSA 44W steel plate, angles and members
Supports and beams	:	CSA 44W steel plate, angles and members
Flanges	:	Carbon Steel, ANSI 125
Collecting Trough	:	304 Stainless Steel

Screws and Bolts	:	304 stainless steel
Structural screws	:	Zinc plated graded bolts and nuts

6.2. PAINTING

A. All ASTM A36 steel shall be painted except parts specifically defined as Hot Dip Galvanized. All 304 Stainless Steel or Aluminum shall be shipped bare. Painting shall be according to following procedures:

A. Surface Preparation

- Internal: SSPC-SP-10
- External: SSPC-SP-6

B. Coating

- Internal:
 - First coat: Sherwin-Williams, Macropoxy 646 NSF, B58LX600 “Light Blue”, 3.0 to 6.0 dry mils per coat.
 - Second coat: Sherwin-Williams, Macropoxy 646 NSF, B58WX610 “Mill White”, 5.0 to 10.0 dry mils per coat.
 - Third coat: Sherwin-Williams, Macropoxy 646 NSF, B58LX600 “Light Blue”, 5.0 to 10.0 dry mils per coat.
- External:
 - First coat: Sherwin-Williams, Macropoxy 646 NSF, B58LX600 “Light Blue”, 5.0 to 10.0 dry mils per coat.
 - Second coat: Sherwin-Williams, UV resistant Acrolon 218 HS, B65-650 Semi-Gloss, 3.0 to 6.0 dry mils per coat, color “International D917 blue”.

PART 7. ELECTRICITY AND CONTROLS

7.1. PRE-WIRING

A. All **DUSENFLO**[®] mounted valves and instruments shall be field mounted and/or wired by the installing contractor.

7.2. MAIN CONTROL PANEL

A. The **DUSENFLO**[®] Package Plant Filters are controlled by the **ACTIFLO**[®] Package Plants PLC Based Control panel.

PART 8. ONSITE INSTALLATION

8.1. CONTRACTOR'S INSTALLATION TASKS

A. The **DUSENFLO**→ Package Plants are pre-mounted as much as possible. However, for freight purposes or general practical reasons, the installation of some items needs to be completed on site by the contractor. Here is a list of tasks that need to be performed by the contractor at job site:

1. The units are coming fully assembled. Approximate gross shipping weights are as follows:

DUS-500: 15433 pounds

2. Filtering media shall be properly installed and washed at job site by the Contractor. EXTREME CARE must be paid during the filtering media installation to protect and maintain the integrity of the internal corrosion protection system inside and outside the **DUSENFLO**[®] tank. **Kruger, Inc.** shall not be held responsible for any corrosion problem occurring inside the tank after the site installation of the filtering media.
3. All **DUSENFLO** electrical wiring, conduit and terminations shall be completed by the installing contractor.
4. Air scour blower: The contractor shall install the air scour blower. The contractor shall assemble and install all items shipped loose: the vibration isolators, the pressure relief with the supplied piping, the check valve and the pressure gauge. The contractor shall do the electrical and the control connections between the blower and the control panel. The contractor shall supply and install the piping between the blower and the DUS units.
5. Backwash pump: The contractor shall supply and install the backwash pumps. The contractor shall do the electrical and the control connections between the pumps and the control panel. The contractor shall supply and install the piping between the pumps and the DUS units.
6. Anchorage: The contractor shall anchor the unit at the site. The anchors are not part of **Kruger, Inc.** supply.
7. Leveling: While anchoring the unit, the contractor shall properly level the unit in place. Leveling system is not part of **Kruger, Inc.** supply.

Section 110030 - Tower Sludge Belt Filter Press System

1. GENERAL

- 1.1 The Tower Belt Filter Press and associated equipment furnished under this contract shall comply with the following specifications which are based upon time proven design. That design combines high strength structural integrity, extensive material longevity, minimal maintenance and utility requirements, and state of the art process resulting in superior overall performance.
- 1.2 **QUALITY ASSURANCE**
System Responsibility: Vested responsibility for operation and control of the BFP system, which is comprised of all equipment supplied and controlled by the BFP control panel, is the BFP manufacturers.
- 1.3 Experience Qualification: BFP equipment shall be provided by a manufacturer who is qualified and experienced in the production, installation, operation, and process control of dewatering polymer, conditioned, aerobically digested sludge from municipal wastewater treatment facilities. A qualified manufacturer is one having a minimum of ten (10) units of the proposed model, each having been in operation for a period of not less than five (5) years.
- 1.4 The belt filter press manufacturer is to have a minimum 20 years of development, assembly and manufacturing experience. No exceptions to this requirement shall be accepted.
- 1.5 The alternate bid manufacturer and Contractor shall absorb all costs associated with changes in layout, piping, controls, electrical wiring, etc. (including engineering costs) if the alternate bid manufacturer is accepted.

2. DESIGN CRITERIA

- 2.1 Number of belt filter presses required: 1
- 2.2 Minimum belt width: 0.7 meter
- 2.3 Maximum overall dimensions: 4' - 10" wide
10' - 2" long
7' - 4" high
- 2.4 The Tower Belt Filter Press shall be Charter Machine Company Model TP 07.5.

3. TOWER BELT FILTER PRESS MAIN FRAME

- 3.1 Main frame design is crucial as it is the support structure of the entire machine. The frame shall be of welded box frame construction to eliminate the possibility of

bolts loosening during operation. Structural members shall be C channels conforming to ASTM Specification A36 and designed to accommodate all operating and static loads without significant deflection, deformation or vibration. Maximum operational loading shall be defined as the sum of the belt tension load based on a belt tension of 30 pli; friction loads; roller, equipment and sludge loads; any loads induced by the belts; and any loads induced by the torque of the drive.

- 3.2 Main frame coating is crucial to the protection of the press main frame. All frame members shall be prepared and coated according to ASTM A123, hot dip galvanized to a minimum 5 mil thickness. All frame members shall be drilled and machined, and all bolted connections shall be disassembled prior to galvanizing.

4. FLOCCULATOR

- 4.1 The belt filter press shall be furnished with an upstream sludge-conditioning device consisting of an inline adjustable orifice venturi type mixer complete with polymer injection device. The mixer shall be designed to condition the sludge with polymer to result in a degree of flocculation that will produce the greatest amount of dewatering while maintaining the highest quality filtrate.
- 4.2 Location of the flocculation device will vary with the application. Several locations may be specified with the unused locations plumbed with spool pieces.

5. GRAVITY DEWATERING ZONE

- 5.1 The gravity-dewatering zone shall be two stage consisting of one (1) rotating sieve drum and a section of the horizontal filter belt. The sieve drum shall be rotated by variable speed drive and shall be an integral part of the belt filter press. The drum shall be at least 29.5" diameter and 36" long with a minimum dewatering area of **23** square feet. Integral internal helical baffles shall gently tumble and transport the sludge through the rotating drum and prevent short-circuiting of the flow thereby allowing all of the sludge to contact the total dewatering area.
- 5.2 The drum shall be covered by a monofilament polyester weave-dewatering screen designed specifically for optimal gravity dewatering. The screen shall be easily replaceable without removing the dewatering drum from the belt filter press.
- 5.3 The rotating sieve drum shall be continually washed by a self-cleaning internal brush type spray manifold with overlapping spray jets.
- 5.4 Sludge from the sieve drum shall be distributed onto the horizontal belt by a baffled type 304 stainless steel chute. The sludge shall be contained on that belt by a type 304 stainless steel box with neoprene seals. An adjustable stainless steel sludge level bar shall provide the desired sludge thickness uniformly across the belt width. Halfway through the second stage gravity zone the sludge shall be completely inverted and shall continue towards the wedge zone.

5.5 The gravity belt section of the second stage-dewatering zone shall be supported by rollers and a grid of high-density polyethylene wear bars. The effective dewatering area of the second stage gravity zone shall be a minimum **2.1** square feet.

6. WEDGE ZONE

The wedge zone shall be provided in order to gently apply and gradually increase the pressure on the thickened sludge. The wedge zone is formed by the convergence of both filter belts coming off of their respective tensioning rollers and gradually forming a cloth/cake sandwich prior to contacting the perforated roll in the pressure section. The pressure shall be gradually increased by a grid of UHMW supports beneath the bottom cloth. The effective dewatering area of the wedge zone shall be a minimum **5.66** square feet.

7. HIGH PRESSURE/SHEAR ZONE

The high pressure/shear zone shall consist of a minimum of fifteen (15) rollers. The first shall be a perforated drum of 14" diameter with perforations of minimum 5/8" diameter and minimum 34% open area. The succeeding rollers shall be solid faced decreasing in diameter from 10-3/4" to 6-5/8" to 5-9/16" and arranged in both a vertical and horizontal configuration. The total effective high pressure dewatering area shall be a minimum **33.57** square feet as measured along the length of a single belt in contact with the pressure rolls.

8. CAKE DISCHARGE ZONE

Adjustable counterweighted doctor blades shall be mounted at the drive roller for removing sludge cake from both belts. The doctor blades shall be made from UHMW polyethylene. The blades shall be rigidly reinforced to provide even gentle pressure on the belts with a minimal amount of abrasiveness and shall be capable of providing passage clearance for the belt seam without injuring that seam. A type 304 stainless steel chute for directing the sludge to the next destination shall be provided.

9. ROLLERS

9.1 All rollers shall be designed for a maximum deflection of less than 0.02" at mid span under maximum loading conditions. Maximum loading shall be defined as the sum of the belt tension load at 50 pli; friction loads; equipment and sludge loads; any loads induced by the elasticity of the belts; and any loads induced by the torque of the drive.

9.2 All rollers and perforated drum shall be of through-shaft design with matched deflection of shafts and end plates. Assembly of rollers, shafts, and end plates shall be of machined concentricity and by means of continuous weld.

9.3 Drive rollers and tracking rollers shall be coated with a minimum 3/8" thick synthetic rubber of 60 durometer to provide the friction required for efficient belt drive and tracking. All other solid rollers shall be coated with Rilsan Nylon II to a thickness of 25 mils by the Electro Static, Fusion Bonded Rilsan Powder Dispersion Process.

9.4 The perforated drum shall be hot dip galvanized to a minimum thickness of 5 mils and shall be totally free of projections that may shorten belt life.

10. BALL BEARINGS AND SEALS

All bearings shall be self aligning and regreasable with all grease fittings located for easy servicing from the machine exterior. All bearings shall be pillow block type with metal shielded, nitrile rubber, land riding contact seals.

11. BELT TENSIONING

11.1 Belt tensioning shall be maintained pneumatically and controlled from the press mounted pneumatic control center.

11.2 Each filter belt shall be tensioned by a pair of corrosion resistant pneumatic cylinders attached to a rigid tensioning assembly. The tensioning assembly shall be attached to each tensioning cylinder in such a way as to assure parallel movement of each tensioning roller.

11.3 Each belt shall be tensioned individually, with capability of changes with the machine operating. Tensioning pressure shall be gauged at the pneumatic control center. Tensioning cylinders shall be power retractable for belt replacement and emergency de-tensioning.

11.4 The tensioning arrangement shall have adequate allowances for normal belt stretch throughout the anticipated belt life.

12. BELT TRACKING

12.1 Belt tracking shall be totally pneumatic and shall function as a continuous automatic belt guidance system. Each belt shall be tracked individually by a type 304 stainless steel paddle arm and analog system sensor which monitors one edge of the belt and pneumatically signals a corrosion resistant pneumatic cylinder for corrective positioning when required. That corrective motion shall be smooth, minimal, and adjustable.

12.2 Each belt tracking assembly shall be center pivoting complete with bearings to minimize dewatering belt stretch and wear.

13. PNEUMATIC CONTROL SYSTEM

- 13.1 All belt press pneumatic system controls, tensioning and tracking, shall be frame mounted on the belt press in a NEMA 4X enclosure with the tension gauges mounted on the panel door. Tensioning adjustments, low air alarm switch, and tensioning valves for on/off control shall be mounted inside the enclosure. Tensioning on/off levers shall extend through the enclosure wall for easy access. The enclosed controls shall be preceded by a three (3) micron filter regulator with gauge and an oil coalescing filter. One (1) supply air connection only shall be required to the total pneumatic system. Lubrication of the pneumatic system is required.
- 13.2 Each belt press shall be furnished with a receiver mounted single stage air compressor. The unit shall be complete with 17 gallon ASME Code receiver rated for 200 psi, pressure gauge, automatic overload protector, intake air filter-muffler, pressure switch, safety valve, tank drain, outlet valve, and constant speed regulator. The motor shall be 1.5 HP, TEFC with 1.15 service factor.

14. BELT WASH STATIONS

Each filter belt and sieve drum shall be equipped with a belt wash station for constant belt washing. Each station shall include a manifold with removable stainless steel nozzles, internal handwheel operated brush, handwheel operated flush valve, and stainless steel neoprene skirted enclosure for containing spray mist. Belt spray water and flush water shall be collected in stainless steel pans and plumbed to the base sump to prevent rewatering of the sludge process. Spray nozzles shall be suitable for use with non-potable water with a maximum solids concentration of 200 mg/l without clogging.

14.1 Wash Water Booster Pump

A washwater booster pump shall be provided for increasing the water flow and pressure to the belt press. The pump shall be centrifugal type with replaceable wear rings. All plumbing connections shall be clearly labeled and numbered terminals shall be provided in the belt press junction box. The booster pump shall be Goulds Model 3656 and come complete with galvanized base and mounted to a maximum 7.5 HP, TEFC motor to be installed by the contractor in the press room.

15. FILTER BELTS AND SIEVE DRUM SCREEN

- 15.1 Filter belts shall be of polyester monofilament wovenware with minimum tensile strength of 890 pounds per lineal inch. Edges shall be chamfered and belt seams shall be type 316 stainless steel clipper type. Mesh shall be selected for optimal pressure dewatering of the pertinent sludge. Belts shall be self threading under power for replacement.

- 15.2 Sieve drum screen shall be of polyester monofilament wovenware specifically designed for optimal gravity (no pressure) dewatering of the pertinent sludge.
- 15.3 Replacement of filter belts and sieve drum screen shall be accomplished without any disassembly of any part of the belt filter press except the belt and screen joints.

16. DRIVES AND MOTORS

- 16.1 Main belt drive shall be 1.5 HP derated to 1.0 HP, variable speed, shaft mounted on one drive roller shaft. Drive shall transfer to the second drive roller by means of a gear combination. The gears shall be totally enclosed by a solid, stainless steel enclosure. The sieve drum drive shall be 0.75 HP, variable speed and shaft mounted on the sieve drum shaft. All motors shall be severe duty TEFC of ample power for starting and operating under normal conditions without exceeding the nameplate horsepower and shall have a service factor of 1.15.
- 16.2 The drive shall be Variable Frequency Drive using AC motor and quadruple gear speed reducer. The inverter, start/stop and speed control of the drive shall be in the belt press control panel.

17. FACTORY WIRING

All equipment and components shall be factory wired using non-metallic, flexible liquid-tight conduit and fittings wired to numbered terminal blocks in a frame mounted NEMA 4X junction box. All conduit shall be run and secured inside the channel frame wherever possible.

18. SAFETY FEATURES

- 18.1 Each belt filter press shall be equipped with a lanyard type safety switch with cable encircling three sides of the press at an easily accessible height.
- 18.2 The tensioning system shall have a limit switch that shall shut down the system in the event of total belt failure.
- 18.3 The belt tracking system shall have a limit switch on each side of the press that shall shut down the system in the event of belt tracking failure.
- 18.4 The pneumatic control center shall have a pressure switch that shall shut down the system in the event of low air pressure.
- 18.5 Each gear drive shall have a solid stainless steel enclosure.
- 18.6 The wash water system shall have a pressure switch that shall shut down the system in the event of low water pressure.

19. ELECTRICAL CONTROL PANEL

1. General Requirements: Each belt filter press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein. The control panel shall meet the following general requirements:
 - a. The control panel shall accept a 460 volts, 60 hertz, 3 phase ac power input. A main disconnect circuit breaker and operator mechanism shall be included. When the disconnect is in the open position, all power shall be removed from the control system.
 - b. IEC rated motor starters shall be provided for the air compressor, belt wash water booster pump, cross conveyor, and the discharge conveyor.
 - c. Variable frequency drive (VFD) shall be provided for the belt drive and sieve drum drive.
 - d. Short circuit protection for each motor shall be accomplished utilizing fuses. Individual thermal overload protection shall be provided (except for the belt drive, dewatering drum drive and sludge feed pump).
 - e. A control power transformer shall be included that will provide 120 volts, AC control power to the system.
 - f. An industrial programmable logic controller (PLC) located in the control panel shall perform all logic functions for the system.
 - g. A CONTROL POWER ON/OFF switch shall be located on the front of the control panel. When in the ON position, the CONTROL POWER ON pilot light will be illuminated and control power shall be distributed to the control system. When in the OFF position, the control system shall be held de-energized.
 - h. An EMERGENCY STOP pushbutton shall be located on the control panel. It shall be a mushroom head style pushbutton that when depressed shall immediately de-energize all moving equipment in the system.
 - i. An alarm horn shall be included with the control panel for audible alarm annunciation along with a horn silencing button in the front of the panel.

2. Control and Pilot Devices: As a minimum, the following control and pilot devices shall be located on the front of the control panel with nameplates as worded below in UPPERCASE LETTERS:

a. Pushbuttons:

- (1) AUTO START
- (2) AUTO STOP
- (3) SYSTEM RESET
- (4) ALARM SILENCE
- (5) WASHWATER PUMP START
- (6) WASHWATER PUMP STOP
- (7) BELT DRIVE START
- (8) BELT DRIVE STOP
- (9) DEWATERING DRUM START
- (10) DEWATERING DRUM STOP
- (11) SLUDGE PUMP START
- (12) SLUDGE PUMP STOP
- (13) POLYMER SYSTEM START
- (14) POLYMER SYSTEM STOP
- (15) CROSS CONVEYOR START
- (16) CROSS CONVEYOR STOP
- (17) DISCHARGE CONVEYOR START
- (18) DISCHARGE CONVEYOR STOP

b. Selector Switches:

- (1) PRESS HAND/OFF/AUTO MODE
- (2) CONTROL POWER ON/OFF
- (3) AIR COMPRESSOR ON/OFF

c. Indicator Lights:

- (1) PREWET CYCLE ON
- (2) POSTWASH CYCLE ON
- (3) AIR COMPRESSOR RUNNING
- (4) WASHWATER PUMP RUNNING
- (5) BELT DRIVE RUNNING
- (6) DEWATERING DRUM RUNNING
- (7) SLUDGE PUMP RUNNING
- (8) POLYMER SYSTEM RUNNING
- (9) CROSS CONVEYOR RUNNING
- (10) DISCHARGE CONVEYOR RUNNING
- (11) LOW AIR PRESSURE

- (12) BELT OVERTRAVEL / BELT BROKEN
- (13) LOW POLYMER

d. Speed Potentiometers:

- (1) SLUDGE PUMP SPEED
- (2) BELT DRIVE SPEED
- (3) SIEVE DRUM SPEED

3. Signal Input and Output Devices:

- a. Discrete Input Signals: The control panel shall receive the following discrete input signals from normally open dry contacts in external devices (contacts close when the equipment runs or a fault occurs):

- (1) POLYMER SYSTEM RUN
- (2) POLYMER SYSTEM FAIL

- b. Discrete Output Signals: The control panel shall provide the following discrete signals for transmission using normally open dry contacts (contacts close when the equipment is called to run or a fault occurs):

- (1) PRESS RUNNING
- (2) PRESS FAULT
- (3) POLYMER SYSTEM RUN

4. Sequence of Operation:

- a. Automatic Mode of Operation:

- (1) The press may be operated in the automatic mode by placing the HAND/OFF/AUTO selector switch in the AUTO position. Place the Air Compressor Selector Switch in the ON position and allow the pressure to reach normal operating level.
- (2) After the air pressure has reached operating level, the operator will press the AUTO START pushbutton, this will energize the washwater pump and belt drive, illuminate the PREWET CYCLE ON pilot light and start the pre-wet time delay. After the pre-wet timer times out, the sludge pump,

polymer system, cross conveyor and the discharge conveyor will be energized.

- (3) Pressing the AUTO STOP pushbutton will de-energize the sludge pump and polymer system, illuminate the WASHDOWN CYCLE ON pilot light and start a washdown time delay. After the washdown timer has timed out, the belt drive, washwater pump, cross conveyor and discharge conveyor will be de-energized.

b. Manual Mode of Operation

- (1) To operate the press in the manual mode, the operator will place the HAND/OFF/AUTO selector switch in the HAND position. Place the Air Compressor Selector Switch in the ON position. After the air pressure has reached operating level, start the washwater pump by pressing the WASHWATER PUMP START pushbutton.
- (2) The operator will not proceed until the belts are allowed to be fully tensioned. No interlock shall be provided to prevent the operator from starting the belt drive in the manual mode. Pressing the BELT DRIVE START and SIEVE DRUM START pushbutton will energize the belt drive and the dewatering drum. At this time, the operator will start the cross conveyor by pressing the CROSS CONVEYOR START pushbutton, the discharge conveyor by pressing the DISCHARGE CONVEYOR START pushbutton, the sludge pump by pressing the SLUDGE PUMP START pushbutton and the polymer pump by pressing the POLYMER SYSTEM START pushbutton.
- (3) The system will be stopped by pressing the respective STOP pushbutton in the reverse order stated above.

5. Faults:

- a. When any of the following fault conditions occur, in automatic or manual mode, the appropriate fault indicator will be illuminated, the alarm horn will sound and the belt filter press and associated equipment will be de-energized:
 - (1) LOW AIR PRESSURE (amber light)
 - (2) BELT OVERTRAVEL / BELT BROKEN (amber light)

- (3) LOW POLYMER (amber light)
- (4) BOOSTER PUMP FAULT (flashing run light)
- (5) BELT DRIVE FAULT (flashing run light)
- (6) DEWATERING DRUM FAULT (flashing run light)
- (7) SLUDGE PUMP FAULT (flashing run light)
- (8) CROSS CONVEYOR FAULT (flashing run light)
- (9) DISCHARGE CONVEYOR FAULT (flashing run light)

6. Components:

- a. Enclosures: Control panel enclosures shall be free-standing, fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service. Enclosures shall be manufactured by Saginaw Manufacturing.
- b. Wiring: All power and control wiring shall be 600 volt, type SIS insulation stranded copper and shall be sized for the required load, 14 AWG minimum.
- c. Circuit Breakers: Circuit breakers for the main disconnect shall be thermal magnetic molded case units. Circuit breakers shall be Square D, Class 650, Type FAL.
- d. Motor Starters: Motor starters shall be full voltage, nonreversing, IEC style across-the-line units. Coils shall be 120 volts ac. Siemens type Sirius 3RT10.
- e. Selector Switches: All selector switches shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10 ampere continuous service. Selector switches shall be Idec Series TWTD.
- f. Pushbuttons: All pushbuttons shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10 ampere continuous service. Pushbuttons shall be Idec Series TWTD.
- g. Pilot Lights: Pilot lights shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC full voltage incandescent type. Pilot lights shall be Idec Series TWTD.
- h. Terminal Blocks: Terminal blocks shall be high density, solderless box lug style, with 600-volt rating. Terminal blocks shall be Allen Bradley type 1492.

- i. Control Relays: Control relays shall be general purpose type with a 10 amp contact rating, miniature square base and internal on status pilot light. Relays shall be Allen Bradley Type 700-HF Series.
- j. Programmable Logic Controller (PLC): The PLC shall be a modular type with discrete and analog capabilities. The CPU shall have 6K minimum RAM for user instructions. The PLC shall be an Allen Bradley Micrologix Type.
- k. Variable Frequency Drive (VFD): The VFD shall be UL listed and shall be manufactured by Control Techniques.

20. UTILITY REQUIREMENTS

- 20.1 Electrical - 460 volt, 3 phase, 60 Hz is standard.
- 20.2 Power
 - Belt Drive - 1.0 HP (1.5 HP derated)
 - Sieve Drum Drive - 0.75 HP
 - Air Compressor - 1.5 HP
 - Wash Water Booster Pump (Optional) - 5.0 HP
- 20.3 Belt Wash - 30 gpm @ 85 psi (minimum)
- 20.4 Pneumatics - 3 cfm at 80-psi min., 250 psi max.

21. SUMMARY OF CONSTRUCTION MATERIALS

- 21.1 Main Frame Box frame of welded C channels conforming to ASTM Specification A36, then hot dip galvanized according to ASTM A123.
- 21.2 Flocculator Type 304 stainless steel and UHMW polyethylene.
- 21.3 Sieve Drum Carbon steel, hot dip galvanized according to ASTM A123.
- 21.4 Perforated Roller Carbon steel, hot dip galvanized according to ASTM A123.
- 21.5 Drive Rollers Carbon steel coated with 3/8" thick synthetic rubber, 60 durometer.
- 21.6 Tracking Rollers Carbon steel coated with 3/8" thick synthetic rubber, 60 durometer.
- 21.7 Other Rollers Carbon steel coated with 25 mils Rilsan II Nylon.

21.8	Bearings	Single race ball, self aligning, grease fittings.
21.9	Bearing Seals	Metal shielded, land riding, nitrile rubber contact seal.
21.10	Pneumatic	200 psi rating, anodized aluminum tube Cylinders with no external tie rods, Teflon seals, graphite bearing, lubrication required.
21.11	Belt Tracking	Fully pneumatic.
21.12	Belt Tensioning	Fully pneumatic.
21.13	Belt Wash Stations	Hand wheel operated internal brush type with stainless steel manifold, valve, nozzles, brush, aluminum handwheel and type 304 stainless steel enclosure with neoprene seals.
21.14	Belts and Screen	Monofilament polyester weave selected for function and particular sludge. Seams are 316 stainless steel clipper type.
21.15	Filtrate Pans	Type 304 stainless steel.
21.16	Sludge Chutes	Type 304 stainless steel.
21.17	Cake Discharge Chute	Type 304 stainless steel.
21.18	Water Plumbing	PVC, schedule 80.
21.19	Pneumatic Plumbing	Polyethylene tubing, 120 psi work, 625 psi burst.
21.20	Doctor Blades	UHMW polyethylene
21.21	Junction Box	NEMA 4X
21.22	Pneumatics Station	NEMA 4X
21.23	Assy. Hardware	Type 304 stainless steel

22. SLUDGE FEED PUMP

The sludge feed pump shall be positive displacement, progressive cavity type designed to feed the processed sludge to the belt filter press. The pump shall be single stage, self-priming, low shear with suction lift up to 28 feet. Pump will be complete with maximum 7.5HP drive with gearbox mounted to a common baseplate and controlled by a VFD located in the master control panel. Contractor to install the sludge feed pump in the press room with start-up supplied by the belt press manufacturer.

23. POLYMER SYSTEM

The polymer system provided shall be capable of metering, diluting and activating an emulsion type polymer with water. The system shall be capable of controlling separately the water flow and the polymer injection dosage. The system shall be furnished to the contractor being factory tested completely assembled and mounted on a 304 stainless steel stand.

Polymer shall be injected in the water stream by the feed pump to a kinetic mixing chamber to create a thorough mixing energy. The design shall include a motor driven impeller to create high impact energy with low fluid shear. Solution shall undergo a tapered mixing intensity slope as it passes through a second recovery zone. Polymer activation efficiency shall be consistent over the entire dilution water range. A portion of the mixed polymer is then recirculated through the mixing chamber ensuring optimum mixing has occurred. A transparent section after the mixing chamber shall be provided to observe the solution consistency.

The polymer preparation system shall be capable of remote start/stop operation. A speed potentiometer for the polymer make-up pump speed rate shall be provided. All controls are to be mounted in a NEMA 4X FRP enclosure and wired directly to its components. A common power feed cord with a standard male plug for a 120V, 20AMP receptacle (provided by others) shall be furnished. The polymer system shall be the L-2 unit as manufactured by Charter Machine Company.

24. DISCHARGE CONVEYOR

The belt press manufacturer shall provide a ten (10) inch shafted screw conveyor by their manufacture designed to convey the dewatered sludge cake as shown on the drawings. The trough shall be a formed flanged type with minimum 14 gauge thickness. The trough shall be manufactured in standard 10 foot lengths with each trough having an end flange which shall mate with the next trough to form a straight conveyor.

The auger shall be a 10 inch sectional flight. The flights shall be a minimum of 1/8" thick and will be staggered intermittent welded to the center pipe. The flights will be mounted on 2" schedule 40 pipe bushed and drilled for 1.5" shafts.

The inlet hopper will be fabricated of 14 gauge stainless steel and flanged to mate with the inlet flange of the trough. All covers shall be 14 gauge stainless steel.

Drive will be a 2HP motor, TEFC, 1750RPM, 240/480V with 1.15 Service Factor. The motor will be washdown rated and all controls will be located in the belt press master control panel.

The manufacturer will provide all necessary structural supports for the conveyor. The supports will be hot-dipped galvanized and be designed to support the conveyor with minimal deflection.

25. FIELD SERVICE

The manufacturer shall include the services of a factory trained field engineer for the purposes of installation inspection, equipment start-up, polymer selection, performance testing and training of plant personnel regarding proper operation and maintenance of the equipment. The factory trained personal will be required to provide two trips and be on site for five days.

Section 110040 CHEMICAL FEED EQUIPMENT

PART 1 GENERAL

1.01 Summary

- A. This section includes providing all materials, services, equipment and incidental as shown, specified and required to furnish, field test and place in satisfactory operation, chemical feed system consisting of chemical metering pumps, chemical transfer pumps, chemical tanks, chemical tank scales, drum and day tank scales, and other equipment as shown on the drawings and as specified herein.

1.02 Submittals

- A. Submittals are required for all components related to the chemical feed system including material compatibility to the chemical fluid being pumped.

1.03 Quality Assurance

- A. All equipment provided under this Section shall be obtained from a single supplier or manufacturer who, with the vendor, shall assume full responsibility for the completeness and proper operation of the chemical feed system.

1.04 Warranty

- A. The supplier shall provide a warranty for all system components and appurtenances for a period of one year on from the date of project substantial completion.

PART 2 PRODUCTS

2.01 Chemical Metering Pumps

- A. Pumps shall be mechanical motor driven peristaltic positive displacement type, as specified herein.
- B. Chemical feed pumps shall be positive displacement peristaltic metering pumps. Their feed rate adjustment feature shall be such as to result in a minimum accuracy of ± 2 percent for mechanical drives over a range of 0 to 100 percent of the pump's maximum rated capacity.
- C. Drive motor speed adjustment must be capable of being made while the pump is in operation.

- D. Each pump shall come with a minimum of 25 feet of each tubing size needed to achieve the specified flow rate for that unit. The tubing shall be compatible with the fluid being pumped.
- E. Peristaltic pump feed rate adjustment shall be accomplished by variable speed stroke and by changing tubing size.
- F. Peristaltic metering pump tubing change-out shall be accomplished without having to take the feed head apart.
- G. All metering pumps shall have flexible hose to connect them to the fixed rigid piping system including connection to the associated bulk and day tanks.
- H. Peristaltic pumps shall have a digital or computer compatible controller which provides precise speed control, flow reversibility, and remote control capability. Pump heads shall provide quick and easy changing of tubing sizes or usage location. Peristaltic pumps shall be ThermoFisher/Masterflex P/S series precision control drives. The pumps shall be as follows:

Solution to be Pumped	No. of pumps required/installed	Specific Gravity	Percent Solution	Max. Discharge Pressure PSIG	Suction Lift Capacity (ft. of chemical)	Design Range @ Max. Discharge Pressure GPH
PACL	2	1.35	45	20	7	*
Hydrofluosilicic Acid	2	1.23	22	20	7	*
Sodium Hypochlorite	4	1.2	12.5	20	7	*
Spare feeders	2			20	7	*

* All pumps shall be capable of pump 0-6 GPH by changing hose size.

- I. Spare Parts, for parts of each pump or model that will most likely require normal maintenance shall be furnished with each pump. Included shall be a minimum of 25 feet of each different size and material of construction hose/tubing.

2.02 Chemical Transfer Pump

- A. The polyaluminum hydroxylchlorosulfate (PACL) pump shall be single-stage, end suction close coupled, leak proof, and of seal-less magnetic drive design.
- B. The pump shall be Finish Thompson model KC4 rated at 11 GPM@6'TDH or approved equal designed to pump PACL with a 1.29 SG and 50% concentration. The suction shall be 1" NPT and discharge ½" NPT.

- C. The pump construction shall be vertically split with back pull-out arrangement to maintain impeller without disconnecting any piping. Provide thrust washer and mounting for impeller spindle in casing. The wetted parts shall be polypropylene casing and impeller, EDPM O-rings, and carbon impeller bushing.
- D. The pump shall be coupled to the motor through a seal-less magnetic drive. The drive shall consist of drive magnet, impeller magnet, impeller magnet housing, and motor bracket.
- E. Provide O-ring seal between impeller magnet housing and pump casing. Drive magnet to be completely isolated from pumped fluid, and act as a clutch to prevent motor overload.
- F. The Motor shall be 1/3 HP, 3500 RPM, 120/3/60, Chemical Duty, TEFC construction.

2.03 Chemical Tanks

- A. The PACL tank shall be a 3000 gallon capacity vertical high density polyethylene tank shall be approximately ninety (90) inches in diameter and one hundred twenty six (126) inches in height. The tank shall be equipped with eighteen (18) inch manway and shall be vented at the top. The tank shall have a 2-inch FNPT outlet and equipped with a quick connect coupling suitable for connection to a pumper truck hose.
- B. The sodium hypochlorite tanks shall be two (2) 300 gallon capacity vertical high density polyethylene tanks shall be approximately thirty five (35) inches in diameter and eighty (80) inches in height. The tank shall be equipped with eighteen (18) inch manway, two (2) inch fill connection, and shall be vented at the top.
- C. Three (3) 55 gal day tanks twenty two (22) inch in diameter and thirty six (36) inch in height with covered tops shall be provided for PACL, and two (2) spare feeders.
- D. The tanks shall be light translucent and shall be UV stabilized. It shall have an average wall thickness of 0.3 inches. The HDPE shall have a specific gravity of 1.68 or 12 pounds per gallon premium grade, as manufactured by Kentucky Tank, Shepherdsville, KY or approved equal.

2.04 Chemical Feed Tank Scales

- A. Two (2) sodium hypochlorite chemical scales of 3000 lbs. capacity shall be provided and shall be of the digital readout/electronic load cell type. Scale platform shall be sized to accept a 36" inch diameter tank. Four (4) adjustable hold down lugs shall be provided on the platform to increase lateral stability and to allow the use of hold down straps for securing the vessel to the platform. Platform scale coating system shall be a minimum dry thickness of 80 mils and be resistant to moisture, chemicals, abrasion, impact and UV light.

- B. Scales shall be of the single load cell design. Weight shall be transferred via a pivoted platform to a single, NTEP approved load cell of the shear beam strain gauge type. Flexible cable shall connect load cell to indicator to allow easy remote installation of the readout. Cable length shall be 20 ft.
- C. A remote mounted 4½ digit LCD indicators shall be housed in a NEMA 4X, UL approved enclosure. LCD Indicators shall be backlit with .5" characters for ease of readability in low light conditions. To allow indication of net weight, indicator shall be equipped with a sealed ten-turn knob for tare adjustment. Indicators shall output net weight via a 4-20mA signal for remote monitoring. Indicators shall have two adjustable set points for alarms or liquid level control.
- D. Full scale accuracy shall be better than 1/4 of 1%. Scales shall be CHEM-SCALE™ with TUF-COAT™ coating, Model 30-DR30LP , and SOLO® 1000 digital display Model SR1000-1 as manufactured by FORCE FLOW, Concord, CA 94520 USA. Scales shall carry a Full Five (5) Year Factory Warranty. "Limited" Warranties shall be considered unacceptable.

2.05 Drum and Day Tank Scales

- A. Five (5) scales, two (2) for hydrofluosilicic acid, one (1) for PACL, and two (2) for spare feeders shall be 600 lbs capacity provided with digital readout/electronic load cells. Scale platforms shall be sized to accept an 18" to 24" diameter drum. Platform height shall be no more than 2" to permit easy loading and unloading of drums. Platform shall be epoxy powder coated steel.
- B. Scales shall be of the single load cell design. Weight shall be transferred via a pivoted platform to a single, NTEP approved load cell of the shear beam strain gauge type. Flexible cable shall connect load cell to indicator to allow easy remote installation of the readout. Cable length shall be 20 feet.
- C. Indicators shall be housed in a NEMA 4X, UL approved enclosure. LCD Indicators shall be backlit with .5" characters for ease of readability in low light conditions. Indicators shall be equipped with a sealed ten-turn knob for tare adjustment. Indicator shall output net weight via a 4-20mA signal for remote monitoring. Indicators shall have two adjustable set points for alarms or liquid level control. Indicator shall be readable in 0.1 lb (0.1kg) increments.
- D. Full scale accuracy shall be better than 1/4 of 1%. Scale shall be DRUMM-SCALE™ Model 27-DR 6 DS, and electronic SOLO® 1000 digital display Model SR1000-2, as manufactured by FORCE FLOW/FLOQUIP, 1150-D Burnett Avenue, Concord CA 94520 USA. Scales shall carry a full five (5) year factory warranty. "Limited" warranties shall be considered unacceptable.

2.06 Accessories

- A. Provide six (6) clear plastic calibration chambers with vent for use in calibrating the metering pumps for each chemical feed system. The chamber shall be sized to give adequate capacity for a minimum 60 second draw down test. The scale shall give direct readings in GPH without the need for calculations. The calibration chamber shall be piped and valved so that each pump shall be able to utilize the calibration chamber without interfering with the operation of the other pumps. The top of the chamber shall have a threaded fitting to allow for piping to a common vent.

2.07 Pipe and Accessories

- A. Pipe and accessories provided by the contractor shall be Schedule 80 PVC or CPVC, or as shown on the drawings or recommended by the pump manufacturer for chemical compatibility with plain and socket ends and unions for easy disassembly.
- B. True-union ball or diaphragm valves shall be utilized. Isolation valves shall be provided at all equipment connections. Seals shall be compatible with the chemical being pumped.
- C. Anti siphon valve shall be installed at the high point of the chemical transfer piping.

PART 3 EXECUTION

3.01 Installation

- A. CONTRACTOR Performance
 - 1. All materials and equipment shall be installed in a neat, workmanlike manner
 - 2. All wiring of the equipment shall be as specified under the electrical section of these specifications and shall terminate at diagram connection points for devices and panels.
 - 3. All equipment specified herein shall be installed in accordance with the manufacturer's recommendations and the contract drawings.

3.03 Manufacturer's Services

- A. Installation and Start up Assistance

1. The manufacturer shall provide supervision services for inspection, start up, performance testing and training. All costs for services furnished by the chemical metering system manufacturer shall be included in the total price, with no additional compensation provided. Services shall be provided for a minimum 1 day per chemical system.
2. The service times specified shall be considered as full 8 hour working days and do not include travel time.

3.04 Manufacturer's Instructions

- A. Manufacturer's instructions must be in compliance with manufacturer's product date; including product technical bulletins, installation instructions, assembly drawings and product container instructions for installation.

END OF SECTION

Section 110060: VERTICAL TURBINE PUMPS

Part 1 GENERAL

1.01. SCOPE

- A. Contractor shall furnish and install open lineshaft, product lubricated vertical turbine pumps as specified herein and as shown on the Plan Drawings.
- B. Pumps are listed in the Schedule below by manufacturer and model to establish the quality expected. The Contractor's Base Bid shall be of the listed manufacturer but other units may be offered for alternate consideration, subject to Engineer's approval.

1.02. SUBMITTALS

- A. Contractor shall submit to the Engineer six (6) copies of shop drawings for approval by the Engineer prior to fabrication. Drawings shall include as a minimum dimensional drawings, materials of construction, pump performance curve with guaranteed minimum bowl hydraulic efficiency, motor electrical characteristics and a description of the manufacturer's test facilities.

1.03. FACTORY TESTING

- A. The pump manufacturer shall conduct full scale, full range factory running bowl performance tests with respect to capacity, head, hydraulic efficiency and horsepower in accordance with the latest Hydraulic Institute standard 14.6.3.4, Grade 1U. The test curve shall include six (6) points throughout the pump range. Three (3) certified copies of the test curve and test data sheets shall be approved by the Engineer before shipment of the pumps. All pumps shall be tested.

1.04. INSTALLATION

- A. The Contractor shall install the pumping equipment in accordance with the manufacturer's recommendations. Installation shall be performed under the direction of a factory trained service representative, if deemed necessary by the Engineer.

1.05. FIELD TESTING

- A. Each pump shall be tested by the Contractor in the presence of the Engineer to establish conformity with the specifications and the factory test curves. The Contractor shall make, at his expense, all necessary changes, modifications and adjustments to ensure proper operation.

1.06. DESCRIPTION

- A. **DISCHARGE HEAD:** Discharge head shall be configured as shown on the Plan Drawings and shall be constructed of high grade fabricated steel or ASTM A-48, Class 30 cast iron. Discharge shall be of the above base surface type or underground design as indicated on the Plan Drawings. The top of the head shall have a machined register to fit the motor. It shall be of sufficient strength to carry the complete weight of the pump and motor and withstand the hydraulic loads imposed on it by the system. The stuffing box shall have the proper type and amount of packing to prevent excessive leakage. The Raw Water Pump stuffing box shall also contain a 416 stainless steel sleeve, 350/400HB. The head shall include a tapped opening for draining away leakage from the packing. Discharge flange shall be Class 125 Lb. Or 250 Lb. ANSI as listed in the Pump Characteristics / Schedule and of the size and location shown.

If the overall length of the pump exceeds 40 feet, the discharge head shall include a tapped opening for a pre-lubrication system which will introduce water to the upper shaft bearings before each startup. Contractor shall be responsible for furnishing and installing a pre-lubrication line complete with solenoid valve, pressure regulator valve, fittings. A time delay relay shall also be installed in the motor starter circuitry.

- B. **SOLE PLATE:** The pump head shall be mounted on an ASTM A36 steel baseplate with a minimum thickness of 7/8". Plate shall be machined on one side.
- C. **COLUMN ASSEMBLY:** Column pipe shall have a maximum length of any section of five feet for variable speed applications and ten feet for constant speed applications. The upper end of the pipe will be flanged to the pump head. The column sections shall be flanged on both ends. The flanges shall have machined male and female registers to ensure proper alignment after assembly. The bottom column section shall be properly adapted to connect to the bowl assembly.

Inner column shafting shall be turned, ground and precision polished ASTM A582, Type 416 stainless steel of ample size to operate the pump without distortion or vibration. The minimum shaft diameter shall be as listed in the Schedule below. Each section of shafting shall have a tolerance of 0.001 inch in diameter and a maximum Total Indicator Runout of 0.0003 inches. Bronze bearing retainers including neoprene bearings (suitable for the service intended) shall be spaced on five foot maximum intervals. The Raw Water Pumps shall also be furnished with 304 stainless steel line shaft sleeves at each bearing journal. Lineshaft couplings shall be A.I.S.I. 410 stainless steel. Maximum shaft length shall be five foot per section. The two-piece top shaft shall be ASTM A582, Type 416 stainless steel. A shaft coupling shall be located above the stuffing box inside the pump head.

- D. **BOWL ASSEMBLY:** The pump bowls shall be of close grained ASTM A48, Class 30 cast iron and free from blow holes. Each bowl shall contain a neoprene bearing and an SAE 660 bronze bearing above each impeller. On bowls larger than 20 inches in diameter, the dual bearings may be rubber backed bronze bearings. The interior of the pump bowls shall be furnished with an enamel coating and a steel neoprene coated

bowl wear ring. The Raw Water Pump bowl wear ring shall be of 420 stainless steel material.

Impellers shall be of ASTM B184, SAE J461 aluminum bronze, accurately machined, finished, mechanically and dynamically balanced. The impellers shall be of the enclosed design for maximum efficiency. Impellers shall be fastened by ASTM A582, Type 303 stainless steel collet to an ASTM A582, Type 416 stainless steel shaft of not less than 12% chrome. Each Raw Water Pump impeller shall be equipped with a 410ss impeller wear ring.

The suction manifold shall be of the bell design and made of ASTM A48, Class 30 cast iron and include permanently greased SAE660 bronze bearings.

- E. STRAINER: The strainer (or vortex suppressor for High Service and Backwash Pumps, if shown) shall be of the basket, clip-on type constructed of 316L stainless steel. The openings of the strainer shall be at least four (4) times the impeller eye area.
- F. MOTOR: Motor shall be of the vertical hollow shaft design, high thrust type, rated for continuous duty. High Service Pump and Raw Water Pump Motors shall be premium efficient Inverter Duty rated, suitable for use with the adjustable frequency drive specified under another section. Motor shall be suitable for 40-degree C ambient and 105-degree C temperature rise at the rated nameplate horsepower, with Class F insulation. The High Service and Backwash Pump Motors shall be Weather Protected Type I enclosure with a 1.15 service factor. The Raw Water Pump motors shall be TEFC enclosure with a 1.15 service factor. Each motor shall be equipped with a non-reverse ratchet plate. The nameplate rating of the motor shall not be exceeded at any operating condition on the pump curve. No part of the service factor shall be utilized under normal operation at any point. Each motor shall be equipped with a 115V space heater, a ground lug in the conduit box and a steady bushing. In addition, each motor shall include a shaft grounding ring and insulated bearings.

Motors 100Hp or less shall be equipped with three (3) normally closed Winding Thermostats. Motors greater than 100Hp shall be equipped with a quantity of six (6) RTDs installed in the stator winding, two (2) per phase.

If pump thrust loads exceed the standard motor thrust rating, the motor shall be furnished with a 175% or 300% extra high thrust bearing with a B-10 or L-10 minimum life rating of five years based on the maximum thrust at any specified operating condition.

- G. SURFACE PREPARATION AND SHOP PAINTING: All surfaces shall be properly prepared and shop primed by the pump manufacturer as a part of the work under this Section. All surfaces coming into contact with the pumpage shall be coated with a coating equal to Tnemec FC20 Pota-Pox epoxy. Approximate dry mil thickness shall be 10 to 12 mils. The epoxy coating shall be FDA, NSF and AWWA approved for potable water. As a minimum, surfaces to be epoxy coated include: discharge head internal flow passages and exterior; exterior and interior of column pipe; exterior of bowls.

F. PUMP ACCESSORIES

1. AIR AND VACUUM VALVE: An adequately sized air and vacuum valve shall be furnished and installed with each pump. The valve shall be as manufactured by Crispin, APCO or Val-Matic, with a throttling device and suitable for the pump's maximum output pressure. Valves 4" diameter inlet and larger shall have flanged connections.
2. PRESSURE GAUGE: Each pump shall be equipped with a discharge pressure gauge located on a spool piece on the pump side of the discharge isolating valve. Gauge shall be of the liquid filled design, four (4) inch diameter dial. Range of the gauge shall be approximately twice the maximum pump discharge pressure. Each gauge shall be furnished with a bronze, 1/2" diameter shutoff valve, pressure snubber, and blow-off. The pressure gauge shall be of the bottom connection design.

1.07. PUMP CHARACTERISTICS/SCHEDULE

Description/Equip. No	Raw Water	High Service	Backwash
Application:.....	River Water	Potable.....	Potable
Peerless Pump Model:	12HXB	14LD.....	18HXB
Design, GPM:	1400	1400.....	4200
Design TDH, feet:.....	130	625.....	40
Min. Eff @ design, %:.....	79	79.....	79
Minimum Shutoff, feet:.....	244	938.....	68
Discharge Flange, diameter inches x Class #:	10 x 125	10 x 250.....	14 x 125
Min. Column Diameter, inches:	8	8.....	14
Min. Col. Sch/Thickness:	0.277	0.277.....	0.375 O.D.
Min. Shaft Diameter, inches:	1.19	1.69.....	1.5
Min. Motor Horsepower:	75	300.....	50
Maximum Speed, RPM:.....	1770	1770.....	1175

Power Supply, Volts, Phase, Hertz: 460, 3, 60

1.08 MANUFACTURER'S SERVICE

- A. Furnish the services of a factory service technician of the pump manufacturer during the installation phase of the equipment. An additional trip for the service technician shall also be required to supervise the initial commissioning of the pumps including field testing, adjustments and training of the Owner's personnel. A

manufacturer's representative or distributor's salesman does not qualify as a factory service representative.

1.09 PRELUBRICATION SYSTEM (Raw Water Pump)

- A. A pre-lubrication system shall be required to lubricate the upper lineshaft bearings and the stuffing box bearing upon startup. The system shall include as a minimum a 3/4" connection into the pump stuffing box, a solenoid valve and a start time delay in the motor starter. When the pump motor is called to start, the solenoid shall open and allow water into the stuffing box for approximately two minutes. The time delay in the motor starter shall prevent the motor starting for a field adjustable time period of one to ten minutes. Upon start of the motor, the solenoid valve shall close.

END OF SECTION

PART 1 GENERAL

1.1 Section includes:

- A. One (1) modular dual channel sc200 controller that works with analog sensor modules and/or digital sensors shall be furnished and installed to receive signals from the 1720e turbidimeter and the effluent pH sensor.

1.2 Measurement Procedures

- A. Microprocessor-based sensor controller.
- B. Change digital sensors connected to the controller by unplugging and plugging in sensors as necessary.
- C. Change analog sensor modules connected to the controller by unplugging and plugging analog sensor modules as necessary.
- D. The controller accepts 4 different analog sensor modules in any combination to measure the following:
 - 1. pH/ORP module
 - a. Combination pH/ORP
 - 2. Conductivity module
 - a. Contacting conductivity
 - b. Inductive conductivity
 - c. Cationic conductivity (Calculated pH)
 - 3. Dissolved Oxygen/Oxygen Scavengers module
 - a. Amperometric dissolved oxygen
 - b. Amperometric oxygen scavengers
 - 4. Analog mA IN module

1.3 Alternates

- A. Parameter-specific controllers that do not allow changing parameter configurations in the field are unacceptable.

1.4 System Description

- A. Performance Requirements
- B. pH/ORP sensor module
 - 1. Measurement range:
 - a. pH: -2.0 to +14.0 or -2.00 to 14.00 pH
 - b. mV: -2100 to +2100 mV
 - 2. Repeatability: 0.1% of range or better
 - 3. Response time (t90%): 0.5 s
 - 4. Temperature range:
 - a. PT100/PT1000: -20 to 200 °C
- C. DO sensor module
 - 1. Measurement range:
 - a. 0 to 2000 ppb
 - 2. Repeatability: ±0.5 ppb or ± 5% whichever is greater
 - 3. Response time (t90%) for step change between 1-40 ppb: <30s
 - 4. Temperature range: 0-45°C (32-113°F)

- D. Oxygen Scavengers sensor module
 - 1. Measurement range:
 - a. 0 to 500 ppb of dissolved N_2H_4
 - b. 0 to 100 ppb of carbohydrazide
 - c. Repeatability: <2% of the measured value or < 1ppb, whichever is greater
 - d. Response time ($t_{90\%}$): < 60 seconds
 - e. Temperature range: 5-45°C (41-113°F)
 - E. Contacting conductivity sensor module
 - 1. Measurement range:
 - a. Conductivity: 0-20,000 μ S/cm
 - b. Resistivity: 0-50 Ω •cm
 - c. TDS: 0-9999 ppm or 0-9999 ppb
 - 2. Repeatability:
 - a. $\pm 1\%$ of reading or 0.002 μ S/cm below 0.2 μ S/cm, whichever is higher
 - 3. Response time ($t_{90\%}$): 0.5 s
 - 4. Temperature range: -20 to 200 °C
 - F. Inductive conductivity sensor module
 - 1. Measurement range:
 - a. Conductivity: 0.5-10,000 mS/cm
 - b. % concentration: 0-99.99 or 0-200.0%
 - c. TDS: 0-9999 ppm
 - 2. Repeatability:
 - a. 0.5-10,000 mS/cm: $\pm 2\%$
 - 3. Response time ($t_{90\%}$): 1 s
 - 4. Temperature range: -2 to 200 °C
- 1.5 Certifications
- A. EMC: CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits)
 - B. Safety: General Purpose UL/CSA 61010-1 with cETLus safety mark
 - C. Australian C-TICK and Korean KC Markings
- 1.6 Environmental Requirements
- A. Operational Criteria
 - 1. Temperature: -4.0 to 140.0 °F (-20.0 to 60.0 °C)
 - 2. Relative humidity: 0 to 95%, non-condensing
- 1.7 Warranty
- A. Warranted for two years from date of shipment from manufacturer defects.
- 1.8 Maintenance Service
- A. Clean controller keypad
 - B. Calibrate mA output signals

PART 2 PRODUCTS

2.1 Manufacturer

- A. Hach Lange GmbH, Berlin, Germany or approved equal
 - 1. Hach model sc200 Controller or approved equal

2.2 Manufactured Unit

- A. The controller is available with the following power requirements:
 - 1. AC powered: 100 to 240 Vac $\pm 10\%$, 50/60 Hz; 15 W with 7 W sensor/network card load, 37 W with 25 W sensor/network card load.
 - 2. 24 VDC powered: 24 VDC, -15%, +20%; 16 W with 7 W sensor/network card load, 34 W with 25 W sensor/network card load (optional Modbus RS232/RS485 and Profibus DPV1 network connection).
- B. The controller uses a menu-driven operation system.
- C. The controller display is graphic dot matrix LCD with LED backlighting.
- D. The controller is equipped with a real-time clock.
- E. The controller is equipped with two security levels.
- F. The controller is equipped with a data logger with RS-232 capability.
- G. The controller shall have worded operation menus in 19 languages.
- H. The controller is equipped with an SD card reader for data download and controller software upload.
- I. Four electromechanical, UL rated, SPDT relays (Form C) are provided for user-configurable contacts rated 100 to 230 Vac, 5 Amp at 30 VDC resistive maximum.
 - 1. The following can be programmed:
 - a. Alarm
 - b. Warning
 - c. Timer/scheduled cleaning
 - d. Feeder control
 - e. Event control
 - f. Pulse width modulation
 - g. Frequency modulation
 - 2. The following can be assigned:
 - a. Primary value measurement I
 - b. Secondary value measurement I
 - c. Tertiary value measurement I
 - d. Quaternary value measurement I
 - e. Primary value Measurement II
 - f. Secondary value measurement II
 - g. Tertiary value measurement II
 - h. Quaternary value measurement II
 - i. Real time clock
 - j. Calculated values
- J. Two analog 0/4-20 mA outputs are provided with a maximum impedance of 500 ohms.
 - 1. The controller can be equipped with three additional 4-20 mA outputs with a maximum impedance of 500 ohms.
 - 2. The following can be programmed:
 - a. Alarms:
 - 1) Low alarm point
 - 2) Low alarm point deadband

- 3) High alarm point
- 4) High alarm point deadband
- 5) Off delay
- 6) On delay
- b. Controls:
 - 1) Linear
 - 1) Bi-linear
 - 2) Logarithmic
 - 3) PID
1. The following can be assigned:
 - a. Primary value measurement I
 - b. Secondary value measurement I
 - c. Tertiary value measurement I
 - d. Quaternary value measurement I
 - e. Primary value measurement II
 - f. Secondary value measurement II
 - g. Tertiary value measurement II
 - h. Quaternary value measurement II
 - i. Calculated values
- K. The controller can be equipped with the following forms of communication:
 1. MODBUS RS-232
 2. MODBUS RS-485
 3. Profibus DP
- L. All user settings of the controller are retained for 10 years in flash memory.
- M. The controller is equipped with a system check for:
 1. Power up test (monitoring and shutdown)
 2. Total power draw
 3. Memory devices
 4. Temperature mother board
- N. The controller has the option of graphical measurement that tracks measurement values over time.

2.3 Equipment

- A. Materials
 1. Housing: polycarbonate, aluminum (powder coated), and stainless steel
 2. Rating: NEMA 4X enclosure, rated IP66
- B. Conduit openings: 0.5 in. NPT

2.4 Components

- A. Standard equipment
 1. Controller
 2. Mounting hardware for wall, pipe, and panel mounting
- B. Dimensions: 144 x 144 x 180 mm (5.7 x 5.7 x 7.1 in.)
- C. Weight: 1.6 kg (3.5 lbs.)

2.5 Accessories

- A. Weather protection shield
- B. Sun screen
- C. RS-232 / RS-485 MODBUS output card
- D. PROFIBUS DP output card
- E. HART output card
- F. Additional mA input card
- G. Additional mA output card

PART 3 EXECUTION

3.1 Preparation

- A. The sensor may need to be installed with additional accessories depending on its application.
 - 1. Mount on rail, panel, pipe, or wall.
 - 2. Sensor to analyzer distance: 300 m (985 ft.)

3.2 Installation

- A. Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
- B. Manufacturer's representative will include a half-day of start-up service by a factory-trained technician, if requested.
 - 1. Contractor will schedule a date and time for start-up.
 - 2. Contractor will require the following people to be present during the start-up procedure.
 - a. General contractor
 - b. Electrical contractor
 - c. Hach Company factory trained representative
 - d. Owner's personnel
 - e. Engineer

3.3 Manufacturer's Service and Start-Up

- C. Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.
- D. Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.
- E. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.
- F. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION

PART 1 GENERAL

1.1 Section includes

- A. Turbidimeter for monitoring sample low-range (0.001 to 100 NTU) turbidity.

1.2 Measurement Procedures

- A. The method of measuring turbidity will nephelometric.
 - 1. Incandescent light will be directed into the sample stream in the turbidimeter body.
 - 2. The light scattered at 90 degrees will be sensed by a submerged photocell in the measuring chamber.
- B. The method will meet or exceed instrument design criteria set by USEPA method 180.1 and Standard Methods 2130B

1.3 Alternates

- A. Other methods of turbidity measurement, such as those that require a sample cell with glass window that can foul or fog or require air purge, desiccant, or cleaning, are not acceptable.

1.4 System Description

- A. Performance Requirements
 - 1. Measurement range: 0.001 to 100 Nephelometric Turbidity Units (NTU).
 - 2. Accuracy
 - a. ± 2 percent of reading or ± 0.020 NTU (whichever is greater) from 0 to 10 NTU
 - b. ± 5 percent of reading from 10 to 40 NTU
 - c. ± 10 percent of reading from 40 to 100 NTU
 - 3. Minimum detection limit: 0.001 NTU
 - 4. Resolution
 - a. 0.0001 NTU up to 9.9999 NTU
 - b. 0.001 NTU from 10.000 to 99.999 NTU
 - 5. Repeatability: $\pm 1.0\%$ of reading or ± 0.002 NTU, whichever is greater

1.5 Certifications

- A. Not applicable

1.6 Environmental Requirements

- A. Operational Criteria
 - 1. Sample flow rate: 200 to 650 mL/minute
 - 2. Sample temperature: 0 to 50 degrees C
 - 3. Operating temperature: 0 to 40 degrees C
 - 4. Operating humidity: 5 to 95 percent non-condensing

1.7 Warranty

- A. The product includes a one-year warranty from the date of shipment.

1.8 Maintenance Service

- A. Scheduled maintenance:
 - 1. Calibration: as experience dictates.
 - a. Use an optical based calibration/verification module.
 - b. OR, use formazin-based standards.
- B. Unscheduled maintenance
 - 1. Clean photocell window
 - 2. Clean instrument enclosure
 - 3. Clean bubble trap
 - 4. Lamp replacement

PART 2 PRODUCTS

2.1 Manufacturer

- A. Hach Company, Loveland, CO
 - 1. Model 1720E Turbidimeter

2.2 Manufactured Unit

- A. The 1720E Turbidimeter consists of an incandescent light source, photocell, and bubble trap.
- B. The 1720E is housed in a NEMA 4X/IP66 enclosure made of corrosion-resistant polystyrene.
- C. The optical components of the 1720E are mounted in a sealed, removable head assembly.

2.3 Equipment

- A. The 1720E operates using 100 to 230 volt selectable AC power.
- B. The 1720E operates continuously.
- C. The sample stream into the 1720E flows through an internal bubble trap.

2.4 Components

- A. Standard equipment:
 - 1. Turbidimeter sensor head
 - 2. Turbidimeter body
 - 3. Manual
- B. Dimensions:
 - 1. Width: 12.3 inches
 - 2. Height: 15.1 inches
 - 3. Depth: 9.4 inches
- C. Weight: 13.5 pounds
- D. Connectors
 - 1. Sample inlet fitting: 0.25-inch NPT female, 0.25-inch compression fitting
 - 2. Drain fitting: 0.5-inch NPT female, 0.5-inch hose barb

2.5 Accessories

- A. Calibration/verification module (Model ICE-PIC for 1720E)
- B. StablCal[®] verification standards

- C. Formazin calibration kit for user-prepared calibration
- D. Floor stand

PART 3 EXECUTION

3.1 Preparation

- A. Wall mount
- B. Clearances: none required.
- C. Storage temperature: -20 to 60 degrees C

3.2 Installation

- A. Contractor will install the turbidimeter in strict accordance with the manufacturer's instructions and recommendation.
- B. Manufacturer's representative will include a half-day of start-up service by a factory-trained technician.
 - 1. Contractor will schedule a date and time for start-up.
 - 2. Contractor will require the following people to be present during the start-up procedure.
 - a. General contractor
 - b. Hach Company factory trained representative
 - c. Owner's personnel

3.3 Manufacturer's Service and Start-Up

- A. Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.
- B. Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.
- C. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.
- D. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION

PART 1 GENERAL

- 1.1 Section includes:
 - A. Chlorine analyzer for monitoring of free or total residual chlorine

- 1.2 Measurement Procedures
 - A. The method of measuring free or total chlorine will be colorimetric. Instrument chemistry will employ N, N-diethyl-p-phenylenediamine (DPD) method.

- 1.3 Alternates
 - A. Other methods of chlorine measurement such as amperometric, potentiometric, and iodometric that employ electrodes or other electrochemical techniques are not acceptable.

- 1.4 System Description
 - A. Performance Requirements
 - 1. Measurement range:
 - a. 0 to 5 mg/L (ppm) free or total residual chlorine
 - 2. Accuracy
 - a. $\pm 5\%$ of reading or ± 0.03 mg/L (ppm), whichever is greater
 - 3. Precision
 - a. 5% of reading or 0.01 mg/L (ppm), whichever is greater
 - 4. Minimum detection limit
 - a. 0.03 mg/L (ppm)
 - 5. Resolution
 - a. 0.01 mg/L (ppm)
 - 6. Repeatability
 - a. 0.05 mg/L (ppm)
 - 7. Cycle Time
 - a. 2.5 minutes

- 1.5 Certifications
 - A. CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits), and EN 61010-1
 - B. General Purpose UL/CSA 61010-1 with cETLus safety mark
 - C. IP62 dust and water ingress protection rating
 - D. Australian CTICK and Korean KC Marking

- 1.6 Environmental Requirements
 - A. Operational Criteria
 - 1. Sample flow rate
 - a. 200 to 500 mL/minute
 - 2. Sample pressure (without conditioning kit)
 - a. 1 to 5 psi (0.07 to 0.34 bar)
 - 3. Sample pressure (with conditioning kit)
 - a. 120 psi (8.27 bar)
 - 4. Sample temperature
 - a. 41 to 104 °F (5 to 40 °C)
 - 5. Operating temperature
 - a. 41 to 104 °F (5 to 40 °C)
 - 6. Operating humidity

- a. 90% at 40 °C maximum
- 1.7 Warranty
 - A. The product includes a one-year warranty from the date of shipment
- 1.8 Maintenance Service
 - A. Scheduled Maintenance
 - 1. Monthly
 - a. Reagent replacement
 - 2. Annually
 - a. Analyzer tubing replacement
 - B. Unscheduled Maintenance
 - 1. Pump tubing replacement is operating temperature dependent
 - a. Operating temperature below 80 °F: six-month intervals
 - b. Operating temperature above 80 °F: three-month intervals

PART 2 PRODUCTS

- 2.1 Manufacturer
 - A. Hach Company, Loveland, CO
 - 1. Model CI17 Chlorine Analyzer, Free Chlorine Residual
 - 2. Model CI17 Chlorine Analyzer, Total Chlorine Residual
- 2.2 Manufactured Unit
 - A. The CI17 Chlorine analyzer consists of a sample and reagent valve and pump, measurement cell, controller, and is shipped with buffer and indicator solutions.
- 2.3 Equipment
 - A. The analyzer must be housed in a NEMA 12 enclosure that is IP62 rated with the gasketed door latched.
 - B. The analyzer shall be capable of measuring free or total residual chlorine by changing the tubing and indicator and buffer solutions.
 - C. A measurement shall be taken every 2.5 minutes and results displayed by a three digit LCD readout in the range of 0 to 5 mg/L.
 - D. The analyzer must operate using 115V or 230V selectable AC power.
 - E. The analyzer must perform a self-test and auto-blanking between analysis points to compensate for sample color, turbidity, and changes in light intensity due to voltage fluctuations or light source aging.
 - F. The analyzer shall operate with an LED light source at a peak wavelength of 510nm.
 - G. The analyzer must be able to operate unattended for 30 days between chemical reagent changes and measurement cell cleaning.
 - H. The analyzer has two feed control (relay) operation modes to operate chemical feed pumps. Available control options are:
 - 1. On/off control where the concentration alarm outputs activate or deactivate a pump when chlorine levels fall below or exceed acceptable levels.
 - 2. Proportional control where the 4-20mA output current is scaled to pace a feed pump proportional to output.
 - I. The analyzer has standard optically isolated analog outputs, selectable as 0/4 to 20mA, field programmable over any portion of the analyzer range

- J. The analyzer has two standard SPDT relay alarms, with contacts rated for 5 amp resistive loads at 230V AC power. Alarm options include concentration set point, analyzer system warning, and analyzer system shut down.

2.4 Components

- A. Standard Equipment
 - 1. CI17 Free or Total Chlorine analyzer
 - 2. One-Month Supply of reagents
 - 3. Installation kit
 - 4. Maintenance kit
 - 5. Sample conditioning kit
 - a. Pressure regulator, strainer, and shut off valve
 - 6. Wall mount kit
 - 7. User manual
- B. Dimensions: 13.5 x 17.9 x 7 inches (343 x 455 x 178 mm)
- C. Shipping weight: 16 lbs (7.3 kg)

2.5 Optional Accessories

- A. Power Cord
- B. Maintenance kit with preassembled tubing
- C. Pocket Colorimeter II for free and total chlorine (high and low range combination)

PART 3 EXECUTION

3.1 Preparation

- 1. Mounting
 - a. The CI17 Free or Total Chlorine analyzer can be wall mounted only.
- 2. Required Clearances
 - a. Horizontal: 15.2 in (386 mm), 26 inches (686 mm) ideal
 - b. Vertical: 19 inches (483 mm)
 - c. Depth: 20 inches (508 mm)
- 3. Sample inlet
 - a. 0.25 inch OD polyethylene tubing
- 4. Sample outlet
 - a. 0.50 inch ID flexible tubing
- 5. Overflow drain
 - a. 0.50 inch ID flexible tubing
- 6. Air purge quick connect
 - a. 0.25 inch OD polyethylene tubing (optional)

3.2 Installation

- A. Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
- B. Manufacturer's representative will include a half-day of start-up service by a factory-trained technician, if requested.
 - 1. Contractor will schedule a date and time for start-up.

2. Contractor will require the following people to be present during the start-up procedure.
 - a. General contractor
 - b. Electrical contractor
 - c. Hach Company factory trained representative
 - d. Owner's personnel
 - e. Engineer
- 3.3 Manufacturer's Service and Start-Up
- A. Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.
 - B. Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.
 - C. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.
 - D. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION

- 1.0 GENERAL: The 9100A Series Magnetic Flowtubes, together with an IMT25 Magnetic Flow Transmitter, combine to form a Magnetic Flowmeter with pulsed dc excitation. It is designed for use with conductive fluids in general purpose, and waste and water applications. The transmitter converts the low level, high impedance signal from the lined flowtube to a scaled transmission signal, either 4 to 20 mA, digital, or pulse output, that is proportional to volumetric flow rate.

- 2.0 FLOWTUBE: Provide and install one flanged flowtube in the High Service Effluent Flow line as shown on the drawings. The overall flowtube enclosure shall be NEMA IV carbon steel with corrosion-resistant, two component coating. The flowtube material shall be 304 stainless welded to carbon steel flanges, 150 lbs. bolt circle, coated with corrosion resistant, two component coating. The wetted components shall be a ebonite lining and Hestalloid C-276 electrodes for sensing and grounding. The flowtube shall be a Foxboro 9112A-SICA-BHJ-GN or Engineer pre-approved equal. Provide and install at startup a submersion kit in the flow tube head.

- 3.0 FLOW TRANSMITTER: Provide and install one IMT25 flow transmitter. The transmitter shall power-up and receive a signal from the flowtube that is representative of the water flow through the station piping. The transmitter shall be composed of the following features: 2-line, 32 character LCD display, local keypad, programmable outputs for both 4-20ma and pulse outputs and protected non volatile memory to protect the configuration and flow totals. The transmitter shall be a Foxboro IMT25-SEATB10M-B or Engineer pre-approved equal.

END OF SECTION

EFFLUENT pH MONITORING SENSOR

This combination sensor shall be designed for specialty applications for immersion or in-line mounting. The reference cell shall feature a double-junction design for extended services life, and a built-in solution ground. The body shall be molded from chemically-resistant Ryton or PVDF and have integral 4.5 m (15 ft.) cables with tinned leads. The PC-series shall be capable of measuring mild and aggressive media. Sensors shall be equipped with rugged dome electrodes, easy to clean flat glass electrodes and HF (hydrofluoric acid) resistant glass electrodes. The sensor shall be insertion type meeting the following criteria:

- Part No. PC2KA
- Probe Type: Insertion
- Material: Flat Glass
- Body Material: PVDF
- Parameter: pH

The sensor shall be Model Hach PCZK2A or approved equal. The Contractor shall be responsible for tapping the effluent water line on a horizontal axis and furnishing a ball valve for the insertion sensor. One (1) sensor required to connect to a Hach SC 200 controller.

END OF SECTION

SECTION 11610 – LABORATORY FUME HOODS AND RELATED PRODUCTS

PART 1: DESCRIPTION OF WORK

1.00 SUMMARY AND SCOPE

- A. Section Includes:
Based on **Kewaunee Scientific Corporation's Supreme Air Series** fume hood design, furnish and install all fume hoods, work tops, and understructures. Furnishing and installing all filler panels, knee space panels and scribes as shown on drawings.
- B. Accessorization (Choose one):
 - 1. Furnishing and delivering all service outlets, accessory fittings, electrical receptacles and switches, as listed in these specifications, equipment schedules or as shown on drawings. Plumbing fixtures mounted on the fume hood superstructures shall be preplumbed per section 2.01.I. Electrical fixtures shall be prewired per section 2.01.J. The fume hood superstructure shall be listed to UL Standards for Safety by Underwriters Laboratories Inc. (UL). Final plumbing and electrical connections are the responsibility of those contractors fulfilling requirements of Divisions 15 and 16.
- C. Removal of all debris, dirt and rubbish accumulated as a result of the installation of the fume hoods to an on-site container provided by others, leaving the premises clean and orderly.
- D. Related Divisions:
 - 1. Division 12: Laboratory Casework
 - 2. Division 15: Plumbing and Exhaust Ducting
 - 3. Division 16: Electrical Fittings and Connections
- E. Related Publications:
 - 1. ASHRAE Standard 110.1995 - Method of Testing Performance of Laboratory Fume Hoods
 - 2. NSF STD#49 – Photometric Method of Testing
 - 3. NIH03-112C - National Institute of Health Specification
 - 4. UL – Underwriters Laboratories
 - 5. ASTM D552 – Bending Test
 - 6. NFPA-45 – National Fire Protection Association

1.01 BASIS OF WORK

- A. It is the intent of this specification to use **Kewaunee Scientific Corporation, Statesville, North Carolina**, as the standard of construction for laboratory fume hoods. The construction standards of the **Kewaunee Supreme Air** product line shall provide the basis for quality and functional installation.
- B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval. This approval must be obtained seven (7) days before the proposal deadline. Procedures for obtaining approval for an alternate manufacturer are defined in section 2.00 C. in this specification.
- C. General Contractors should secure a list of approved fume hood manufacturers from the architect as a protection against non-conformance to these specifications.

- D. The owner/architect reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.
- E. Submittals:
1. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of fume hood. Provide data indicating compliance with ASHRAE Standard 110.1995.
 2. Samples: Samples if called for will be reviewed for color, texture, and pattern only. Submit the following:
 - a. Hood interior lining, 6 by 6 inches.
 - b. Hood enclosure, 6 by 6 inches, of color selected.
 - c. Operation sign(s).
 - d. Shop Drawings:

Submit shop drawings for fume hoods showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings:

 - 1) Coordinate shop drawings with other work involved.
 - 2) Provide roughing-in drawings for mechanical and electrical services when required.
 - 3) Provide face opening, air volume, and static pressure drop data.
 3. Non-Specified Manufacturer's Samples:

A sample from each non-specified manufacturer will be required and reviewed per specification. This sample shall be delivered, at no cost to the architect or owner to a destination set forth by the architect or owner. The sample must then be tested per section 1.02.C by an independent test agency hired by the submitting company and approved by the owner/architect. A passing test and owner/architect approval of the prototype must be written and approved seven (7) days before quotation deadline as a condition of acceptance for any quotation participant.

1.02 STANDARD FUME HOOD PERFORMANCE REQUIREMENTS

- A. Fume hoods shall be of complete airfoil design to insure maximum operating efficiency. Foil sections at the front facias of the hood shall minimize eddying of air currents at the hood face and the rear baffle system shall minimize turbulence in the upper portion of the hood interior.
- B. Standard Fume Hood Types (Choose One):
1. Open Bypass:

The hoods shall be of the bypass type. The fume hood design shall allow for automatic air bypass above the sash opening. The bypass shall limit the maximum air velocity through the face of the hood and provide for a constant volume of air through the hood regardless of sash position. The bypass shall control the increase in face velocity as the sash is lowered to limit the maximum velocity to not more than three and one-half, times the velocity with the sash full open.
- C. Containment
1. Purpose:

The purpose of this specification is to prequalify the performance of the bidder's laboratory fume hood before award of contract. At his option, the owner or his representative may require the same tests to be performed and the same performance be achieved before acceptance of the hood after award of contract. The owner or his representative shall witness the tests. Failure to meet the performance specified shall be cause for rejection of the bidder.
 2. Test Method:

The hood shall be tested per the American Society of Heating, Refrigerating, and Air

Conditioning Engineers (ASHRAE) Standard 110-1995 and by the Auxiliary Air Capture Test (Auxiliary Air hoods only).

3. Location of Tests and Test Facility:

All tests referenced herein shall be performed in the bidder's fume hood test facility. Field testing is described in Section 3.01.F.

The test facility shall meet the following requirements:

- a. The test facility shall have sufficient area so that a minimum of 5 feet of clear space is available in front of and on both sides of the hood for viewing tests.
- b. The facility's ventilation system shall have adequate heating and air conditioning so that room air temperatures can be maintained within the desired ranges.
- c. Room air currents in the test area shall be less than 20 FPM.
- d. The hood exhaust system shall be properly calibrated so that the desired exhaust air volumes can be easily attained.

4. Instrumentation, Equipment and Test Personnel:

Qualified personnel to perform the tests shall be supplied by the bidder.

Instrumentation and equipment required shall be supplied by the bidder at his expense. Required instrumentation shall include but not be limited to the following items:

- a. Thermal anemometer capable of measuring air velocities from 10 to 600 ft./minute
- b. Three dozen one-half minute smoke candles
- c. Four ounces of Titanium Tetrachloride
- d. Supply of cotton throat swabs
- e. ITI Leakmeter 120 calibrated to indicate concentration of sulfur hexafluoride or equivalent
- f. Flowmeter – 150 ml/minute capacity
- g. Flowmeter – 15 L/minute capacity
- h. Four gas sampling bags – 8 liter capacity
- i. Two vacuum pumps – 1 CFM capacity
- j. Two flow regulating valves
- k. Two size 3 tanks of sulfur hexafluoride with a two-stage regulator or other tracer gas suitable for detector to be used
- l. Three-way gas valve
- m. Mannequin, 5'7" in height, or reasonable human proportions with arms hanging at its side
- n. ASHRAE 110-1995 tracer gas ejector

5. ASHRAE Standard 110-1995 Test:
Hood shall be tested with a face velocity of 100 FPM full open vertically and at 100 FPM right, left and center 100% open horizontally. If horizontal openings are present, additional sash configurations and face velocities may be specified. The hood shall have a performance rating of 4.0 AM 0.01 or better wherein:

4.0 = tracer gas release in liters/minute
AM = as manufactured
0.01 = level of control of tracer gas in parts per million (ppm).

1.03 QUALITY ASSURANCE

- A. The laboratory fume hood manufacturer shall provide fume hood work tops and casework all **manufactured or shipped from the same geographic location** to assure proper staging, shipment and single source responsibility.
- B. General Performance: Provide certification that fume hoods meet the performance requirements described in section 1.02.C.

PART 2 – PRODUCTS

2.00 MANUFACTURERS

- A. The basis of this specification is the **Supreme Air** fume hood as manufactured by **Kewaunee Scientific Corporation**, 2700 West Front Street, Statesville, North Carolina.
- B. All laboratory equipment covered by the specification **shall be the product of one manufacturer and be fabricated at one geographic location** to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewaunee Scientific shall contain a review of the following capabilities:
1. List of shop facilities
 2. List of engineering and manufacturing personnel
 3. Proof of financial ability to fulfill the contract
 4. List of a minimum of ten installations over the last five years of comparable scope
 5. Proof of project management and installation capabilities
- C. The selected manufacturer must warrant for a period of one-year starting (date of acceptance or occupancy, whichever comes first) that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.01 MATERIALS AND CONSTRUCTION

- A. Fume Hood Superstructure Frame:
A free-standing rigid frame structure of steel angle shall be provided to support exterior panels and interior liner and baffle panels. To allow for maintenance and replacements, the interior liner panels shall be removable without disassembly of the frame structure and outer steel panels. Likewise, the exterior steel panels shall be removable without disassembly of the frame structure and inner liner panels. Fume hoods that require disassembly of the superstructure for liner replacement are not acceptable.
- B. Fume Hood Interior Walls:
Double wall ends, not more than 4" wide, shall be provided to maximize interior working area. The area between the double wall ends shall be closed to house the remote control valves.

The front vertical fascia section shall have a full 135 degree 1" radius at the front leading edge to provide a streamlined section and insure smooth even flow of air into the hood. The vertical facias shall contain the required service controls, electrical switches and receptacles. The hood interior end panels and sash track shall be flush with the fascia to prevent eddy currents and back flow of air.

C. Fume Hood Airfoil:

A streamlined airfoil shall be integral at the bottom of the hood opening on bench and distillation hoods. This foil shall provide a nominal 1" open space between the foil and the top front edge of the work surface to direct an air stream across the work surface to prevent back flow of air. The airfoil shall extend back under the sash, so that the sash does not close the 1" opening. The foil shall be removable to allow large equipment into the hood. The foil shall be of 12-gauge steel to resist denting and flexing. Walk-in hoods shall have a stop located at the bottom of the sash track that will ensure a nominal 1" opening between the bottom of the sash and the floor.

D. Fume Hood Top Panel :

1. Standard Grille Bypass Configuration:

The top front panel shall be of the same material as the exterior fascia. It shall have an integral grille stamped into the upper portion.

E. Fume Hood Baffles:

1. A stable, non-adjustable baffle with three fixed horizontal slots shall be provided to aid in distributing the flow of air into and through the hood. The baffle shall be spaced out 2-1/4" from the back liner. The baffle shall be removable for cleaning

F. Fume Hood Duct Collar (select one):

1. A 12" diameter stainless steel bell-mouthed duct collar shall be located in the top of the hood plenum chamber.

G. Fume Hood Lighting:

A one-tube, energy-efficient, T-5 fluorescent light fixture of the size given below shall be provided in the hood roof. Illumination at 13" above the worksurface shall be at least 100 foot-candles.

Hood Size, Ft.	Nominal Fixture Length, Ft.
4	3
5	4
6	4
8	3 (2 Fixtures)

The light fixtures shall be isolated from the hood interior by a 1/4" thick tempered glass panel sealed from the hood cavity. Fixture shall be UL labeled.

H. Fume Hood Sash:

1. Vertical Rising Sash:

A vertical rising sash of 1/4" laminated safety float glass shall be provided. The sash shall have a neutral colored polyvinyl chloride horizontal member at the top and a full length metal handle at the bottom. The sash shall be counterbalanced with a single weight to prevent tilting and binding during operation. The sash track shall be a neutral colored polyvinyl chloride set flush with the interior liner panels to minimize turbulence.

Bench hoods shall have one sash in a single slotted sash track. Walk-in hoods shall have two sashes in a double slotted sash track

I. Fume Hood Plumbing Services:

1. Plumbing services shall consist of remote control valves as selected located within the end panels, controlled by extension rods projecting through the control panels of the hood, with color coded plastic handles. Interior fitting for gases and water shall be nylon panel flanges and angle serrated hose connectors, color coded. Interior fittings for distilled water shall consist of a bronze tin lined, white color-coded, panel flange and angle serrated hose connector. Interior fittings for steam shall consist of a cast bronze flange and angle serrated hose connector with a chemical resistant metallic bronze finish. Water goosenecks shall be cast bronze with a chemical resistant metallic bronze finish. All plumbing fittings shall be factory installed and piped between the valve and the outlet. Inlet piping shall have a single-point connection for each valve provided and carried to a point 1" above the fume hood roof or 1" above the worktop rear corner depending on the rough-in locations shown in the drawings. Points of final service connection by other trades shall be at the stub provided by the fume hood manufacturer.

Fume Hood Electrical Services:

1. The hood superstructure shall be pre-wired and contain a UL label certifying acceptable wire gauge, connections, fixtures and wire color coding. Wiring electrical services shall consist of two duplex receptacles and a light switch. The duplex receptacles shall be 20 Amp., 125 volt AC, and 3-wire polarized grounded with ground fault interruption. The receptacles shall be of specification grade, side wired only, to insure a positive connection. The light switch shall be 20 Amp., 125 volt AC, and 3-wire polarized grounded. Wiring shall terminate in one 6" x 6" x 4" service junction box located on the fume hood roof. Final wiring and circuit dedication shall be by others.

Hood Work Surface:

1. Epoxy Resin:
Hood worksurface shall be 1-1/4" thick molded epoxy resin made in the form of a watertight pan, not less than 3/8" deep to contain spillage with a 6" wide safety ledge across the front edge. Top shall be manufactured at the same manufacturing location as the fume hood to assure proper cutout alignment and coordinated shipping. A cup drain flush with the recessed worksurface shall be provided. The worksurface and cup drain shall be available in either black or grey.

Access Opening:

The interior end liner panels shall be furnished with an opening that provides access to the service piping and valves to facilitate installation and maintenance. The openings shall be covered with a removable panel with rounded corners. Panels that require tools to remove are not acceptable. The panel shall provide an overlapping seal on all edges.

J. Fume Hood Finish:

After the component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.

After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied

powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.

The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS.

K. Performance Test Results (Chemical Spot Tests):

a. Testing Procedure:

Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

b. Test Evaluation:

Evaluation shall be based on the following rating system.

- Level 0 – No detectable change.
- Level 1 – Slight change in color or gloss.
- Level 2 – Slight surface etching or severe staining.
- Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

After testing, panel shall show no more than three (3) Level 3 conditions.

c. Test Reagents

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformamide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle

18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Chloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

L. Performance Test Results (Heat Resistance):

Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

M. Performance Test Results (Impact Resistance):

A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.

N. Performance Test Results (Bending Test):

An 18 gauge steel strip, finished as specified, when bent 180° over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.

O. Performance Test Results (Adhesion):

Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a

soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".

P. Performance Test Results (Hardness):

The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).

The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one-that is, the hardest pencil that will not rupture the film-is then used to express or designate the hardness.

Q. Fume Hood Dimensions

Double wall end panel thickness shall not exceed 4". Interior clear working height shall be not less than 41-3/4" at any location in the interior of the hood on bench hoods and 76" on walk-in and distillation hoods. Interior depth from the back of the sash to the front of the rear baffle shall not be less than 25-1/4". The sash opening shall be not less than 28" in height above the worksurface on bench hoods and 60" on walk-in and distillation hoods.

R. Fume Hood Liners:

1. KMER Epoxy Resin Lining:

KMER epoxy resin liner shall be the manufacturing standard for liners in this specification. To assure proper punching and coordination with remaining pieces of assembled fume hood superstructure, this liner material must be manufactured at the same geographic location and the fume hood superstructure. Interior liner panels shall be 1/4" thick epoxy resin sheets of a neutral color. Interior liner panels shall be fastened using stainless steel screws with plastic covered heads.

Flame spread of material as measured by ASTM E84 shall be 6.2 or less.

Fiberglass reinforced plastics or polyesters shall not be acceptable substitute liner materials for epoxy resin.

Q. Liner Tests – Chemical Spot Tests – 24 Hours

1. Chemical spot test shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. ± 3 degrees F.

2. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

3. Ratings/Legend:

- | | |
|--|--|
| 1 – KMER (Kewaunee Modified Epoxy Resin) | A = No effect or slight change in gloss |
| 2 – Glass Reinforced Polyester | B = Slight change in gloss or color |
| 3 – Stainless Steel 304 | C = Slight etching or severe staining |
| 4 – Stainless Steel 316 | D = Swelling, pitting, or severe etching |
| 5 – Reinforced Phenolic Resin | |

RESULTS:	1	2	3	4	5
1. Acetic Acid 98%	A	C	B	B	A
2. Acetone **	A	A	A	A	A
3. Acid Dichromate	A	B	A	A	A
4. Ammonium Hydroxide ** 28%	A	A	B	B	A
5. Amyl Acetate **	A	A	A	A	A
6. Benzene **	A	A	A	A	A
7. Butyl Alcohol **	A	A	A	A	A
8. Carbon Tetrachloride **	A	B	A	A	A
9. Chloroform **	A	B	A	A	A
10. Chromic Acid 60%	B	C	C	C	A
11. Cresol	A	A	A	A	A
12. Dichloroacetic Acid	A	A	B	A	A
13. Dimethylformamide	A	A	A	A	A
14. Dioxane **	A	A	A	A	A
15. Ethyl Acetate **	A	A	A	A	A
16. Ethyl Ether **	A	A	A	A	A
17. Ethyl Alcohol **	A	A	A	A	A
18. Formaldehyde	A	A	A	A	A
19. Formic Acid 90%	A	B	A	A	A
20. Furfural **	B	C	A	A	C
21. Gasoline **	A	A	A	A	A
22. Hydrochloric Acid 37%	A	A	B	B	A
23. Hydrofluoric Acid 48%	B	A	D	D	A
24. Hydrogen Peroxide 30%	A	A	A	A	A
25. Methyl Ethyl Ketone **	A	A	A	A	A
26. Methyl Alcohol **	A	A	A	A	A
27. Methylene Chloride **	A	B	A	A	A
28. Monochlorobenzene **	A	A	A	A	A
29. Naphthalene **	A	A	A	A	A
30. Nitric Acid 20%	B	A	B	A	A
31. Nitric Acid 30%	B	B	B	A	A
32. Nitric Acid 70%	B	B	B	A	A
33. Phenol ** 85%	A	A	A	A	A
34. Phosphoric Acid 85%	A	A	B	A	A
35. Silver Nitrate	B	C	A	A	C
36. Sodium Hydroxide 40%	A	A	A	A	A
37. Sodium Hydroxide 20%	A	A	A	A	A
38. Sodium Hydroxide 10%	A	A	A	A	A
39. Sodium Hydroxide Flake	A	A	A	A	A
40. Sodium Sulfide	A	A	A	A	A
41. Sulfuric Acid 77%	A	A	C	A	A
42. Sulfuric Acid 96%	C	B	C	A	C
43. Sulfuric Acid 33%	A	A	C	A	A
44. Tincture of Iodine	A	C	B	B	A
45. Toluene **	A	A	A	A	A
46. Trichlorethylene **	A	A	A	A	A
47. Xylene **	A	A	A	A	A
48. Zinc Chloride	A	A	B	A	A

49. Nitric 70%/Sulfuric Acid 77%* B B B A A

* Equal parts of Nitric Acid 70% and Sulfuric Acid 77%.

** Indicates these solvents tested with cotton and jar method

S. Fume Hood Base Cabinets

1. Standard Steel

- a. Unless otherwise indicated base units under hoods shall be fabricated of cold rolled prime grade roller leveled furniture steel. Gauges of steel used in construction shall be 18 gauge except as follows:
- b. Corner gussets for leveling bolts and apron corner braces, 12 gauge.
- c. Hinge reinforcements, 14 gauge.
- d. Top and intermediate front horizontal rails, apron rails and reinforcement gussets, 16 gauge.
- e. Door assemblies and adjustable shelves, 20 gauge.
- f. Performance of the painted surfaces shall match that of the fume hood outer panels.

2. Special Purpose Cabinets for Use Under Fume Hoods:

a. Acid Storage Cabinets:

Where indicated acid storage cabinets shall use the same gauges of steel and construction features as other base cabinets. In addition, they shall have a one-piece liner insert made of linear low-density polyethylene. The liner insert shall form a one-inch pan at the bottom to retain spillage. Each door will have a set of louvers at the top and bottom. The door shall be lined with a polyethylene sheet. Each cabinet shall be vented into the fume hood with a 1-1/2" vent pipe. Providing a positive airflow directly into the fume hood exhaust system.

b. Solvent Storage Cabinets:

Solvent storage cabinets shall be UL labeled and specifically designed for the storage for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UL, UFC, OSHA, and NFPA No. 30 – 1993. The bottoms, top, sides and doors shall be fabricated of 18" gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless steel piano hinges and shall be fully insulated. The right hand door shall be equipped with a three point latching device and the left-hand door shall have a full height astragal. The doors are self-closing and synchronized so that both doors will always fully close. The right hand door is equipped with a three-point latching system that automatically engages when the doors close. Each door is equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long have only one door, self-closing, and equipped with a three-point latching system and hold-open feature. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills. A full-depth adjustable shelf is also provided. The shelf is perforated to allow air circulation within the cabinet. Two diametrically opposed vents with spark screens are provided in the back of the cabinet as well as a grounding screw. The cabinet shall have interior finish same as exterior. The cabinet shall be labeled: "FLAMMABLE – KEEP FIRE AWAY".

T. Accessories:

1. Filters and Housings:

Where called for, a filter housing shall be provided above the hoods. The housing shall contain an absolute filter (99.97% efficient for 0.3 micron particles) and a furnace type prefilter. The housing shall form a rigid, self-supporting assembly and have a gasketed front cover to allow replacement of the filters without disturbing the ductwork. The filter

housing shall be fabricated of cold rolled steel with a chemical resistant finish.

2. Alarms :

a. Digital Face Velocity Alarm System:

Fume hoods shall be provided with an alarm system to detect low and high hood face velocities. The alarm system shall indicate the actual face velocity of the hood regardless of sash position. The system shall have an air velocity sensor mounted on the interior side liner of the hood where it is easily accessible for cleaning. The velocity monitor shall have a digital display of the air velocity through the hood face in feet per minute. The alarm signals shall activate any time the face velocity falls below the low velocity alarm set point or rises above the high velocity alarm set point. There shall be both visual and audible alarm signals. The audible alarm shall have a mute. Low and high alarm contacts shall be provided for remote monitoring.

2.02 SPECIFIC PURPOSE FUME HOODS N/A

PART 3 – EXECUTION – SUPREME AIR SERIES FUME HOOD AND RELATED PRODUCTS

3.00 SITE EXAMINATION

The owner and/or his representative shall certify building conditions conducive to the installation of a finished goods product, including all critical dimensions.

3.01 INSTALLATION

A. Preparation:

Prior to beginning installation of fume hood, check and verify that no irregularities exist that would affect quality of execution of work specified.

B. Coordination:

Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

C. Performance:

Install fume hoods, plumb, level, rigid, securely anchored to building and adjacent furniture in proper location, in accordance with manufacturer's instructions and the approved shop drawings. Provide filler panels between top of hood and ceiling. Securely attach access panels but provide for easy removal and secure reattachment. Do not install any damaged units.

D. Adjust and Clean:

1. After installations are complete, adjust all moving parts for smooth operation.
2. Remove all packing materials and debris resulting from this work, and turn over the fume hoods to the Owner clean and polished both inside and out.
3. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.

E. Protection:

1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.

2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.
- F. Certification:
1. Fume Hood Manufacturer shall field test a random sample of 20% of the installed units using ANSI/ASHRAE 110-1995 to a control level of AI 0.01 ppm or better.
 2. Project substantial completion shall be withheld until all required fume hood certification letters, tests, and reports have been submitted to and approved by the Architect.

SECTION 12 35 53 – STEEL LABORATORY CASEWORK AND RELATED PRODUCTS

PART 1 — DESCRIPTION OF WORK

1.00 SUMMARY AND SCOPE

A. Section Includes:

1. Using **Kewaunee Scientific Corporation, RESEARCH COLLECTION Laboratory Furniture** as a steel casework specification standard, furnish all cabinets and casework, including tops, ledges, supporting structures, and miscellaneous items of equipment as listed in these specifications, equipment schedules, and drawings. Include delivery to the building, set in place, level, and scribe to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings.
2. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles and switches as listed in these specifications, equipment schedules, and drawings, as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment, shall be packaged separately and properly marked for delivery to the appropriate contractor.
3. Furnish and deliver, for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, which occur above the floor, and where these items are part of the equipment or listed in these specifications, equipment schedules, and drawings. All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
4. Furnish service strip supports where specified, and set in place, service tunnels, service turrets, supporting structures and reagent racks of the type shown on the drawings.
5. Remove of all debris, dirt and rubbish accumulated as a result of the installation of the laboratory furniture to an onsite container provided by others, leaving the premises broom clean and orderly.

B. Related Divisions:

1. Divisions 5 & 6: Behind-the-Wall Blocking and Studs
2. Division 9: Base Molding
3. Division 11: Chemical Fume Hoods
4. Division 22: Plumbing
5. Division 26: Electrical Fittings and Connections
6. Division 27: Communications

C. Related Publications:

1. SEFA 3 - Scientific Equipment and Furniture Association
2. SEFA 8 - Scientific Equipment and Furniture Association
3. NFPA 30 - National Fire Protection Association
4. NFPA-45 - National Fire Protection Association
5. UL - Underwriters Laboratories
6. ASTM D522 - Bending Test

1.01 BASIS OF WORK

- A. It is the intent of this specification to use **Kewaunee Scientific Corporation – RESEARCH COLLECTION Laboratory Furniture** as the standard of construction for laboratory furniture. The construction standards of this product line shall provide the basis for quality and functional installation.
- B. Supply all equipment in accordance with this specification. The offering of a product differing in materials and construction from this specification requires written approval from the

owner/architect. This approval must be obtained seven (7) days before the quotation deadline. Procedures for obtaining approval for an alternate manufacturer are defined in section 1.03.B in this specification.

- C. General Contractors should secure a list of approved laboratory furniture manufacturers from the architect as a protection against non-conformance to these specifications.
- D. Participants in the quotation process have the option of clarifying deviations to the specified design, construction, or materials. Without such clarifications, sealed quotations to the owner or owner representative will be construed as being in total conformance to the requirements of the specification.
- E. The owner/owner's representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

1.02 QUALITY ASSURANCE

- A. The steel laboratory furniture contractor shall also provide worktops and fume hoods all manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.
- B. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8.
- C. Finish Performance: Provide independent test lab certification that furniture shall meet the performance requirements described in section 2.05 of these specifications.

1.03 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of casework.
- B. Samples:

Samples from non-specified manufacturers will be required and reviewed per specification. Samples shall be delivered, at no cost to the architect or owner, to a destination set forth by the architect or owner. This must be done seven (7) days before quotation deadline as a condition of approval of each bidder. Samples shall be full size, production type samples. Miniature or "Show Room" type samples are not acceptable. Furnish the following:

1. One 18" combination (1) drawer and (1) cupboard base unit showing complete construction details, including (1) shelf
2. One 36" acid storage base cabinet typical of specified elevations
3. One sample of all top materials shown or called for, of sufficient size to perform finish requirement tests
4. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware

The architect or owner will retain the above samples of the successful manufacture to insure that material delivered to jobsite conforms in every respect to the samples submitted.

- C. Shop Drawings:

Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings.

 1. Coordinate shop drawings with other work involved
 2. Provide roughing-in drawings for mechanical and electrical services when required

PART 2 — PRODUCTS

2.00 MANUFACTURERS

- A. The basis of this specification is steel casework manufactured according to the standards used by **Kewaunee Scientific Corporation**, 2700 Front Street, Statesville, North Carolina. The specified design is Research Collection. All laboratory equipment covered by the specification shall be the product of one manufacturer and be fabricated at one geographic location to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewaunee Scientific Corporation shall contain a review of the following capabilities:
1. List of shop facilities
 2. List of engineering and manufacturing personnel
 3. Proof of financial ability to fulfill the contract
 4. List of a minimum of ten (10) installations over the last five (5) years of comparable scope
 5. Proof of project management and installation capabilities
 6. SEFA member in Good Standing
- B. The selected manufacturer shall warrant that all products be free of defects in material and workmanship for a period of one year. The period shall start at the date of acceptance or occupation, whichever comes first. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

2.01 CABINET MATERIAL: (Choose one)

- A. Steel:
Cabinet bodies, drawer bodies, shelves, drawer heads and door assemblies shall be fabricated from cold rolled steel. (*Note: All Drawer and Door Styles are available*)

2.02 DRAWER AND DOOR STYLE:

- A. Inset – Square Edge
Drawers and doors, when closed, shall be recessed to create an overall flush face with 1/8" reveals. The outer drawer and door head shall have a channel formation on all four sides to eliminate sharp raw edges of steel. The top front corners of the door shall be welded and ground smooth. Cabinets shall be available with either Positive or Roller door catches and optional pulls.

2.03 MATERIALS

- A. General Requirements:
It is the intent of this specification to provide a high quality steel cabinet specifically designed for the laboratory environment.
- B. Steel:
1. Cold Rolled Steel:
Cold rolled sheet steel shall be prime grade 12, 14, 16, 18 and 20 gauge U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.
 2. Stainless Steel:
Stainless Steel shall be Type 304; 12, 14, 16, 18 and 20 gauge U.S. Standard. Stainless steel shall be supplied with a #4 finish free of burrs, weld marks, or other imperfections.

C. Composition Core Plywood

Composition core plywood shall be 3-ply and shall be compliant with ANSI A208.1-199, and/or ANSI A208.2-1994

D. Hardware and Trim:

1. Drawer and Door Pulls: (chose one)

- a. Drawer and door pulls shall be mounted on 4" centers, offering a comfortable hand grip, and be securely fastened to doors and drawers.
They shall be manufactured from: (chose one)

Pull Style 1 – Anodized aluminum in a shallow rounded shape.

2. Hinges: (Choose one) *(Note: not all hinges meet SEFA 8 specifications)*

a. Inset 5-Knuckle Hinges:

Inset style cabinets shall use 5-Knuckle hinges made of Type 304 stainless steel .089 thick, 2-1/2" high, with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" in height shall be hung on three hinges. *(Note: meets SEFA 8 specifications)*

3. Drawer Slide: (Choose One)

- a. Heavy duty, full extension, soft-close, self-closing, zinc plated, ball bearing slides, rated for 100 pound loads (See Drawer Assemblies in 2.04, option 1)

4. Locks:

a. Disk Tumbler:

Locks when shown or called for shall be a 5-disc tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers. Locks shall have capacity for 2000 primary key changes and Master Keyed one level with the potential of 5 different, non-interchangeable Master Key groups.

5. Catches – For steel casework with 5-knuckle hinges:

a. Positive Catch: All Doors must have Positive Catch

A two-piece heavy-duty cam action positive catch Main body of the catch shall be confined within an integral cabinet top or divider rail, while latching post shall be mounted on the hinge side of door. Polyethylene roller type catches are not acceptable.

6. Shelf Adjustment Clips:

Shelf adjustment clips shall be die formed, nickel-plated steel.

7. Leg Shoes:

Leg shoes shall be a pliable, black vinyl material and shall be provided on all table legs, unless otherwise specified, to conceal leveling device. Use of a leg shoe, which does not conceal leveling device, will not be acceptable.

8. Base Molding:

Base molding shall be provided by others.

9. Sink Supports:

Sink supports shall be the hanger type, suspended from end panels of sink cabinet by four 1/4" dia. rods, threaded at bottom end and offset at top to hang from two full-depth reinforcements,

welded to the top of end panels. Two 3/4" x 1-1/2" x 12 gauge channels shall be hung on the threaded rods to provide an adjustable sink cradle for supporting sinks.

2.04 CONSTRUCTION

A. Steel Cabinet Construction:

1. General:

- a. The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled workmanship to meet the intended quality and quantity for the project.
- b. All cabinet bodies shall be flush front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane without overlap. Exterior corners shall be spot welded with heavy back up reinforcements.
- c. Each cabinet shall be complete so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.
- d. Case openings of Inset style cabinets shall be rabbeted on all four sides for both hinged and sliding doors to provide a dust resistant case.
- e. All cabinets shall have a cleanable smooth interior. Bottoms shall be formed down on sides and back to create easily cleanable corners with no burrs or sharp edges.
- f. Cabinets shall be designed using a standardized grid pattern to allow reconfiguration of doors and drawers.

2. Steel Gauges:

Gauges of steel used in construction of cases shall be 18 gauge, except as follows:

- a. Leveling bolt reinforcements 12 gauge.
- b. Top and intermediate front horizontal rails, apron rails, hinge reinforcements, and reinforcement gussets, 16 gauge.
- c. Drawer assemblies, door assemblies, bottom, bottom back rail, toe space rail, and adjustable shelves, 20 gauge.

B. Base Cabinets:

1. End uprights shall be formed into not less than an L formation at top, bottom, back and a 3/4" wide front C formation. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for the support of drawer channels, intermediate rails, hinge screws, and shelf adjustment holes.
2. A 7/8" high top horizontal rail shall interlock with the flange at top of end panels for strength, but shall be flush at face of unit. Top rails not flush with face of end uprights are not acceptable.
3. Intermediate rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. Intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.
4. Intermediate vertical uprights shall be furnished to enclose cupboards when used in a unit in

combination with a half width bank of drawers.

5. Cabinet bottom shall be formed of one piece of steel, except in corner units, and shall be formed down on sides and back to create a square edge transition welded to cabinet end panels. Front edge shall include a C formation to form a 7/8" high bottom front rail and shall be flush with face of end uprights. Cabinet bottom front rails not flush with face of end uprights are not acceptable.
 6. Toe space rail shall extend up and forward to engage bottom panel to form a smooth surfaced fully enclosed toe space, 3" deep x 4" high.
 7. Back construction shall be one piece with integral channel formed for maximum strength and welded to back of top and bottom flanges of end uprights.
 8. Each bottom corner of base cabinets shall have a 3/8"-16 leveling bolt, 2-1/2" long capable of supporting 500 lbs. Access to the leveling bolts shall be through plug buttons in the cabinet bottom. Access to leveling bolts through toe space or leveling bolts requiring special tools to adjust are not acceptable.
 9. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear and formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
 10. Steel Door assembly (two-piece) for solid panel swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material. Door assemblies shall be painted prior to assembly, and shall be punched for attaching pulls. Inner pan formation of door shall be indented for in-field installation of locks when required.
 11. Doors shall be readily removable and hinges easily replaceable. Hinges shall be applied to the cabinet and door with screws. Welding of hinges to either cabinet or door will not be acceptable.
 12. Drawer Assemblies: (Choose One)
 - a. Drawer bodies shall be made in one-piece construction including the bottom, two sides, back and front. They shall be fully coved at interior bottom on all four sides for easy cleaning. The top front of the inner drawer body shall be offset to interlock with the channel formation in drawer head providing a 3/4" thick drawer head.
 13. Knee space panels, where shown or specified, shall be 20 gauge, finished same as casework cabinets, and easily removable for access to mechanical service areas.
- C. Special Purpose Storage Cabinets:
1. Acid Storage Fume Hood Cabinets:

Acid storage fume hood cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be completely lined with a one piece polyethylene corrosion resistant liner. The liner shall be 1/4" thick, molded into a seamless tub, including top, sides and bottom, with a 1" lip at the bottom front to contain spills. Tubs shall include integral cleats at both ends and back to support an optional shelf. Each door shall have

a set of louvers at the top and bottom, and have a 1/8" sheet polyethylene liner. Where specified, each cabinet shall be vented into the fume hood with a 1-1/2" vent pipe allowing a positive airflow directly into the fume hood exhaust system. When specified or shown on drawings, cabinet shall include a full-depth phenolic resin.

2. Solvent Storage Cabinets:

Solvent storage cabinets shall be specifically designed for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by UFC, OSHA and NFPA No. 30 - 1993, and cabinets shall be FM approved and labeled. The bottoms, top, sides and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2" air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure. The doors shall swing on full-length stainless steel piano hinges and shall be fully insulated. The doors are self-closing and synchronized so that both doors will always fully close. The right hand door is equipped with a three-point latching system that automatically engages when the doors close. Each door is equipped with a fusible-link hold-open feature that will ensure the door closes should the temperature outside the cabinet exceed 165 degrees Fahrenheit. Units 24" long have only one door, self-closing, and equipped with a three-point latching system and hold-open feature. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills. A second pan shall be provided to serve as a full-depth adjustable shelf. Two, 2" diameter, diametrically opposed vents with spark screens shall be provided in the back of the cabinet as well as a grounding screw. The cabinet shall have interior finish same as exterior. The cabinet shall be labeled: "FLAMMABLE - KEEP FIRE AWAY".

D. Upper Cabinet Construction:

1. Upper cabinets shall have a completely finished interior same as exterior and shall be designed so that no mounting hardware is visible when installed.
2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front edge of end upright shall be 3/4" wide. A pilaster shall be added to the inside front of the upright for cabinet and hinge reinforcement and shall be perforated for hinge screws, and shelf adjustment holes.
3. Cabinet tops shall be formed with a 7/8" high C formation at the front edge and turned down at the back to engage a wall hanging rail.
4. Cabinet flush bottoms shall be formed with a 7/8" high C formation at the front edge.
5. Cabinet false bottoms shall be formed down on all four edges and shall be removable.
6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes. Holes shall be enclosed by end uprights.
7. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear, formed down 3/4" at each end. Shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.
8. Glazed doors shall be 3/4" thick and consist of an inner and outer door pan welded together to form a single unit. Outer door pan shall be 18 gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3" wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18 gauge steel, flanged at all four sides, and pierced for a glass opening in center of the door. Glass shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Doors shall be glazed with: (Choose one)

- a. 1/4" safety glass
9. Solid panel doors shall consist of an inner and outer door pan. Outer door pan shall be formed into a channel or flanged shape at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material.
10. Sliding doors shall be suspended from the top in a roll formed steel track fastened to the cabinet top and shall glide on nylon rollers. Track shall be so designed to prevent accidental removal of doors.
11. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.
12. Plate glass doors shall operate on an extruded aluminum track at the bottom of the cabinet, and in an extruded aluminum channel at the top. The bottom of each glass door shall be furnished with a continuous aluminum shoe the full length of the door, which shall be equipped with two nylon rollers that operate on the extruded aluminum track. The aluminum shoes on the bottom of the plate glass doors shall be equipped with pulls for operation of the doors, and also to prevent bypassing of the doors. Plate glass doors shall close against rubber bumpers. Plate glass doors shall be: (Chose one)

1/4" safety glass

E. Steel Full Height Cabinet Construction:

1. Full height storage cabinets shall have a completely finished interior same as exterior.
2. End uprights shall be formed at front, bottom and back to provide maximum strength and rigidity. Front fascia of upright shall be 1-1/4" wide with inside edge formed in a channel 1/2" x 3/8". A full height box reinforcement shall be fitted to the channel, formed to provide a recessed strike for door and to reinforce the cabinet. The backside of the reinforcement shall be perforated with shelf adjustment holes spaced at not more than 1" centers. Back of upright shall be formed in a 2-1/2" formation. 16 gauge hinge reinforcement shall be welded to inner side of front uprights.
3. Cabinet tops shall be formed into a channel shape at front with flange at rear and sides for electro-welding cabinet top to cabinet back and ends. Front fascia channel shall be strengthened with electro-weld reinforcements.
4. Cabinet bottoms for storage cabinets shall be formed down on sides and back to create a square edge transition welded to cabinet end panels, and front edge shall be offset to create a seamless door recess rabbet for dust stop. Cabinet bottoms shall be formed to provide a flush 1" face rail with a return flange to give a 9/16" deep x 5" high toe space. All cabinets shall have a cleanable smooth interior.
5. Toe space rails shall interlock in back of bottom rail and with end panel to provide a welding plate, and shall extend to the floor with a flange turned back and up for support.
6. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes on not more than 1" centers. Holes shall be enclosed by a formation in cabinet back and enclosed by end uprights.
7. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear; formed down 3/4" at each end. Shelves over 42" long shall be further

reinforced with a channel formation electro-welded to underside of shelf. Shelves shall be adjustable on not more than 1" increments.

8. Glazed doors shall be 3/4" thick and consist of an inner and outer door pan welded together to form a single unit. Outer door pan shall be 18 gauge steel, formed into a channel or flanged shape at all four sides. It shall be pierced and formed to create a 3" wide frame with a beveled edge around the glass opening in the center of the door. Inner door pan shall be 18 gauge steel, flanged at all four sides, and pierced for a glass opening in center of the door. Door glazing shall be held in place by a rubber or vinyl gasket around the entire edge of the glass. Doors shall be glazed with: (Choose one)
 - a. 1/4" safety glass
9. Solid panel doors shall consist of inner and outer pan formations mechanically assembled after painting. All full height solid panel doors shall be further reinforced by a full-height channel formation welded to inner pan. Doors shall be 3/4" thick and contain sound deadening material.
10. Sliding doors shall be suspended from the top in a roll formed steel track welded to cabinet top and shall glide on nylon rollers. Track shall be so designed to prevent accidental removal of doors.
11. Swinging doors under 36" high shall be hung on one pair of hinges, doors over 36" high shall be hung on three hinges.

F. Apron and Leg Assembly Construction:

1. In general, freestanding tables and/or apron and leg assemblies consist of welded leg assemblies connected to aprons by mechanical fasteners.
2. Table apron rails shall be formed of 16-gauge steel. The rails shall be 4" high, formed top and bottom into a channel formation. Where drawers occur, the apron rails shall provide the required opening.
3. Table legs shall be 2" square welded tubing. Securely welded to bottom end shall be a 14-gauge die formed gusset with four flanges. A threaded clinch nut shall accommodate a 3/8" 16 x 2-1/2" long leveling bolt. Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling bolts. Use of leg shoe which does not conceal leveling device will not be acceptable.
4. Stretchers shall be constructed of 18-gauge steel and furnished where indicated on drawings. They shall be formed into a 2-7/64" x 1-1/2" channel formation, and secured to table legs by a die-formed clip of 16-gauge steel. Clips shall be welded at ends of channel.

2.05 PERFORMANCE REQUIREMENTS

A. Steel Casework Construction Performance:

1. Base cabinets shall be constructed to support at least a uniformly distributed load 200 pounds per square foot of cabinet top area, including working surface without objectionable distortion or interference with door and drawer operation.
2. Base cabinet leveling bolts shall support 500 pounds per corner, at 1-1/2" projection of the leveling bolt below the cabinet bottom.
3. Each adjustable and fixed shelf 4 feet or shorter in length shall support an evenly distributed load of 40 pounds per square foot up to a maximum of 200 pounds, with nominal temporary

deflection, but without permanent set.

4. Full extension soft-close, self-closing ball bearing zinc plated drawer slide shall be rated for 100 pound loads.
5. Swinging doors on floor-mounted inset style casework shall support 200 pounds suspended at a point 12" from hinged side, with door swung through an arc of 160 degrees. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.

B. Steel Paint System Finish and Performance Specification:

1. Steel Paint System Finish:

After Cold Rolled Steel and Textured Steel component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to the steel and to aid in the prevention of corrosion. Physical and chemical cleaning of the steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine grained crystalline phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.

After the phosphate treatment, the steel shall be dried and all steel surfaces shall be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance.

The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS.

2. Performance Test Results (Chemical Spot Tests):

a. Testing Procedure:

Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

b. Test Evaluation:

Evaluation shall be based on the following rating system.

- Level 0 – No detectable change.
- Level 1 – Slight change in color or gloss.
- Level 2 – Slight surface etching or severe staining.
- Level 3 – Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

After testing, panel shall show no more than three (3) Level 3 conditions.

c. Test Reagents

Test No.	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Acid Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Acid	Cotton ball & bottle
16.	Dimethylformamide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Acid, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Chloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Acid, 20%	Watch glass
32.	Nitric Acid, 30%	Watch glass
33.	Nitric Acid, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Acid, 85%	Watch glass
36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Acid, 33%	Watch glass
43.	Sulfuric Acid, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

3. Performance Test Results (Heat Resistance):
Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.
4. Performance Test Results (Impact Resistance):
A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.
5. Performance Test Results (Bending Test):
An 18 gauge steel strip, finished as specified, when bent 180° over a 1/2" diameter mandrel, shall show no peeling or flaking off of the finish.
6. Performance Test Results (Adhesion):
Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197-68, "Standard Method of Test for Adhesion of Organic Coatings".
7. Performance Test Results (Hardness):
The test sample shall have a hardness of 4-H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8-H is the hardest, and next in order of diminishing hardness are 7-H, 6-H, 5-H, 4-H, 3-H, 2-H, F, HB, B (soft), 2-B, 3-B, 4-B, 5-B (which is the softest).

The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel-like manner until one is found that will cut or scratch the film. The pencil used before that one, that is, the hardest pencil that will not rupture the film, is then used to express or designate the hardness.

2.06 WORKSURFACES

- A. Materials: (Choose one or more and import information from WORKSURFACES spec.)
 1. Epoxy Resin Tops (Kemresin)

WORK TOP PERFORMANCE REQUIREMENTS:

1. Molded Epoxy Resin (Kemresin and EarthResin):
 - a. Physical Properties:

Flexural Strength (A.S.T.M. Method D790-90) =	15,000 PSI
Compressive Strength (A.S.T.M. Method D695-90) =	30,000 PSI
Hardness, Rockwell E (A.S.T.M. Method D785-89) =	100
Water Absorption (A.S.T.M. Method D570-81)% by weight, 24 Hours =	0.04
% by weight, 7 Days =	0.05
% by weight, 2 Hour Boil =	0.04
Specific Gravity =	1.97
Tensile Strength =	8,500 PSI
 - b. Performance Test Results (Heat Resistance):
A high form porcelain crucible, size 0, 15 ml capacity, shall be heated over a Bunsen burner until the crucible bottom attains an incipient red heat. Immediately, the hot crucible

shall be transferred to the top surface and allowed to cool to room temperature. Upon removal of the cooled crucible, there shall be no blisters, cracks or any breakdown of the top surface whatsoever.

c. Performance Test Results (Chemical Resistance):

Tops shall resist chemical attacks from normally used laboratory reagents. Weight change of top samples submerged in the reagents* listed in the next paragraph for a period of seven (7) days shall be less than one-tenth of one percent, except that the weight change for those reagents marked with ** shall be less than one percent. (Tests shall be performed in accordance with A.S.T.M. Method D543-67 at 77o F.).

*Where concentrations are indicated, percentages are by weight.

Acetic Acid, Glacial	Iso-Octane
Acetic Acid, 5%	Kerosene
Acetone	Methyl Alcohol
Ammonium Hydroxide, 28%	Mineral Oil
Ammonium Hydroxide, 10%	Methyl Ethyl Ketone
Aniline Oil	Nitric Acid, 70%**
Benzene	Nitric Acid, 40%
Carbon Tetrachloride	Nitric Acid, 10%
Chromic Acid, 40%**	Oleic Acid
Citric Acid, 10%	Olive Oil
Cottonseed Oil	Phenol, 5%
Dichromate Cleaning Solution**	Soap Solution, 1%
Diethyl Ether	Sodium Carbonate, 20%
Dimethyl Formamide	Sodium Carbonate, 2%
Distilled Water	Sodium Chloride, 10%
Detergent Solution, 1/4%	Sodium Hydroxide, 50%
Ethyl Acetate	Sodium Hydroxide, 10%
Ethyl Alcohol, 95%	Sodium Hydroxide, 1%
Ethyl Alcohol, 50%	Sodium Hypochlorite, 5%
Ethylene Dichloride	Sulfuric Acid, 85%
Heptane	Sulfuric Acid, 30%
Hydrochloric Acid, 37%	Sulfuric Acid, 3%
Hydrochloric Acid, 10%	Toluene
Hydrogen Peroxide, 28%	Transformer Oil
Hydrogen Peroxide, 3%	Turpentine

NOTE: Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

d. Performance Test Results (Chemical Spot Tests - 24 Hours):

Chemical spot tests shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 1-1/2" diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1" or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 2-ounce, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F. At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

Ratings:

A = No effect or slight change in gloss.

B = Slight change in color or marked loss of gloss.

C = Slight surface etching or severe staining.

D = Swelling, pitting, or severe etching.

Reagents*	Rating
Acetic Acid, 98%	A
Acetone**	A
Ammonium Hydroxide, 28%	A
Carbon Tetrachloride**	A
Chloroform**	A
Chromic Acid, 60%	C
Chromic Acid, 40%	C
Dichromate Cleaning Solution***	C
Dimethyl Formamide	A
Ethyl Acetate**	A
Ethyl Alcohol**	A
Formaldehyde, 37%	A
Formic Acid, 90%	A
Hydrochloric Acid, 37%	A
Hydrofluoric Acid, 48%	C
Hydrogen Peroxide, 28%	A
Methanol**	A
Methylethyl Ketone**	A
Nitric Acid, 70%	B
Phenol, 85%	A
Phosphoric Acid, 85%	A
Sodium Carbonate, 20%	A
Sodium Hydroxide, 40%	A
Sodium Hydroxide, 10%	A
Sodium Hypochlorite, 5%	A
Sulfuric Acid, 96%	D
Sulfuric Acid, 85%	A
Toluene**	A
Wrights Blood Stain	A
Xylene**	A

* Where concentrations are indicated, percentages are by weight.

** Indicates these solvents tested with cotton and jar method.

*** Dichromate cleaning solution is a formula from Lange's Handbook of Chemistry.

2.07 SINKS CUPSINKS, AND DRAINS

A. Sinks:

1. Molded Epoxy Resin Sinks

B. Cupsinks:

1. Molded Epoxy Resin

SERVICE FITTINGS AND ACCESSORIES

A. MATERIALS:

1. Laboratory Service Fittings:

Service fittings shall be laboratory grade, and water faucets and valve bodies shall be cast red brass alloy or bronze forgings, with a minimum content of 85%. All fittings shall be chromium plated unless specified otherwise.

2. Plastic Coated Finish (Sepia Bronze):

When specified, laboratory service fittings shall have an acid resistant plastic coating applied over a fine sand-blasted surface. Surfaces shall be sprayed and baked three times with a minimum thickness of .0005 to .0010 mils. (See Performance Ratings).

3. Service Indexes:

Fittings shall be identified with service indexes in the following color coding:

Hot Water Red
Cold Water Dark Green
Gas Dark Blue
Air Orange
Vacuum Yellow
Distilled Water .. White
Steam Black
Nitrogen Brown
Oxygen Light Green
Hydrogen Pink
Special Gases .. Light Blue

B. CONSTRUCTION:

1. Water Fittings:

Water fittings shall be provided with a renewable unit containing all operating parts which are subject to wear. The renewable unit shall contain an integral volume control device and all faucets shall be capable of being readily converted from compression to self-closing, without disturbing the faucet body proper. Four (4) arm forged brass handles shall contain plastic screw-on type colored service index buttons.

2. Steam Fittings:

Steam fittings shall have a black, heat resistant composition handle, and shall be the heavy pattern design with stainless steel removable seat and flat Teflon seat disc. They shall have Teflon impregnated packing, and shall be so constructed that they can be repacked under pressure.

3. Distilled Water Fittings:

Distilled water fittings shall be chromium plated cast bronze with the interior tin lined, and shall be the self-closing type, or shall be made of aluminum and not be the self-closing type. Handles shall be furnished with tamper-proof and vandal resistant service indexes.

4. Laboratory Ball Valves:

Laboratory ball valves shall have a forged brass valve body with a non-removable serrated hose end and a forged brass lever-type handle with a full view color-coded index button. Valves shall have a floating chrome plated brass ball and molded TFE seals. Valves shall be certified by CSA International for use with natural gas under ANSI Z21.15./CGA9.1

5. Needle Valve Hose Cocks:

Needle type valves shall have a stainless steel replaceable floating cone, precision finished and self-centering. Cone locates against a stainless steel seat, easily removable and replaced with a socket wrench. Valve shall have "TEFLON" impregnated packing and designed so unit can be repacked while under pressure.

6. **Gooseneck Type Outlets:**
Gooseneck outlets shall have a separate brazed coupling to provide a full thread attachment of anti-splash, serrated tip or filter pump fittings.
7. **Remote Control Valves:**
All valves for remote control use shall be as previously specified, but shall be complete with aluminum extension rods, escutcheon plates, brass forged handles and screw-on type colored service index button.
8. **Tank Nipples:**
Tank nipples shall be provided with locking nut and washer for all fixtures where fittings are anchored to equipment.
9. **Sink Outlets:**
Unless otherwise specified, sink outlets for other than stainless steel sinks shall be sin, with integral cross bars, tapered for overflow and be complete with gasket and lock nut with 1-1/2" I.P.S. male straight thread outlet. Overflows shall not be furnished for sink outlets unless specifically called for.
10. **Crumb Cup Strainers:**
Crumb cup strainers shall be stainless steel or chromium plated brass, as specified, and shall be furnished for stainless steel sinks, and be complete with gasket, lock nut and 4" long unthreaded tailpiece outlet in 1-1/2" size.
11. **Vacuum Breakers:**
Vacuum breakers where required shall be "Nidel" or "Watts" unless otherwise specified or identified to be an integral part of the water fixture assembly.
12. **Aerator Outlets:**
Aerator type outlets shall be furnished for all gooseneck water faucets not furnished with serrated hose connectors.
13. **Waste Lines:**
Waste lines shall be furnished by other trades.
14. **Traps:**
Traps shall be furnished by other trades.
15. **Electrical Fittings:**
Electrical fittings shall contain 20 Amp., 125 Volt AC, 3-wire polarized grounded receptacles, unless otherwise specified. Pedestal and line-type boxes shall be of aluminum, metallic finish with stainless steel flush plates. Receptacle boxes shall be of plated steel. All electrical or conduit fittings called for or to be furnished under these specifications shall meet the requirements of the National Electrical Code.

C. PERFORMANCE:

1. **Maximum Line Pressures:**

Laboratory Ball Valves (Gas and Air).....	75 PSI
Needle Point Cocks (Gas and Air).....	65 PSI
Vacuum.....	28.5" Mercury
Hot and Cold Water	80 PSI
Steam	30 PSI
2. **Sepia Bronze Finish Performance:**
Finish shall show no rupture, other than a slight discoloration or possible softening when subjected to the following fumes for approximately six (6) days: Plastic coated fittings shall be suspended in a container, 6 cu. ft. capacity 12" above open beakers, each containing 199 cc.

of 70% Nitric Acid, 94% Sulphuric Acid, 37-38% Hydrochloric Acid, respectively. Finish shall also withstand direct contact of reagents dropped from a burette at a rate of 60 drops/min. for a period of 10 minutes. Chemicals are shown below:

Concentrated Hydrochloric Acid 37-38%*

Concentrated Nitric Acid 70%*

Concentrated Sulphuric Acid 94%

Glacial Acetic Acid 99.5%*

Ethyl and Other Alcohols

Toulene and Other Hydrocarbons

Carbon - Tetrachloride

Mineral Oil

*Percentages are by weight.

PART 3 — EXECUTION

3.00 SITE EXAMINATION

- A. The owner and/or his representative shall assure all building conditions conducive to the installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.

3.01 INSTALLATION

- A. Preparation:
Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.
- B. Coordination:
Coordinate the work of the Section with the schedule and other requirements of other work being prepared in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.
- C. Performance:
 - 1. Casework:
 - a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
 - b. Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
 - c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
 - d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8".
 - 2. Worksurfaces:
 - a. Where required due to field conditions, scribe to abutting surfaces.
 - b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
 - c. Secure worksurfaces to casework and equipment components with materials and procedures recommended by the manufacturer.
- D. Adjust and Clean:
 - 1. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
 - 2. Adjust doors, drawers and other moving or operating parts to function smoothly.
 - 3. Clean shop finished casework; touch up as required.
 - 4. Clean worksurfaces and leave them free of all grease and streaks.
 - 5. Casework to be left broom clean and orderly.
- E. Protection:
 - 1. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
 - 2. Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

SECTION 131200 - PRE-ENGINEERED BUILDINGS

PART I - GENERAL

1.01 RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-I Specification sections apply to work specified in this section.

1.02 DESCRIPTION OF WORK:

- A. Extent of pre-engineered buildings work is shown on drawings.
- B. Type is clear span rigid frame metal building of nominal width, length, wall height and roof pitch indicated.
- C. Manufacturer's standard components may be used, providing components, accessories, and complete structure conform to architectural design appearance shown and to specified requirements.
- D. Concrete floor and foundations and installations of anchor bolts are specified in Division 3.

1.03 QUALITY ASSURANCE:

- A. Design Criteria:
- B. For structural steel members, comply with AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings".
- C. For light gage steel members, comply with AISI "Specification for the Design of Cold-Formed Steel Structural Members".
- D. Design primary and secondary members and covering for applicable loads and combination of loads in accordance with Metal Building Manufacturer's Association (MBMA) "Recommended Design Practices Manual".
- E. For welded connections, comply with AWS "Structural Welding Code".
- F. Design Loads: Basic design loads, as well as auxiliary and collateral loads, are indicated on drawings.
- G. Building Design shall comply with 2006 International Building Code and ANSI/ASCE 7 Minimum Design Loads for buildings and other structures latest edition unless noted differently.
- H. Building to be designed for exposure classification "C" enclosed structure.
- I. Design each member to withstand stresses resulting from combinations of loads that produce maximum percentage of actual to allowable stress in that member, as prescribed in MBMA "Recommended Design Practices Manual".
- J. Tributary stress reduction shall not be considered in engineering calculations.
- K. Portal frames will be acceptable for wind loading stresses if changes do not shift or reduce architectural elements of the building significantly.

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- L. All primary framing members shall be bolted connections. Secondary members at angle intersections only may be field welded by a certified welder. All welds shall be cleaned and primed..
 - M. Fabrication Criteria: Provide prefabricated metal buildings as produced by a manufacturer who is regularly engaged in fabrication and erection of pre-engineered metal structures of type and quality indicated.
 - N. Design sizes of prefabricated components and necessary field connections required for erection to permit easy assembly and disassembly. Fabricate components in such manner that once assembled they may be disassembled, repackaged and reassembled with a minimum amount of labor and maximum salvageability.
 - O. Clearly and legibly mark each piece and part of assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.

1.04 SUBMITTALS:

- A. Product Data: Submit manufacturers product information, specifications and installation instructions for building components and accessories.
- B. Shop Drawings: Submit complete erection drawings showing anchor bolts settings, sidewall, end-wall, and roof framing, transverse cross sections, covering and trim details, and accessory installation details to clearly indicate proper assembly of building components. All drawings to be stamped and signed by a Professional Engineer Registered to practice in the state where building is to be erected.
- C. Certification: Submit written Certification prepared and signed by a Professional Engineer, registered to practice in the State where building is to be erected, verifying that building design meets indicated loading requirements and codes of authorities having jurisdiction.
- D. Samples: Submit samples of the following. Designer's review will be for color and texture only. Compliance with other requirements is responsibility of Contractor.
- E. 12" long by actual width of roofing and siding panels, with required finishes.
- F. Fasteners for application of roofing and siding panels.
- G. Sealants and closures.
- H. Maintenance Stock: Furnish at least 5% excess over required amount of nuts, bolts, screws, washers, and other required fasteners for each building. Pack in cartons and store on site where directed.

1.05 DELIVERY, STORAGE AND HANDLING:

Deliver and store prefabricated components, sheets, panels, and other manufactured items so they will not be damaged or deformed. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering. Store metal sheets or panels so that water accumulations will drain freely. Do not store sheets or panels in contact with other materials which might cause staining.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, or equal, the following:

1. Nucor Building Systems
2. Ceco Building Systems
3. Liberty Building Systems
4. Bigbee Steel Buildings, Inc.

2.02 MATERIALS:

Hot-Rolled Structural Shapes: ASTM A 36 or A 529.

Tubing or Pipe: ASTM A 500, Grade B; ASTM A 501; or ASTM A 53.

Members Fabricated from Plate or Bar Stock: 42,000 psi minimum yield strength; ASTM A 529, A 570, or A 572.

Galvanized Steel Sheet: ASTM A 446 with G 90 coating; "Class" to suit building manufacturer's standards.

2.03 STRUCTURAL FRAMING COMPONENTS:

- A. Rigid Frames: Hot rolled structural steel. Factory welded and shop painted built-up "I" shape rigid frame consisting of tapered or parallel flange beams and tapered columns. Furnish complete with attachment plates, bearing plates, and splice members. Factory drilled for bolted field assembly.
- B. Length of span and spacing of frames as indicated except slight variations acceptable to meet manufacturer's standard.
- C. End Wall Columns: Factory welded, built-up "I" shape or hot rolled wide flange shapes.
- D. Wind Bracing: Adjustable, threaded steel rods, ½" diameter minimum; ASTM A 36 or A 572, Grade D.
- E. No cable bracing will be allowed.
- F. Portal Frames: Factory welded built-up "I" shape or hot rolled wide flange shapes with base design as shown on drawings.
- G. Secondary Framing: Purlins, eave struts, end wall beams, flange and sag bracing; minimum 16 ga. rolled formed sections. Shop painted.
- H. Base channel, sill angle, end wall structural members (except columns and beams), purlin spacers; minimum 14 ga. cold formed steel, galvanized.
- I. Bolts ASTM A 307 or A 325 as necessary for design loads and connection details. Shop painted, except provide zinc- or cadmium-plated units when in direct contact with panels.
- J. Fabrication: Shop fabricate to the indicated size and section, complete with base plates, bearing

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- plates, and other plates as required for erection, welded in place, and with all required holes for anchoring or connections shop drilled or punches to template dimensions.
- K. Shop connection power riveted, bolted, or welded.
 - L. Field connections bolted.
 - M. Shop Painting: Clean surfaces to be primed of loose mill scale, rust, dirt, oil, grease, and other matter precluding paint bond. Follow procedures of SSPC-SP3 for power tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSPC-SPI for solvent cleaning.
 - N. Prime structural steel primary and secondary framing members with manufacturer's standard rust-inhibitive primer having over 50% rust-inhibitive pigment, such as red-lead mixed pigment alkyd varnish (FS TT-P-86, Type II) or zinc chromate iron-oxide alkyd (TT-P-636).
 - O. Prime galvanized members, after phosphoric acid pretreatment, with zinc dust-zinc oxide primer (FS TT-P-641).

2.04 ROOFING/ SIDING

- A. General: Provide roofing and siding sheets formed to general profile or configuration as indicated. Provide flashings, closers, fillers, metal expansion joints, ridge covers, fascias, and other sheet metal accessories, factory formed of same material and finish as roofing and siding.
- B. Steel Sheets: Either zinc coated complying the ASTM A 446, Grade C with G 90 coating, or aluminum coated complying with ASTM A 463, Drawing Quality with TI-40 coating.
- C. Metal thickness not less than 24 ga.
- D. Sheet Panel Fasteners: Manufacturer's standard system of self- tapping screws, bolts and nuts, self-locking rivets, self-locking bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
- E. Provide metal-backed neoprene washers under heads of fasteners bearing on weather side of panels.
- F. Use zinc or cadmium plated fasteners for exterior application and galvanized or cadmium plated fasteners for interior applications.
- G. Locate and space fastenings for true vertical and horizontal alignment. Use proper type fastening tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.
- H. Provide fasteners with heads matching color of roofing or siding sheets by means of plastic caps or factory applied coating.
- I. Flexible Closure Strips: Closed-cell, expanded cellular rubber, self-extinguishing, cut or premolded to match corrugation configuration of roofing and siding sheets. Provide where indicated and necessary to ensure weathertight construction.
- J. Sealing Tape: 100% solids, pressure sensitive grey polyisobutylene compound tape with release paper backing. Not less than 1/2" wide and 1/8" thick, nonsag, nontoxic, nonstaining and permanently elastic.
- K. Joint Sealant: One-part elastomeric; polyurethane, polysulfide, or silicone rubber as recommended by building manufacturer.
- L. Siding: All prefinished exterior siding shall be manufacturer's standard configuration with "Kynar

500" finish.

- M. Roofing: All prefinished roofing shall be manufacturer's standard configuration standing seam with nominal 3" rib and 24" net coverage. Furnish with concealed clips and fasteners. All panels shall have galvalume finish.
- N. The exposed surfaces of all roof panels, wall panels, flashing and trim shall be color coated.
- O. The coating system shall have the exterior side finished with an extended life, fluoropolymer coating utilizing "Kynar 500 Resin" or equal. This coating shall be applied over a G-90 galvanized steel coating. Surfaces shall be properly prepared and primed, then coated and oven-baked to cure. Panels shall be coated prior to roll forming.
- P. For roofing and exterior siding, apply finish coat as specified above on exterior facing and apply manufacturer's standard wash coat on reverse side.
 - Colors:
 - Roof - Galvalume
 - Walls - Light Tan
 - Trim - Bronze
 - Liner Panels – White

2.05 SHEET METAL ACCESSORIES:

- A. General: Unless otherwise indicated, provide coated steel accessories with coated steel roofing and siding; aluminum accessories with aluminum roofing and siding.
- B. Gutters: Furnish gutters designed and sized in accordance with SMACNA "Architectural Sheet Metal Manual" 6th Edition, for the rainfall intensity inches/hour for a five minute duration for storms which should be exceeded only once in 10 years for the area where the building is erected. Gutters shall be formed in sections not less than 8 ft. in length, complete with end pieces, outlet tubes, and special pieces that may be required. Join sections with riveted and soldered or sealed joints. Unless otherwise indicated, provide expansion- type slip joint at center of runs. Furnish gutter supports spaced at 36" o.c., constructed of same metal as gutters. Provide standard bronze, copper, or aluminum wire ball strainers at each outlet. Finish to match roof fascia and rake, "Kynar 500". Slope gutters to drain.
- C. Downspouts: Furnish downspouts designed and sized in accordance with SMACNA "Architectural Sheet Metal Manual" 6th Edition, for the rainfall intensity inches/hour for a five minute duration for storms which should be exceeded only once in 10 years for the area where the building is erected. Downspouts shall be formed in sections approximately 10 ft. long, complete with elbows and offsets. Join sections with minimum 1- 1/2" telescoping joints. Provide fasteners for top, bottom, and 5' o.c. intermediately between, designed to securely hold downspouts not less than 1" away from walls. Finish to match trim "Kynar 500."
- D. Provide bird screens of 1/2" x 1/2" galvanized steel or expanded diamond mesh.

2.06 METAL BUILDING INSULATION:

- A. Insulation shall be blanket-type, fiberglass with vapor barrier facing, suitable for application to walls and roof of metal buildings. Thickness as indicated on drawings.
- B. The insulation shall be made of long and fine fiber fiberglass, evenly distributed and of uniform density, bonded with phenolic thermo-setting resins. Product shall be CertainTeed Metal Building Insulation 202-96 or equal, with a UL Fire Hazard classification of 25/50. Standard

insulation designations, nominal thicknesses as indicated on drawings.

- C. Vapor barrier facing shall be vinyl reinforced polyester (VRP) film (3 mil approximate thickness) and shall have an Underwriters Laboratories flame spread rate of 25 or less * and a smoke developed rating of 50 or less. Water vapor transmission value is 1.00 perms for vinyl film facing and .02 perms for VRP facing. Color of facing material shall be white, and width shall be 78 inches so as to provide a 3-inch tab projecting beyond each side of the fiberglass blanket.
- D. Blanket type insulation shall be installed on roof and/or walls between exterior panels and secondary framing members (purlins and girts). Tabs on facing material shall be lapped, and taped with pressure sensitive vinyl to match insulation COLOR.

PART 3 - EXECUTION

3.01 ERECTION:

- A. Framing: Erect structural framing true to line, level and plumb, rigid and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use a non-shrinking grout to obtain uniform bearing and to maintain a level base line elevation. Moist cure grout for not less than 7 days after placement.
- B. Purlins and Girts: Provide rake or gable purlins with tight fitting closure channels and fascias. Locate and space wall girts to suit door and window arrangements and heights. Secure purlins and girts to structural framing and hold rigidly to a straight line by sag rods.
- C. Bracing: Provide diagonal rod or angle bracing in both roof and sidewalls as indicated.
- D. Movement resisting frames may be used in lieu of sidewall rod bracing, to suit manufacturer's standards.
- E. Where diaphragm strength of roof or wall covering is adequate to resist wind forces, rod or other forms of bracing will not be required.
- F. Framed Openings: Provide shapes of proper design and size to reinforce opening and to carry loads and vibrations imposed, including equipment furnished under mechanical or electrical work. Securely attach to building structural frame.

3.02 ROOFING AND SIDING:

- A. General: Arrange and nest sidelap joints so that prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line. Protect factory finishes from damage.
- B. Provide weather seal under ridge cap; flash and seal roof panels at eave and rake with rubber, neoprene, or other closures to exclude weather.
- C. Roof Sheets: Provide sealant tape at lapped joints of ribbed or fluted roof sheets, and between roof sheeting and protruding equipment, vents and accessories. Apply sealant tape continuous to clean, dry surface of weather side of fastenings on end laps and on sidelaps of corrugated or nesting type, ribbed or fluted panels and elsewhere to make weatherproof to driving rains.
- D. Wall Sheets: Apply elastomeric sealant continuous between metal base channel (sill angle) and concrete and elsewhere as necessary for waterproofing. Handle and apply sealant and back-up

in accordance with sealant manufacturer's recommendations.

- E. Align bottoms of wall panels and fasten panels with blind rivets, bolts, or self-tapping screws. Fasten flashings, trim around openings, etc. with self-tapping screws; fasten window and door frames with machine screws or bolts. When building height requires two rows of panels at gable ends, align lap of gable panels over wall panels at eave height.
- F. Install screw fasteners with power tool having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
- G. Sheet Metal Accessories: Install gutters, downspouts, ventilators and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weathertight mounting. Adjust operating mechanism for precise operation.
- H. Align horizontal laps with adjacent roofing and siding panels.
- I. Seal intermediate end laps and side laps of translucent panels with translucent mastic.
- J. Clean panels in accordance with manufacturer's instructions.

3.03 METAL BUILDING INSULATION:

- A. Apply insulation units to substrate complying with manufacturer's recommendations. Insulation shall be dry, tight and free of wrinkles or sags. All joints shall be lapped a minimum of 3" and taped with pressure sensitive vinyl to match insulation color.
- B. Dissimilar Materials: Where aluminum surfaces come in contact with ferrous metal or other incompatible materials, keep aluminum surfaces from direct contact by applications to the other material as follows:
- C. One coat of zinc chromate primer, FS TT-P-645, followed by two coats of aluminum paint, SSPC-Paint 101.
- D. In lieu of 2 coats of aluminum paint, apply one coat of high-build bituminous paint, SSPC-Paint 12, applied to a thickness of 1/16" over zinc chromate primer.

3.04 WARRANTY:

- A. Metal Building Manufacturer shall furnish the following:
- B. Twenty (20) year wall, trim and roof paint warranty.
- C. Twenty (20) year roof weather-tightness warranty.

END OF SECTION 131200

SECTION 15052 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 1. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 1. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

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

1.4 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.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

- 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.

2.2 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. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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. Available Manufacturers:
 - a. Dresser Industries, Inc.; DMD Div.
 - b. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - c. Smith-Blair, Inc.
 - d. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

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3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: [CPVC] [PVC] [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.
- Available Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- Available Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, [CPVC] [PVC] [CPVC and PVC] four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- Available Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
- Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.5 MECHANICAL SLEEVE SEALS

Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.

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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: Carbon steel. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - Underdeck Clamp: Clamping ring with set screws.
- D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC Pipe: ASTM D 1785, Schedule 40.
- F. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 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, Cast-Brass Type: With set screw.
 - Finish: Polished chrome-plated and rough brass.
- C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - Finish: Polished chrome-plated and rough brass.

2.8 GROUT

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. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.

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- f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated or rough-brass finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. 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.
 - 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. Coordinate sleeve requirements with Division 15 Section "Plumbing Insulation."
 - 4. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For all pipes.
 - b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - Seal space outside of sleeve fittings with grout.
 - 5. 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.
- Q. 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.

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2. 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 annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 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.

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- 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. 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.
 - 3. PVC Non-pressure Piping: Join according to ASTM D 2855.
 - 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.

3.3 PIPING CONNECTIONS

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 not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 9 Sections "Interior Painting" and "Exterior Painting."

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- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 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 plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.8 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 15052-COMMON WORK RESULTS FOR PLUMBING

SECTION 15053 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to all Division 15 Sections.

1.2 SUMMARY

This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:

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1. CPVC: Chlorinated polyvinyl chloride plastic.
 2. PE: Polyethylene plastic.
 3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data - For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

In other Part 2 articles in all of Division 15 where subparagraph titles below introduce lists, the following requirements apply for product selection:

- 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.

2.2 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. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. 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.
- D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

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- 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.
 - Available Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
 - D. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - E. 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 .
 - Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Metraflex Co.
 - c. 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: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 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. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - Underdeck Clamp: Clamping ring with set screws.
- D. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC Pipe: ASTM D 1785, Schedule 40.
- F. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 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, Cast-Brass Type: With set screw.
 - Finish: Polished chrome-plated and rough brass.

2.8 GROUT

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.

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- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
 - C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
 - D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - F. Install piping to permit valve servicing.
 - G. Install piping free of sags and bends.
 - H. Install fittings for changes in direction and branch connections.
 - I. Install piping to allow application of insulation.
 - J. Select system components with pressure rating equal to or greater than system operating pressure.
 - K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 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 polished chrome-plated or rough-brass finish.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - i. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - j. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - k. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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- 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.
 - Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 - Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
 - P. 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.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches 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.
 - Q. 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.
 - R. Verify final equipment locations for roughing-in.

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- S. 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. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

3.3 PIPING CONNECTIONS

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. 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 not indicated.

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- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
 - C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
 - D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in the respective Division 9 Painting Sections.
- 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 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 HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for HVAC 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 15053 – COMMON WORK RESULTS FOR HVAC

SECTION 15058 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.

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- C. Service Factor: 1.15.
 - D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
 - E. Multispeed Motors: Separate winding for each speed.
 - F. Rotor: Random-wound, squirrel cage.
 - G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
 - H. Temperature Rise: Class B.
 - I. Insulation: Class F.
 - J. Code Letter Designation:
 - 1. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
 - K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.

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- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

N/A

END OF SECTION 15058-COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

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

1.1 SUMMARY

This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Metal framing systems.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment 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.

1.4 SUBMITTALS

- A. Product Data: For the following:
 1. Steel pipe hangers and supports.
 2. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 1. Metal framing systems. Include Product Data for components.

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- 2. Equipment supports.
 - C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

- 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 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. Bergen-Power Pipe Supports.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Grinnell Corp.
- 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 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.

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2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 3. Thomas & Betts Corporation.
 4. 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.

2.4 FASTENER SYSTEMS

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.

- Available Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. MKT Fastening, LLC.

2.5 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Available Manufacturers:
1. C & S Mfg. Corp.
 2. HOLDRITE Corp.; Hubbard Enterprises.
 3. Samco Stamping, Inc.

2.6 EQUIPMENT SUPPORTS

Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.7 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. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. 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.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

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- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod.
 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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- J. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
 - K. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
 - L. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- C. Fastener System Installation:
Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- 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 and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- L. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.

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- 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 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 5. Insert Material: Length at least as long as protective shield.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

-
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-inch.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15061 – HANGERS AND SUPPORTS FOR PLUMBING AND EQUIPMENT

15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Metal framing systems.
 - 3. Thermal-hanger shield inserts
 - 4. Fastener systems.
 - 5. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

-
1. Metal framing systems. Include Product Data for components.
 2. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 1. Bergen-Power Pipe Supports.
 2. B-Line Systems, Inc.; a division of Cooper Industries.
 3. ERICO/Michigan Hanger Co.
 4. Grinnell Corp.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Non-metallic 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.

2.2 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 1. B-Line Systems, Inc.; a division of Cooper Industries.
 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 3. Thomas & Betts Corporation.
 4. 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.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. Pipe Shields, Inc.
 - 4. Rilco Manufacturing Company, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 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.
 - Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. MKT Fastening, LLC.

2.5 EQUIPMENT SUPPORTS

Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

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.

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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. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 10. 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.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.

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13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod.
 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

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- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
 - K. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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 to properly support piping from building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- 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 lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- L. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.

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- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 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.
 5. Insert Material: Length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Remove welding flux immediately.

-
3. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-inch.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15062–HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

SECTION 15076 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Warning tags.

1.2 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Blue.
4. Maximum Temperature: Able to withstand temperatures up to 160°F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
6. Minimum Letter Size: 1/4-inch for name of units if viewing distance is less than 24-inches, 1/2-inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-Steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
 - C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.

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2. Lettering Size: At least 1-1/2 inches high.

2.4 WARNING TAGS

Warning Tags: Pre-printed or partially pre-printed, 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 PREPARATION

Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

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

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Domestic Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
2. Sanitary Waste Piping:
 - a. Background Color: White.
 - b. Letter Color: Black.

3.4 WARNING-TAG INSTALLATION

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

END OF SECTION 15076 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Warning tags.

1.2 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
3. Minimum Letter Size: 1/4-inch for name of units if viewing distance is less than 24-inches, 1/2-inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.

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3. Background Color: Blue.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
 6. Minimum Letter Size: 1/4-inch for name of units if viewing distance is less than 24-inches, 1/2-inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
- F. Minimum Letter Size: 1/4-inch for name of units if viewing distance is less than 24-inches, 1/2-inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 WARNING TAGS

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 PREPARATION

Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

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

3.3 PIPE LABEL INSTALLATION

Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

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1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50-feet along each run. Reduce intervals to 25-feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 WARNING-TAG INSTALLATION

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

END OF SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

SECTION 15082 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
2. Adhesives.
3. Sealants.
4. Factory-applied jackets.
5. Tapes.
6. Securements.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 1. Submit an insulation schedule and details of proposed materials.

1.3 REGULATORY

For indoor applications, use products with VOC content of 50g/l or less when calculated according to 40 CFR 59, subpart D (EPA method 24).

1.4 COORDINATION

- A. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- B. Coordinate installation and testing of heat tracing.

1.5 SCHEDULING

Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Owens Corning; All-Service Duct Wrap.
- E. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000(Pipe Insulation.
 - d. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

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- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aero seal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. Marathon Industries, Inc.; 225.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. Marathon Industries, Inc.; 225.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

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

2.3 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

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4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.5 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.

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7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 2. Width: 3 inches.
 3. Film Thickness: 4 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.

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6. Tensile Strength: 55 lbf/inch in width.

2.6 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.

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- c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
 4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
 - D. Wire: 0.080-inch nickel-copper alloy.

PART 3 - EXECUTION

3.1 EXAMINATION

Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- D. Install multiple layers of insulation with longitudinal and end seams staggered.
- E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.

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2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
- B. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

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7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

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3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

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4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.8 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
- Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

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2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1/2 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - d. Phenolic: 1 inch thick.
 - e. Polyisocyanurate: 1 inch thick.
 - f. Polyolefin: 1/2 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - d. Phenolic: 1 inch thick.
 - e. Polyisocyanurate: 1 inch thick.
 - f. Polyolefin: 1 inch thick.

B. Domestic Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Domestic Cold Water (Potable):

- All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

- All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

E. Condensate and Equipment Drain Water below 60 Deg F:

- All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

- All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

G. Hot Service Drains:

- All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

H. Hot Service Vents:

- All Pipe Sizes: Insulation shall be one of the following:

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- a. Cellular Glass: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

3.12 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.
- B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.

END OF SECTION 15082 – PLUMBING INSULATION

SECTION 15083 – HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
2. Adhesives.
3. Sealants.
4. Factory-applied jackets.
5. Field-applied jackets.
6. Tapes.
7. Securements.
8. Corner angles.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Table indicating type and thickness of insulation for each application on this project.

1.3 REGULATORY

For indoor applications, use products with VOC content of 50 g/l or less when calculated according to 40 CFR 59, subpart D (EPA method 24).

1.4 COORDINATION

Coordinate clearance requirements with piping Installer for piping insulation application duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.5 SCHEDULING

Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Owens Corning; All-Service Duct Wrap.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA Inc.; Aero seal.
 - b. Armacell LCC; 520 Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.

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- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
- Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

2.3 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.4 FACTORY-APPLIED JACKETS

Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

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1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and Kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

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- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

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- a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive-backed base with a peel-off protective cover.
 6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
 - D. Wire: 0.080-inch nickel-copper alloy.

2.8 CORNER ANGLES

Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- D. Install multiple layers of insulation with longitudinal and end seams staggered.
- E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

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- F. Keep insulation materials dry during application and finishing.
 - G. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
 - H. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
 - I. Install insulation with factory-applied jackets as follows:
 1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches o.c.
 - For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
 - J. Cut insulation in a manner to avoid compressing insulation more than 50 percent of its nominal thickness.
 - K. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
 - L. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4-inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

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1. Seal penetrations with flashing sealant.
 2. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2-inches.
 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
- Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

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- insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe

insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Finish exposed surfaces with a metal jacket.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

- A. Blanket Insulation Installation on Ducts: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, 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.

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3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 4. For ducts with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2-inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3-inches.
 5. Overlap un-faced blankets a minimum of 2-inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18-inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install 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 insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches o.c.

3.8 FIELD-APPLIED JACKET INSTALLATION

Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches o.c. and at end joints.

3.9 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
 - Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

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- D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

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

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

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in non-conditioned space.
4. Indoor, exposed return located in non-conditioned space.
5. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
6. Outdoor, exposed supply.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Vibration-control devices.
4. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round supply-air duct insulation shall be the following:

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- Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- B. Concealed, rectangular, supply-air duct insulation shall be the following:
- Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- C. Concealed, rectangular, return-air duct insulation shall be the following:
- Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- D. Concealed, rectangular, outdoor duct insulation shall be the following:
- Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-16/cu. Ft. normal density.
- E. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
- Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- F. Exposed, rectangular, supply-air duct insulation shall be the following:
- Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- G. Exposed, rectangular, return-air duct insulation shall be the following:
- Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- H. Exposed, rectangular, outdoor duct insulation shall be the following:
- Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-16/cu. Ft. normal density.

3.13 ABOVEGROUND, OUTDOOR DUCT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
- B. Exposed, rectangular, outdoor-air duct insulation shall be the following:
- Mineral-Fiber Blanket: 2 inches and 1.5-lb/cu. ft. nominal density.

3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

Refrigerant Suction and Hot-Gas Piping:

- All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

Refrigerant Suction and Hot-Gas Piping:

- All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Ducts and Plenums, Exposed, up to 48-Inches in Diameter or with Flat Surfaces up to 72-Inches:
 - Aluminum, smooth or corrugated 0.020 inch thick.
- C. Equipment, Concealed:
 - None.
- D. Piping, Concealed:
 - None.
- E. Piping, Exposed:
 - Painted Aluminum, smooth or corrugated 0.020 inch thick.

END OF SECTION 15083 - HVAC INSULATION

SECTION 15140 – DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Escutcheons.
5. Sleeves and sleeve seals.
6. Wall penetration systems.

1.2 PERFORMANCE REQUIREMENTS

Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings:

For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved

1. Domestic water piping.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.5 PROJECT CONDITIONS

Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

- 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of water service.
- 2. Do not proceed with interruption of water service without Owner's written permission.

1.6 COORDINATION

Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. 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.
 - 5. Copper Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
 - 3) Viega; Plumbing and Heating Systems.

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- b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
6. Copper Push-on-Joint Fittings:
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) NVent LLC.
 - b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
7. Copper-Tube Extruded-Tee Connections:
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) T-DRILL Industries Inc.
 - b. Description: Tee formed in copper tube according to ASTM F 2014.
8. Grooved-Joint Copper-Tube Appurtenances:
- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Anvil International.
 - 2) Shurjoint Piping Products.
 - 3) Victaulic Company.
 - b. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.
- B. Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.
- 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 2. Copper Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
 - 3) Viega; Plumbing and Heating Systems.

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- b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 PVC PIPE AND FITTINGS

PVC Pipe: ASTM D 1785, Schedule 40.

- 1. PVC Socket Fittings: ASTM D 2466 for Schedule 40.
- 2. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 SPECIALTY VALVES

- A. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.

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3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - C. Sleeve-Type Transition Coupling: AWWA C219.
 - Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dresser, Inc.; Dresser Piping Specialties.
 - b. Ford Meter Box Company, Inc. (The).
 - c. JCM Industries.
 - D. Plastic-to-Metal Transition Fittings:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.
 2. Description: One-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
 - E. Plastic-to-Metal Transition Unions:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.
 2. Description: Four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:

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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - d. Zurn Plumbing Products Group; Wilkins Water Control Products.
 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Description:
 - a. Non-conducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
2. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and non-corrosive, thermoplastic.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
2. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and non-corrosive, propylene.

2.8 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.
- C. One-Piece Floor Plates: Cast-iron flange.

2.9 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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- C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
 - D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
 - E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
 - F. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - Underdeck Clamp: Clamping ring with setscrews.

2.10 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex, Inc.
 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.11 WALL PENETRATION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - SIGMA.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
 1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 3. Housing-to-Sleeve Gasket: EPDM rubber.
 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.

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5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

2.12 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- D. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- H. 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.

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- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
 - J. Install piping adjacent to equipment and specialties to allow service and maintenance.
 - K. Install piping to permit valve servicing.
 - L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
 - M. Install piping free of sags and bends.
 - N. Install fittings for changes in direction and branch connections.
 - O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- H. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

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1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 3. PVC Piping: Join according to ASTM D 2855.
- J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- B. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."
 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 1. Vertical Piping: MSS Type 8 or 42, clamps.

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2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
 - C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
 - D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - E. Install supports for vertical copper tubing every 10 feet.
 - F. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 - G. Install supports for vertical PVC piping every 48 inches.
 - H. Support piping and tubing not listed in this article 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 water-service piping with shutoff valve; extend and connect to the following:
 1. Water Heaters: Cold-water inlet 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. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.

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3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.
 5. Bare Piping in Equipment Rooms: One piece, stamped steel with set screw or spring clips.
 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals or wall penetration systems specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:

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1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. PVC pipe sleeves for pipes smaller than NPS 6.
 - b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE.
 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - c. Do not use sleeves when wall penetration systems are used.
 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. PVC pipe sleeves for pipes smaller than NPS 6.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.11 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.12 WALL PENETRATION SYSTEM INSTALLATION

- A. Install wall penetration systems in new, exterior concrete walls.
- B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.13 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.14 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.

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- E. Prepare test and inspection reports.

3.15 ADJUSTING

Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.16 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

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1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.17 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be one of the following:
1. Soft copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and brazed joints.
 2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints. (Drainage pipe only)
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints. (Drainage pipe only)
- F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L wrought-copper solder-joint fittings; and soldered joints.
 2. PVC, Schedule 40 pipe; socket fittings; and solvent-cemented joints. (Drainage pipe only)
- G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and soldered joints.
 2. PVC, Schedule 40 pipe; socket fittings; and solvent-cemented joints. (Drainage pipe only)

3.18 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 15140 - DOMESTIC WATER PIPING

SECTION 15145 – DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
 2. Backflow preventers.
 3. Water pressure-reducing valves.
 4. Strainers.
 5. Hose bibbs.
 6. Wall hydrants.
 7. Drain valves.
 8. Air vents.
 9. Trap-seal primer valves.

1.2 PERFORMANCE REQUIREMENTS

Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 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. NSF Compliance:
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

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:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. 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:
 - a. Conbraco Industries, Inc.
 - b. Legend Valve.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASSE 1011.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Reduced-Pressure-Principle Backflow Preventers:

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:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.

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2. Standard: ASSE 1013.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 10 psig maximum, through middle 1/3 of flow range.
 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger
 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 7. Configuration: Designed for horizontal, straight through flow.
 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.2 STRAINERS FOR DOMESTIC WATER PIPING

Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.3 HOSE BIBBS

Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

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8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 9. Finish for Service Areas: Rough bronze.
 10. Finish for Finished Rooms: Chrome or nickel plated.
 11. Operation for Equipment Rooms: Wheel handle or operating key.
 12. Operation for Service Areas: Operating key.
 13. Operation for Finished Rooms: Operating key.
 14. Include operating key with each operating-key hose bibb.
 15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.4 WALL HYDRANTS

Wall hydrants without integral vacuum breakers or backflow preventers are available but not recommended.

A. Non-freeze Wall Hydrants:

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:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): Two with each wall hydrant.

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.6 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.

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6. Inlet and Vent Outlet End Connections: Threaded.

2.7 DRAINAGE – TYPE, TRAP-SEAL PRIMER VALVES

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:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. 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 water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- D. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- E. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- F. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

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- B. Ground equipment according to Division 16.
 - C. Connect wiring according to Division 16.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

END OF SECTION 15145-DOMESTIC WATER PIPING SPECIALTIES

SECTION 15150 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. PVC: Polyvinyl chloride plastic.
- D. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer: 50 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

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 MANUFACTURERS

In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

- 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 PIPING MATERIALS

Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
 - 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.
 - PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.
- D. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SPECIAL PIPE FITTINGS

- A. Flexible, Non-pressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Fernco, Inc.
 - b. Mission Rubber Co.

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- c. NDS, Inc.
 - d. Plastic Oddities, Inc.
 - 2. Sleeve Materials:
 - a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - b. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - B. Shielded Non-pressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
 - C. Rigid, Unshielded, Non-pressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - Manufacturers:
 - a. ANACO.
 - D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - Manufacturers:
 - a. SIGMA Corp.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Flexible, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

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1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 2. Dissimilar Pipe-Material Couplings: Flexible, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 2. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: Flexible, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- E. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 2. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: Flexible, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.2 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install 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. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Common Work Results for Plumbing."
- D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of

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- lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
1. 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.
- H. Install engineered soil and waste drainage and vent piping systems as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- J. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- K. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- M. Install locator tape on all underground PVC pipe.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Common Work Results for Plumbing".
- B. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet, if indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. 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 5: 48 inches with 5/8-inch rod.
- F. Install supports for vertical PVC piping every 48 inches.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

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3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 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.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 15150 - SANITARY WASTE AND VENT PIPING

SECTION 15155 – SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Air-admittance valves.
5. Roof flashing assemblies.
6. Through-penetration firestop assemblies.
7. Miscellaneous sanitary drainage piping specialties.

1.2 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Field quality-control test reports.
- B. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.5 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 size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

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:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:

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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:
 - a. IPS Corporation.
 - b. Oatey.
 - c. Plastic Oddities; a division of Diverse Corporate Technologies.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Size: Same as connected piping.
 3. Body: ABS [PVC].
 4. Cover: Same material as body with threaded access to check valve.
 5. Check Valve: Removable swing check.
 6. End Connections: Socket type.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:

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:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, brass or cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

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:
 - a. Oatey.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.

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2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
 3. Size: Same as connected branch.
 4. Type: Adjustable housing.
 5. Clamping Device: Not required.
 6. Body or Ferrule: Cast iron.
 7. Outlet Connection: Threaded.
 8. Closure: Cast-iron plug.
 9. Adjustable Housing Material: Cast iron with threads.
 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 11. Top Loading Classification: Heavy Duty.
 12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 13. Standard: ASME A112.3.1.
 14. Size: Same as connected branch.
 15. Housing: Stainless steel.
 16. Closure: Stainless steel with seal.
 17. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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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:
 - a. MIFAB, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.6.3.

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
- B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counter-flashing fitting.
 1. Open-Top Vent Cap: Without cap.
 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

Through-Penetration Firestop Assemblies:

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:
 - ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft. thickness.
 2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.
- 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- 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. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

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- I. Assemble open drain fittings and install with top of hub 1 inch above floor.
 - J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
 - K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
 - L. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
 - M. Install vent caps on each vent pipe passing through roof.
 - N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
 - O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
 - P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
 - Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
 - R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
 - S. 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 pipe fittings.

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. Ground equipment and connect wiring according to Division 16.

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:
 - 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.

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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 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155-SANITARY WASTE PIPING SPECIALTIES

SECTION 15183 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-22:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.
- B. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Filter dryers.
 - 4. Strainers.
 - 5. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Welding certificates.
- D. Field quality-control test reports.

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- E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.6 COORDINATION

Coordinate size and location of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

C. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

D. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

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- E. Thermostatic Expansion Valves: Comply with ARI 750.
 - 1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 - 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 - 3. Packing and Gaskets: Non-asbestos.
 - 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 - 5. Suction Temperature: 45 deg F.
 - 6. Superheat: Adjustable.
 - 7. Reverse-flow option (for heat-pump applications).
 - 8. End Connections: Socket, flare, or threaded union.
 - 9. Working Pressure Rating: 700 psig.

 - F. Moisture/Liquid Indicators:
 - 1. Body: Forged brass.
 - 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 - 3. Indicator: Color coded to show moisture content in ppm.
 - 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 - 5. End Connections: Socket or flare.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 240 deg F.

 - G. Permanent Filter Dryers: Comply with ARI 730.
 - 1. Body and Cover: Painted-steel shell.
 - 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 3. Desiccant Media: Activated alumina.
 - 4. Designed for reverse flow (for heat-pump applications).
 - 5. End Connections: Socket.
 - 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 - 7. Maximum Pressure Loss: 2 psig.
 - 8. Rated Flow: Up to 1.5 tons.
 - 9. Working Pressure Rating: 500 psig.
 - 10. Maximum Operating Temperature: 240 deg F.

2.3 REFRIGERANTS

- 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:

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1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-22: Monochlorodifluoromethane.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-22

- A. Suction Lines NPS 2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type K, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

3.3 VALVE AND SPECIALTY APPLICATIONS

“Install specialties as recommended by system manufacturer.”

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.

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- 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 adjacent to machines to allow service and maintenance.
 - G. Install piping free of sags and bends.
 - H. Install fittings for changes in direction and branch connections.
 - I. Select system components with pressure rating equal to or greater than system operating pressure.
 - J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
 - K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels, if required.
 - L. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
 - M. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
 - N. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
 - O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
 - P. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

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- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
 - D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
 - E. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2 - 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
- D. Support multi-floor vertical runs at least at each floor.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.8 SYSTEM CHARGING

Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 1. Verify that compressor oil level is correct.
 2. Open compressor suction and discharge valves.
 3. Open refrigerant valves except bypass valves that are used for other purposes.
 4. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 15183-REFRIGERANT PIPING

SECTION 15223 CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Single-wall piping.
2. Double-containment piping.
3. Field-fabrication containment piping.
4. Piping specialties.
5. Neutralization tanks.

1.2 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

1.3 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water.
- B. Double-Containment Piping Pressure Rating:
 1. Carrier Piping: 5-psig air test pressure.
 2. Containment Piping: 5-psig air test pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks, to include in emergency, operation, and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
- B. Do not store plastic pipe or fittings in direct sunlight.

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- C. Protect pipe, fittings, and seals from dirt and damage.

1.6 COORDINATION

Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

- A. PE Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.
 - 1. Manufacturers:
 - a. ISCO Industries, LLC.
 - b. Performance Pipe; a division of Chevron Phillips Chemical Company LLC.
 - c. PolyPipe, Inc. Div.; Rinker Materials Corporation.
 - 2. Pipe: ASTM F 1412, Schedule 40.
 - 3. Fittings: ASTM F 1412, Schedule 40, socket-fusion, drainage pattern complying with ASTM D 3311.
- B. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion- and mechanical-joint ends.
 - 1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
 - 2. Manufacturers:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
 - c. Watts Industries (Canada) Inc.
 - d. Zurn Plumbing Products Group; Chemical Drainage Systems.
- C. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.2 DOUBLE-CONTAINMENT PIPE AND FITTINGS

- A. Manufacturers:
 - 1. Eslon Thermoplastics; Guardian Div.
 - 2. Insul-Tek Piping Systems, Inc.

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3. NIBCO INC.
 4. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
- B. Description: Factory-fabricated, double-wall pipe and fittings. Sizes indicate carrier-pipe size; with carrier (inner) pipe and fittings; annular-space, carrier-pipe supports; containment (outer) pipe and fittings; and joining materials and fasteners. Include manufacturer's standard piping materials according to the following:
1. PE, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.
 - a. Carrier and Containment Pipes: ASTM F 1412, Schedule 40.
 - b. Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311.
 2. PP, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4101, PP resin.
 - a. Carrier and Containment Pipes: ASTM F 1412, Schedule 40.
 - b. Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311.
- C. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.3 FIELD-FABRICATION CONTAINMENT PIPING

- A. Manufacturers:
1. Flo Safe, Inc.
 2. Sloane, George Fischer Inc.
- B. Description: Containment split pipe and split fittings with carrier-pipe centralizers. Include manufacturer's fastening devices and materials.
1. Material: HDPE or PP pipe and fittings.
 2. Fastening System: FPM gaskets, clamps, and pins.
 3. Material: Clear PVC pipe and fittings with adhesive channels, for use with drainage-pattern carrier piping.
 4. Fastening System: Adhesive.

2.4 JOINING MATERIALS

- A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
- B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

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- C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

2.5 PIPING SPECIALTIES

A. Plastic Dilution Traps:

1. Manufacturers:
 - a. IPEX Inc.
 - b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - c. Sloane, George Fischer Inc.
2. Material: Corrosion-resistant PP, with removable base.
3. End Connections: Mechanical joint.
4. Dilution Tanks: 1-gal. capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 top inlets and one NPS 1-1/2 side outlet.
5. Small Dilution Jars: 1-pint capacity, with clear base unless colored base is indicated; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.
6. Large Dilution Jars: 1-quart capacity; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.

B. PP Floor Drains :

1. Manufacturers:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
 - c. Watts Industries (Canada) Inc.
2. Body: With 7- to 9-inch top diameter, with flashing flange and weep holes; and with trap-primer connection.
3. Outlet: Bottom, to match connecting pipe, with NPS 2, NPS 3, NPS 4, or NPS 6 outlet as indicated.

C. Plastic Backwater Valves:

- Description: Full-port NPS 3 check valve, PP or PVDF, matching or compatible with system piping and compatible with system liquid, with EPDM seals and flanged ends.
 - a. Exception: PVC material for use with PVC piping systems.

D. PP Sink Outlets:

- Description: NPS 1-1/2, with clamping device, stopper, and 7-inch- high overflow fitting.

2.6 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks:

1. Manufacturers:
 - a. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - b. Sloane, George Fischer Inc.
 - c. Watts Industries (Canada) Inc.
2. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.

2.7 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- B. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- C. Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, plain ends.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - Underdeck Clamp: Clamping ring with set screws.

2.8 SLEEVE SEALS

A. Manufacturers:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.

B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Plastic.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.9 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.
- D. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw and chrome-plated finish.
- E. One-Piece, Floor-Plate Escutcheons: Cast iron.
- F. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.10 GROUT

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 EARTHWORK

Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 CONCRETE BASES

Anchor neutralization tanks to concrete bases.

- 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch centers around full perimeter of base.
- 2. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
- 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
- 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 5. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

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6. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement.
 7. Comply with requirements in Division 3 for cast-in-place concrete materials and placement.

3.3 PIPING INSTALLATION

A. Chemical-Waste Sewerage Outside the Building:

1. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
5. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
6. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
7. Install PE drainage piping according to ASTM D 2321 and ASTM F 1668.
8. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

B. Chemical-Waste Piping Inside the Building:

1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.
4. Install underground fiberglass piping according to ASTM D 3839.
5. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
6. 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.
7. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

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8. Install piping at indicated slopes.
 9. Install piping free of sags and bends.
 10. Install fittings for changes in direction and branch connections.
 11. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - a. New Piping:
 - 1) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2) Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - 4) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
 - 5) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw.
 - 6) Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
 - 7) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 12. Sleeves are not required for core-drilled holes.
 13. Permanent sleeves are not required for holes formed by removable PE sleeves.
 14. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
 15. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - a. Cut sleeves to length for mounting flush with both surfaces.
 - 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.
 - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - c. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - 1) PVC Pipe Sleeves: For pipes smaller than NPS 6.
 - 2) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 3) Seal space outside of sleeve fittings with grout.
 - d. 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.

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16. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - a. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - b. 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.
 17. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - a. Sleeve-Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble 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.
 18. 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.
 19. Verify final equipment locations for roughing-in.

3.4 PIPING SPECIALTY INSTALLATION

- A. Embed floor drains in 4-inch minimum depth of concrete around bottom and sides.
- B. Fasten grates to drains if indicated.
- C. Set floor drains with tops flush with pavement surface.
- D. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.
 - Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface.
- E. Install backwater valves in horizontal position. Include riser to cleanout at grade.

3.5 JOINT CONSTRUCTION

- A. Chemical-Waste Sewerage Outside the Building:
 1. Plastic-Piping, Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
 2. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.

B. Chemical-Waste Piping Inside the Building:

1. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
2. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe sizes in this article refer to aboveground, single-wall piping and carrier piping of containment piping.
- B. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
 1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.
- D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- E. Support vertical piping and tubing at base and at each floor.
- F. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch.
- G. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2: 33 inches with 3/8-inch rod.
 2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- H. Install supports for vertical PP piping every 72 inches.
- I. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 36 inches with 3/8-inch rod.

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2. NPS 1-1/2 and NPS 2: 42 inches with 3/8-inch rod.
 3. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- J. Install supports for vertical PVC piping every 48 inches.
- K. Install vinyl-coated hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:
1. All Sizes: Install continuous support for piping with liquid waste at temperatures above 140 deg F.
 2. NPS 1/2 and Smaller: 30 inches with 3/8-inch rod.
 3. NPS 3/4 to NPS 1-1/2: 36 inches with 3/8-inch rod.
 4. NPS 2: 36 inches with 3/8-inch rod.
 5. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
 6. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- L. Install supports for vertical PVDF piping NPS 1-1/2 every 48 inches and NPS 2 and larger every 72 inches.
- M. Support piping and tubing not listed above according to MSS SP-69.

3.7 NEUTRALIZATION TANK INSTALLATION

- A. Install exterior collection and neutralization tanks, complete with appurtenances indicated.

3.8 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated. Comply with requirements in Division 2 Section "Sanitary Sewerage."
- B. Set tops of manhole frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.
- C. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

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- D. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
 - E. Install piping adjacent to equipment to allow service and maintenance.

3.10 LABELING AND IDENTIFICATION

Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

- A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.
 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Air Tests for Drainage Piping: Comply with UNI-B-6.
 2. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Submit separate reports for each test.
- B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
- C. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 ADJUSTING

- A. Adjust neutralization-system set points.

3.13 CLEANING

Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

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2. Clean piping by flushing with potable water.

3.14 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
- B. Single-Wall, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:
 1. NPS 1-1/2 to NPS 4: PE drainage pipe and fittings and heat-fusion joints.
 2. NPS 1-1/2 to NPS 4: PP drainage pipe and fittings and electrofusion joints.
 3. NPS 1-1/2 to NPS 4: Glass pipe and fittings and coupled joints.
- C. Underground, Double-Containment, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:
 1. NPS 2 to NPS 12: PE double-containment drainage pipe and fittings.
 2. NPS 2 to NPS 12: PP double-containment drainage pipe and fittings.
- D. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use any of the following piping materials for each size range:
 1. NPS 1-1/2 to NPS 6: PP drainage piping and electrofusion joints.
 2. NPS 1-1/2 to NPS 6: PE or PP, double-containment drainage piping and manufacturer's standard joints.

END OF SECTION 15223 – CHEMICAL WASTE SYSTEMS FOR
LABORATORY & HEALTHCARE FACILITIES

SECTION 15732 – PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Hot-gas reheat.
 - 3. Electric-heating coils.
 - 4. Economizer outdoor- and return-air damper section.
 - 5. Integral, space temperature controls.
 - 6. Grade mounted curbs.
- B. Related Sections include the following:

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- D. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. VVT: Variable-air volume and temperature.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each

field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

- Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Commissioning Reports: Indicate results of startup and testing requirements. Submit copies of checklists.
- D. Operation and Maintenance Data: For RTU'S to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. ARI Compliance:
1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- C. UL Compliance: Comply with UL 1995.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than one year from date of Substantial Completion.

1.6 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One (1)-set for each belt-driven fan.
2. Filters: One (1)-set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. AAON, Inc.
2. Trane; American Standard Companies, Inc. (Morganizer)

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Access to filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with handles. Door fastening screws are not acceptable.
- C. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - Exterior Casing Thickness 0.0626 inch thick.
- D. Inner Casing Fabrication Requirements:
 - Inside Casing: Galvanized steel, 0.028 inch thick Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 1. Materials: ASTM C 1071, Type I.
 2. Thickness: 1 inch., (1 ½ lb density).
 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 4. Liner Adhesive: Comply with ASTM C 916, Type I.

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- E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep , and complying with ASHRAE 62.1-2004.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple .
 - 3. Pan-Top Surface Coating: Corrosion-resistant compound.
 - F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.3 FANS

- A. Direct-Driven Supply-Air Fans: Double width, centrifugal; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- D. Fan Motor: Comply with requirements in Division 15 Section "Motors."

2.4 OUTSIDE AIR DAMPER

Units shall have a 0-100% motor operated outdoor air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 15 CFM of leakage per sq. ft. of damper area when subjected to 2-inch w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure.

2.5 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum late fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 - 3. Coil Split: Interlaced.
 - 4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1-2004.
- B. Hot-Gas Reheat Refrigerant Coil:

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1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

C. Electric-Resistance Heating:

1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
2. Over-temperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
3. Over-current Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and over-current protection. Include the following controls:
 - a. Magnetic contactors.
 - b. Step Controller: Pilot lights and override toggle switch for each step.
 - c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - d. Time-delay relay.
 - e. Airflow proving switch.

2.6 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: mounted on vibration isolators; with internal over-current and high-temperature protection, internal pressure relief, and crankcase heater.
- C. Refrigeration Specialties:
 1. Refrigerant: R-410A.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Brass service valves installed in compressor suction and liquid lines.
 9. Low-ambient kit high-pressure sensor.
 10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

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11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.7 AIR FILTRATION

Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber: Minimum 30 percent arrestance, and MERV 5.

2.8 ELECTRICAL POWER CONNECTION

Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in over-current protection.

2.9 CONTROLS

- A. Refer to section 15940 - "Sequence of Operation"

2.10 ACCESSORIES

- A. Low-ambient kit for operation down to 35 deg F.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Hail guards of galvanized steel, painted to match casing.

2.11 GRADE MOUNTED CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Unit Support: Install unit curb level concrete pad. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
- C. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. Connect supply ducts to RTUs with flexible duct connectors specified in Division 15 Section "Duct Accessories."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- B. Tests and Inspections:
 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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- C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to compressor, coils, and fans.
 - 3. Inspect internal insulation.
 - 4. Verify that labels are clearly visible.
 - 5. Verify that clearances have been provided for servicing.
 - 6. Verify that controls are connected and operable.
 - 7. Verify that filters are installed.
 - 8. Clean condenser coil and inspect for construction debris.
 - 9. Remove packing from vibration isolators.
 - 10. Verify lubrication on fan and motor bearings.
 - 11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 12. Adjust fan belts to proper alignment and tension.
 - 13. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 - 14. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 15. Operate unit for an initial period as recommended or required by manufacturer.
 - 16. Calibrate thermostats.
 - 17. Adjust and inspect high-temperature limits.
 - 18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
 - 19. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
 - 20. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
 - 21. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. Low-temperature safety operation.
 - b. Filter high-pressure differential alarm.

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22. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15732 – PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

SECTION 15738 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty 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

Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fails in materials or workmanship within specified warranty period. Warranty includes loss of oil.

- Warranty Period: Five (5) years from date of Substantial Completion.

1.5 EXTRA MATERIALS

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: One (1) set of filters for each unit.
2. Fan Belts: One (1) set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Envriomaster International, LLC
3. Mitsubishi Electric, Mr. Slim
4. Trane Company (The); Unitary Products Group.
5. York International Corp.

2.2 CONCEALED EVAPORATOR-FAN COMPONENTS

- A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 1. Insulation: Faced, glass-fiber duct liner.
 2. Drain Pans: Galvanized steel, with connection for drain; insulated.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- D. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
- E. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."
 - Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- F. Disposable Filters: Washable
- G. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 FLOOR-MOUNTING, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
 - 1. Duct Collar.
 - 2. Insulation: Faced, glass-fiber, duct liner.
 - 3. Drain Pans: Galvanized steel, with connection for drain; insulated.
 - 4. Air-stream Surfaces: Surfaces in contact with the air-stream shall comply with requirements in ASHRAE 62.1-2004.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for over-current protection.
- D. Fan: Direct drive, centrifugal with power-induced outside air.
- E. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."
 - Special Motor Features: Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
- F. Filters: Disposable.

2.4 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 - 1. Air-stream Surfaces: Surfaces in contact with the air-stream shall comply with requirements in ASHRAE 62.1-2004.
 - 2. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2004.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for over-current protection.
- D. Fan: Direct drive, centrifugal fan.
- E. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."

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- Special Motor Features: Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.

F. Filters: Washable.

2.5 CEILING-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

1. Air-stream Surfaces: Surfaces in contact with the air-stream shall comply with requirements in ASHRAE 62.1-2004.
2. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2004.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for over-current protection.

D. Fan: Direct drive, centrifugal fan and integral condensate pump.

E. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."

- Special Motor Features: Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.

F. Filters: Permanent, cleanable

2.6 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Reciprocating or Scroll.
2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant: R-22 R-410A

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.

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- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
 - E. Fan: Aluminum-propeller type, directly connected to motor.
 - F. Motor: Permanently lubricated, with integral thermal-overload protection.
 - G. Low Ambient Kit: Permits operation down to 30 deg F. (Permit operation down to 0 deg F on ductless split systems.)
 - H. Mounting Base: Polyethylene.
 - I. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.7 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."
- B. Thermostat: Low voltage with sub-base to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounting, compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install ground-mounting, compressor-condenser components on polyethylene mounting base.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch.
- F. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

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 unit to allow service and maintenance.
- C. Duct Connections: Duct installation requirements are specified in Division 15 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 15 Section "Duct Accessories."
- D. Ground equipment according to Division 16 Section.
- E. Electrical Connections: Comply with requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

Train the Owner's maintenance personnel to adjust, operate and maintain units.

END OF SECTION 15738 – SPLIT-SYSTEM AIR-CONDITIONING UNITS

SECTION 15762 – UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Propeller unit heaters with electric-resistance heating coils.

1.2 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene plastic.
- B. TFE: Tetrafluoroethylene plastic.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Plans, elevations, sections, and details.
 2. Location and size of each field connection.
 3. Details of anchorages and attachments to structure and to supported equipment.
 4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
 5. Location and arrangement of integral controls.
 6. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

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.

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

- 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. Airtherm; a Mestek Company.
 2. Indeeco
 3. Markel Products; a division of TPI Corporation.
 4. Trane.
- B. Description: An assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.
- C. Comply with UL 2021.
- D. Cabinet: Removable panels for maintenance access to controls.
- E. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- F. Discharge Louver: Adjustable fin diffuser
- G. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in 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 high-temperature protection of heaters.
 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.
- H. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- I. Fan Motors: Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."
- Motor Type: Permanently lubricated.
- J. Control Devices:

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1. Unit-mounted thermostat.

2.2 WALL AND CEILING HEATERS

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive 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 unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 Section "Joint Sealants."
- B. Install propeller unit heaters level and plumb.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment." Retain first paragraph below if controls are provided by unit heater manufacturer. To comply with requirements of the Americans with Disabilities Act, verify mounting height with authorities having jurisdiction.

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. Comply with safety requirements in UL 1995.
- D. Ground equipment according to Division 16.
- E. Connect wiring according to Division 16.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

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1. Operational Test: 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 safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

END OF SECTION 15762-UNIT HEATERS

SECTION 15815 – METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

1.3 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

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2. Factory- and shop-fabricated ducts and fittings.
 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 4. Elevation of top of ducts.
 5. Dimensions of main duct runs from building grid lines.
 6. Fittings.
 7. Reinforcement and spacing.
 8. Seam and joint construction.
 9. Penetrations through fire-rated and other partitions.
 10. Equipment installation based on equipment being used on Project.
 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable

sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Available Manufacturers:
 - a. McGill AirFlow LLC.
 - b. SEMCO Incorporated.
 - c. Sheet Metal Connectors, Inc.
 - d. Spiral Manufacturing Co., Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct

construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- E. 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.

2.4 DUCT LINER (Use only where specifically indicated on plans)

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Available Manufacturers:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

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1. Available Manufacturers:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
 9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
 10. VOC: Maximum 395 g/L.
 11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 12. Service: Indoor or outdoor.
 13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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- D. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
 - F. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design

considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- 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. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 15 Section "Duct Accessories" for fire and smoke dampers.
- K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 7. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 8. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 9. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 10. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.

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2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with 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.

3.7 PAINTING

- Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9 painting Sections.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

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2. Test all ducts with Class Higher than 3-Inch wg (Ducts upstream of VAV Terminal Units): Test representative duct sections, totaling no less than 25 percent of total installed duct area for each designated pressure class.
 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 4. Test for leaks before applying external insulation.
 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 15 Section "Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Roof Top Units, Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:

1. Ducts Connected to Air Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative: 2 inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.

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2. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
 - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
 - c. Liquid tight welded seams and joints.
 - d. Pressure Class: Positive or negative 2-inch wg.
 - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - f. SMACNA Leakage Class: 3.
 3. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
 - a. Type 304, stainless-steel sheet.
 - 1) Exposed to View: No. 4 finish.
 - 2) Concealed: No. 2D finish.
 - b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
 - c. Pressure Class: Positive or negative 3-inch wg.
 - d. Minimum SMACNA Seal Class: A welded seams, joints, and penetrations.
 - e. SMACNA Leakage Class: 3.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Roof Top Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
- F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
 2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.

G. Liner:

1. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1500 fpm or lower: Conical tap.
 - b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 15815 – METAL DUCTS

SECTION 15820 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

Section Includes:

1. Backdraft dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.
10. Electric Duct Heaters

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings. Manual volume damper installations.
 - b. Control damper installations.
 - c. Fire-damper, installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - d. Wiring Diagrams: For power, signal, and control wiring.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.4 EXTRA MATERIALS

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- Fusible Links: Furnish quantity equal to ten (10) percent of amount installed.

PART 2 - PRODUCTS

2.1 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: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 2B finish for exposed ducts.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT DAMPERS

- A. Available Manufacturers:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Ruskin Company.
 - 4. SEMCO Incorporated.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

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- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
 - G. Blade Action: Parallel.
 - H. Blade Seals: Neoprene, mechanically locked.
 - I. Blade Axles:
 - Material: Galvanized steel.
 - J. Tie Bars and Brackets: Aluminum.
 - K. Return Spring: Adjustable tension.
 - L. Bearings: Steel ball or synthetic pivot bushings.

2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Available Manufacturers:
 - a. McGill AirFlow LLC.
 - b. METALAIRE, Inc.
 - c. Ruskin Company.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat-shaped, galvanized steel channels, 22 gauge minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel
 - 7. Bearings:
 - a. Molded synthetic
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Available Manufacturers:

1. Greenheck Fan Corporation.
2. Ruskin Company.

B. Type: Static and dynamic rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

- Minimum Thickness: 20 Gauge thick, and of length to suit application.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 24 gauge-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 24 gauge-thick, galvanized-steel blade connectors.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.5 FLANGE CONNECTORS

A. Available Manufacturers:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.

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3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 - B. Description: [Add-on] [or] [roll-formed], factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
 - C. Material: Galvanized steel.
 - D. Gage and Shape: Match connecting ductwork.

2.6 TURNING VANES

- A. Available Manufacturers:
 1. Ductmate Industries, Inc.
 2. METALAIRE, Inc.
 3. SEMCO Incorporated.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vaness and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

- A. Available Manufacturers:
 1. Greenheck Fan Corporation.
 2. McGill AirFlow LLC.
 3. Nailor Industries Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 1. Door:
 - a. Double wall, rectangular.

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- b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.

2.8 DUCT ACCESS PANEL ASSEMBLIES

- A. Available Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.9 FLEXIBLE CONNECTORS

- A. Available Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..

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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.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
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.

2.10 FLEXIBLE DUCTS

- A. Available Manufacturers:
1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
- B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
- C. Duct insulation shall be a minimum 1-inch thick with thermal conductance of R-6.0 or greater.
- D. Flexible Duct Connectors:
- Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.11 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.12 ELECTRIC DUCT HEATERS

- A. Available Manufacturers:
1. Indeeco.
 2. Nailor Industries, Inc.

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- B. Flanged, UL listed open coil electric duct heater.
 - C. Electric-Resistance Heating Coils: Nickel Chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secure with stainless-steel hardware.
 - 1. Access door interlocked disconnect switch.
 - 2. Downstream air temperature sensor with local connection to override discharge-air not to exceed a maximum temperature set point (adjustable).
 - 3. Airflow switch for proof of airflow.
 - 4. Fan interlock contacts.
 - 5. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - 6. Magnetic contactors for each step of control.
 - 7. Integral control transformer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.

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- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of electric duct heaters.
 - 2. Upstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 3. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 4. At each change in direction and at maximum 50-foot spacing.
 - 5. Upstream from turning vanes.
 - 6. Control devices requiring inspection.
 - 7. Elsewhere as indicated.
 - I. Install access doors with swing against duct static pressure.
 - J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
 - K. Install flexible connectors to connect ducts to equipment.
 - L. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
 - M. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

Tests and Inspections:

- 1. Operate dampers to verify full range of movement.
- 2. Inspect locations of access doors and verify that purpose of access door can be performed.
- 3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
- 4. Inspect turning vanes for proper and secure installation.
- 5. Operate remote damper operators to verify full range of movement of operator and damper.



END OF SECTION 15820 – DUCT ACCESSORIES

SECTION 15838 – POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes the following:

1. Centrifugal Sidewall Ventilators.
2. Centrifugal Roof Ventilators.
3. Inline Centrifugal Fans.
4. Backward inclined centrifugal fans

1.2 PERFORMANCE REQUIREMENTS

Operating Limits: Classify according to AMCA 99.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 1. Certified fan performance curves with system operating conditions indicated.
 2. Certified fan sound-power ratings.
 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 4. Material thickness and finishes, including color charts.
 5. Dampers, including housings, linkages, and operators.
 6. Roof curbs.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

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- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
 - D. UL Standard: Power ventilators shall comply with UL 705.
 - E. UL Standard: Kitchen exhaust fan shall comply with UL 762.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL SIDEWALL VENTILATORS

- 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. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
- C. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust air-stream.
- F. Accessories:

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1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
 3. Bird Screens: Removable, mesh, aluminum or brass wire.
 4. Wall Grille: Ring type for flush mounting.
 5. Dampers: Counterbalanced, parallel-blade, back-draft dampers mounted in wall sleeve; factory set to close when fan stops.
 6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

2.2 CENTRIFUGAL ROOF VENTILATORS

- 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. Greenheck.
 2. Loren Cook Company.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, square, one-piece, aluminum base with venturi inlet cone.
 - Hinged Sub-base: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
 1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
- G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

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1. Sound Curb: Curb with sound-absorbing insulation matrix.
 2. Pitch Mounting: Manufacture curb for roof slope.
 3. Metal Liner: Galvanized steel.
 4. Mounting Pedestal: Galvanized steel with removable access panel.
 5. Vented Curb: Unlined with louvered vents in vertical sides.

2.3 IN-LINE CENTRIFUGAL FANS

A. Available Manufacturers:

1. Acme Engineering & Mfg. Corp.
2. Greenheck.
3. Loren Cook Company.

B. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Companion Flanges: For inlet and outlet duct connections.
2. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.4 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Available Manufacturers:

1. Carrier Corporation.
2. Chicago Blower Corporation.
3. Loren Cook Company.
4. New York Blower Company (The).
5. Trane.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

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- C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
 - 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 2. Spun inlet cone with flange.
 - 3. Outlet flange.
 - D. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades and fastened to shaft with set screws.
 - E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - F. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
 - 1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
 - G. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 1. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
 - H. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.2.
 - 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 6. Motor Mount: Adjustable for belt tensioning.
 - I. Accessories:
 - 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 - 2. Cleanout Door: gasketed door allowing access to fan scroll, of same material as housing.
 - 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 - 4. Companion Flanges: Rolled flanges for duct connections of same material as housing.

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5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
 6. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
 7. Inlet Screens: Grid screen of same material as housing.
 8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 9. Spark-Resistant Construction: AMCA 99.
 10. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 11. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- J. Motors: Comply with requirements in Division 15 Section "Motors."
1. Enclosure Type: Totally enclosed, fan cooled.

2.5 MOTORS

- A. Comply with requirements in Division 15 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.

2.6 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 15 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connection to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.5 DEMONSTRATION

Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15838-POWER VENTILATORS

SECTION 15855 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Louver face diffusers.
3. Adjustable bar registers and grilles.

B. Related Sections: Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 DEFINITIONS

A. Diffuser: Air distribution device where direction of air is controlled by face pattern. A separate damper located upstream of a diffuser is required for volume control.

B. Grille: Air distribution or collection device where face pattern is fixed (adjustable face grille where specifically indicated.) A separate damper located in the duct connected to the grille is required for volume control.

C. Register: Air distribution or collection device where direction and volume of air is controlled. Face pattern controls direction while an integral damper behind the face controls volume via a mechanical adjustment located on the face (generally required in a hard ceiling.)

1.3 SUBMITTALS

Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

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

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- a. Krueger.
 - b. Price Industries.
 - c. Titus.
 - d. Tuttle & Bailey.
2. Material: Steel.
 3. Finish: Baked enamel, white.
 4. Face Size: As indicated on air distribution schedule.
 5. Mounting: As indicated on air distribution schedule.
 6. Pattern: Adjustable.
- B. Louver Face Diffuser:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Krueger.
 - b. Price Industries.
 - c. Titus.
 - d. Tuttle & Bailey.
 2. Material: Steel.
 3. Finish: Baked enamel, white.
 4. Face Size: As indicated on air distribution schedule.
 5. Mounting: As indicated on air distribution schedule.
 6. Pattern: Adjustable core style.
 7. Accessories:
 - a. Square to round neck adaptor.

2.2 REGISTERS AND GRILLES

- A. Adjustable Bar Register:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Krueger.
 - b. Price Industries.
 - c. Titus.
 - d. Tuttle & Bailey.
 2. Material: Steel.
 3. Finish: Baked enamel, white.

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4. Core Construction: Removable.
 5. Frame: 1 inch wide.
 6. Mounting: As indicated on air-distribution schedule.
 7. Damper Type: Adjustable opposed blade.
- B. Adjustable Bar Grille:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Krueger.
 - b. Price Industries.
 - c. Titus.
 - d. Tuttle & Bailey.
 2. Material: Steel.
 3. Finish: Baked enamel, white.
 4. Core Construction: Removable.
 5. Mounting: As indicated on air-distribution schedule.

2.3 SOURCE QUALITY CONTROL

Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling

panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15855–DIFFUSERS, REGISTERS, AND GRILLES

SECTION 15870 – COMMERCIAL KITCHEN HOODS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes commercial kitchen hoods.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Standard hoods.
 - 2. Filters/baffles.
 - 3. Fire-suppression systems.
 - 4. Lighting fixtures.
 - 5. Wiring Diagrams: Power, signal and control wiring.
 - 6. Control panel terminal layout.
- B. Shop Drawing: Show dimensions of hood(s), manufacturer, model number, exhaust and supply, CFM, static pressure for head collars and UL lighting.
- C. Field quality-control test reports.

PART 2 - PRODUCTS

Refer to plans for details.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

3.2 INSTALLATION

- A. Complete field assembly of hoods where required.
 - 1. Make closed butt and contact joints that do not require filler.
 - 2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish.
- B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.
- C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.
- D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.
- E. Install hoods to operate free from vibration.
- F. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.
- G. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.
- H. Install lamps, with maximum recommended wattage, in equipment with integral lighting.
- I. Set initial temperatures, and calibrate sensors.
- J. Set field-adjustable switches.

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 with clearance to allow service and maintenance.
- C. Connect ducts according to requirements in Division 15 Section "Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquid-tight joint.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Tests and Inspections:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
4. Perform hood performance tests required by authorities having jurisdiction.
5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

Train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15870-COMMERCIAL KITCHEN HOODS

SECTION 15940 – SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. All set points indicated for devices shall be manually adjustable by end user.

1.2 ABBREVIATIONS

- A. DDC: Direct Digital Control
- B. Deg F: Degrees Fahrenheit

1.3 GENERAL REQUIREMENTS

- A. Provide all necessary components to accomplish the control sequences listed below.
- B. All wiring greater than 24 volts shall be installed by a licensed electrical contractor.
- C. All wiring, conduit, and ancillary components, regardless of voltage, shall adhere to the requirements of Division 16000. Installation methods shall also adhere to the requirements of Division 16000.

1.4 CONTROL SEQUENCES

- A. AIR HANDLING UNIT (AHU-1), CONDENSING UNIT (CU-1), OUTSIDE AIR UNIT (OSU-1), DUCT HEATERS (DH-1,2), INTERLOCKED EXHAUST FAN (EF-1)
 - 1. Occupied Mode:
 - 1. The air handling unit supply fan shall start and run continuously. A factory furnished 7-day programmable thermostat shall activate the condensing unit cooling compressor or electric duct heating as required to maintain the set points (initially 75°F cooling and 72°F heating.). The outside air unit supply fan shall also start and run continuously and the OSA damper shall open to its predetermined minimum position. The outside air unit shall activate its cooling compressor(s) or electric heating as required to deliver neutral air at the set points (initially 75°F cooling and 72°F heating.). The outside air unit controller shall override cooling set point and energize cooling for dehumidification to maintain the relative humidity set-point (initially 50%). Once in dehumidification, the unit's hot gas reheat valve shall cycle open and closed to prevent over cooling.
 - 2. Interlocked exhaust fan shall operate in the occupied mode.
 - 2. Unoccupied Mode:
 - 1. A factory furnished 7-day programmable thermostat shall cycle the AHU-1 supply fan and activate the condensing unit cooling compressor or duct heater electric heating as required to maintain the set points (initially 78°F cooling and 65°F heating.)
 - 2. The outside air unit shall not operate and its OSA damper shall remain closed.

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3. Interlocked exhaust fan shall not operate while the affected air handling unit is in the unoccupied mode.
 3. Smoke Mode:
 - Upon detection of products of combustion by smoke detector located in either the supply or return airstreams, the air handling unit and outside air unit supply fans shall shut down and the units shall cease operation.
- B. LABORATORY EXHAUST FAN (LEF-1)
1. Fan shall be controlled from an “H-O-A” selector switch. In “Hand” the fan shall start manually and run continuously. In “Off” the fans shall not operate. In “Auto” the fan shall start and run continuously anytime AHU-1 and OSU-1 are in the occupied mode (Default switch position is Auto).
- C. KITCHEN HOOD EXHAUST FAN (KEF-1)
1. Fan shall be controlled from a “On – Off” selector switch. In “On” the fan shall start and run continuously. In “Off” the fan shall not operate.
 2. In the event that the fire extinguishing system is activated, the fan KEF-1 shall override to run for an additional 5 minutes after the other systems are shut down.
 3. Kitchen exhaust fan shall have interlock to prevent activation while AHU-1 is in the unoccupied mode.
- D. VENTILATION EXHAUST FANS (EF-2,3,5-7)
- The fans shall be controlled from an “H-O-A” selector switch. In “Hand” the fans shall start manually and run continuously. In “Off” the fans shall not operate. In “Auto” a wall mounted thermostat shall cycle the fans as required to maintain the cooling set point (initially 80°F).
- E. EQUIPMENT ROOM VENTILATION (EF-2,3 and 2 SPEED EF-4)
- The fans shall be controlled from an “H-O-A” selector switches. In “Hand” the fans shall start manually and run continuously (at the high speed for EF-4). In “Off” the fans shall not operate. In “Auto” a wall mounted thermostat shall cycle the fans on and off (between low and high speed for EF-4) as required to maintain the cooling set point (initially 80°F). Fan EF-4 shall operate continuously at the low speed when high speed operation is not enabled by the thermostat.
- F. DUCTLESS SPLIT SYSTEM AND HEAT PUMP (DS-1,3, HP-1,2)
- The air handling unit supply fan shall start and run continuously. A factory furnished 7-day programmable thermostat shall activate the heat pump cooling compressor or electric heat pump heating as required to maintain the set points (initially 75°F cooling and 72°F heating.). For DS-3 and HP-2, if the heat pump cannot satisfy the heating set point, then the air handling unit auxiliary electric heater shall be energized to maintain the set point.
- G. DUCTLESS SPLIT SYSTEM AND CONDENSING UNIT (DS-2, CU-2)

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- The air handling unit supply fan shall start and run continuously. A factory furnished 7-day programmable thermostat shall activate the condensing unit cooling compressor as required to maintain the set point (initially 75°F cooling).

H. UNIT HEATER (EUH-1-4)

- A factory furnished stem mounted thermostat shall activate electric heating as required to maintain the heating set point (Initially 55°F).

PART 2 - PRODUCTS

N/A

PART 3 - EXECUTION

N/A

END OF SECTION 15940-SEQUENCE OF OPERATION

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

Section Includes Balancing Air Systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. TAB: Testing, adjusting, and balancing.
- C. TABB: Testing, Adjusting, and Balancing Bureau.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB reports.
- C. Sample report forms.
- D. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.
- B. Certify TAB field data reports and perform the following:

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1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- D. 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.

1.5 COORDINATION

- A. Notice: Provide seven (7) days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS

N/A

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment and sequences of controls.
- D. Examine equipment performance data including fan curves.
 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

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2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
 - E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
 - F. Examine test reports specified in individual system and equipment Sections.
 - G. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
 - H. Examine operating safety interlocks and controls on HVAC equipment.
 - I. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 1. Permanent electrical-power wiring is complete.
 2. Automatic temperature-control systems are operational.
 3. Equipment and duct access doors are securely closed.
 4. Balance and fire dampers are open.
 - 5.
 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 15 Section "Duct Accessories."

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3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 15 Section "HVAC Insulation."
- C. 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. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections and functioning.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - c. Report the cleanliness status of filters and the time static pressures are measured.
 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling,

full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

- B. Measure air outlets and inlets without making adjustments.
 - Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- C. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 PROCEDURES FOR HEAT PUMPS AND CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.

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2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- B. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.
 5. Refrigerant suction pressure and temperature.

3.9 TOLERANCES

Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.

3.10 REPORTING

Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate performance measuring and balancing. Recommend changes to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems. Include a table of contents indicating the items under each TAB.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.

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4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 14. Test conditions for fans performance forms including the following:
 - a. Settings for outdoor-, 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. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
- E. Air-Handling-Equipment Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
 - a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling-coil static-pressure differential in inches wg.
 - g. Heating-coil static-pressure differential in inches wg.
 - h. Outdoor airflow in cfm.
 - i. Return airflow in cfm.
 - j. Outdoor-air damper position.
 - k. Return-air damper position.
- F. 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.

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- 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. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-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. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig.
 - j. Refrigerant suction temperature in deg F.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.

-
- f. Voltage at each connection.
 - g. Amperage for each phase.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 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.

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- f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

J. Instrument Calibration Reports:

- Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.12 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - b. Verify that balancing devices are marked with final balance position.
 - c. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. Architect may randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded.
2. If 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."
3. 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.

- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

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1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 15950 – TESTING, ADJUSTING, AND BALANCING

SECTION 16
ELECTRICAL WORK

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SECTION 16

ELECTRICAL WORK

16.01 GENERAL PROVISIONS

a. General

(1) Work Included

Provide all materials, labor and equipment required to furnish and install a complete electrical system as indicated on plans and as specified herein. Electrical work includes but is not limited to the following:

- (a) Complete distribution system for lighting and power including necessary main switchboard, motor control centers, transformers, panelboards, motor starters, contactors, feeders, branch circuits, safety switches, lighting fixtures, control switches and receptacles.
- (b) Excavation, trenching and backfilling for conduit and/or cable.
- (c) Grounding.
- (d) Installation of standby diesel engine generator system including automatic transfer switch and remote annunciator at the Proposed Raw Water Intake. Installation of standby diesel engine generator system including automatic transfer switch and remote annunciator at the Proposed Treatment Facilities Building. The electrical sub-contractor shall be responsible for the complete installation and start up of standby generator system for proper operation under standby power. This includes the proper setup of all connected load control devices including main circuit breakers, solid state reduced voltage starters, variable frequency drives, etc.
- (e) Lightning protection system for Proposed Raw Water Intake Building, Treatment Facilities Building and Backwash Basin Building.
- (f) Surge protection devices.
- (g) Power, interlock and control wiring for equipment furnished under other Sections.

This includes, but is not limited to, heating, ventilation or exhaust fans and associated damper motors and air conditioning equipment. Install control components furnished under other Sections of these Specifications including, but not limited to controllers, relays, thermostats, etc. Wire and connect controls complete and in working order.

- (h) Conduit rough-in and wiring for all equipment furnished under other Sections.

This includes, but is not limited to, flow meters, transmitters, level transducers, float switches, solenoid valves, turbidimeters, PH monitors, chlorine analyzer, level sensors, scale indicators, chemical feed pumps, electric valves, variable frequency drives, filter press control panel and equipment, filter and clarifier control equipment, polymer control panel, clarifier control panel, telemetry panel and SCADA panel. Exact locations of outlets for equipment furnished under other Sections shall conform with manufacturer's rough-in plans.

Starters, alternators, power interlocks and control wiring for equipment furnished under other Sections unless otherwise noted on Plans.

Control components furnished under other sections for this equipment shall be installed under this Section. Wire and connect controls complete and in working order, in accordance with schematic diagrams on Plans and as recommended by control equipment manufacturer.

It shall be the responsibility of the electrical sub-contractor to review all of the final installation instructions and shop drawings from the equipment suppliers and adjust all installations accordingly. Provide a complete and fully functional installation and system.

- (h) Removal and relocation of equipment shown on Plans. Cooperate with the general and sub-contractors involved and follow the schedule of changeover.
- (i) Supply and installation of temporary wiring for construction power and lighting for the project, in compliance with Article 590 of the National Electrical Code.

(2) Related Work

The following work shall be furnished under other Sections of these Specifications.

- (a) Flashing of conduits into roofing and outside walls.
- (b) Concrete foundations, curbs and pads
- (c) Painting.
- (d) Cutting and patching.

(3) Definitions

Provide: As used shall mean "furnish, install and connect, and put in good working order."

Wiring: As used shall mean "wire and cable, installed in raceway with all required boxes, fittings, connectors, etc. complete.

Engineer: As used in various sections shall mean "Engineer of record whose seal is affixed to the Contract Specifications and/or Plans."

(4) Requirements of Regulatory Agencies

Equipment furnished shall be UL listed where such label is available. Installation shall conform to UL Standards where applicable.

Electrical work shall be installed in accordance with Plans and Specifications, edition of NEC in effect at project location, recommendations of NFPA, state and local electrical and building codes and special codes having jurisdiction over specific portions within complete installation. This includes, but is not limited to the following:

- (a) 2014 National Electrical Code.
- (b) 2013 Kentucky Building Code.
- (c) 2012 International Building Code.

In event of conflict between Plans, Specifications and such codes, Engineer shall be notified in writing prior to bid. A ruling shall then be made by Engineer in writing.

Obtain permits and certificates of approval from all authorities having jurisdiction over installation and pay all fees required.

b. Products

(No products specified under this Section.)

c. Execution

(1) Submittals

Refer to Section 1, Submittals (Shop Drawings) for general requirements of shop drawing submittals. **There shall be a separate submittal section or brochure for each product listed below with all sections or brochures submitted at the same time in one package.** In the event scheduling or other special circumstances requires the review of submittals for only a portion of the products listed hereinafter, the Engineer will review these independently submitted submittals; however, the independently reviewed submittal shall also be incorporated into the single package submittal described in this paragraph. First sheet in each product section or brochure shall summarize and list all components, manufacturer's name and catalog number. Submittals shall include but not be limited to the following:

1. Main switchboard.
2. Motor control centers including schematics.
3. Panelboards.
4. Automatic transfer switches.
5. Standby diesel engine generator systems.
6. Dry type transformers.
7. Motor starters.
8. Safety switches
9. Lighting contactors.
10. Time switches.
11. Wiring devices and plates.
12. Polyvinyl (PVC) coated rigid galvanized steel conduit and fittings.
13. Rigid galvanized steel conduit and fittings.
14. PVC conduit and fittings.
15. Conduit and device mounting support channels, fittings, and fasteners.
16. Hazardous location wiring devices and fittings.
17. Pullboxes and junction boxes
18. Wire and cable.
19. Low voltage shielded cable.
20. Grounding components.

21. Cable connectors and lugs.
 22. Insulating materials.
 23. Lighting fixtures and lamps.
 24. Lightning protection systems.
 25. Surge protection devices.
 26. Short circuit, protective device coordination and arc flash hazard analysis studies.
- (2) Submittals shall be checked by the electrical sub-contractor and evidence of such checking shall be indicated thereon. **SUBMITTALS NOT BEARING THE ELECTRICAL SUB-CONTRACTOR'S MARK OF ACCEPTANCE AND APPROVAL WILL NOT BE REVIEWED BY THE ENGINEER.** The electrical sub-contractor shall be completely responsible for the accuracy, completeness, compliance with Plans and Detailed Specifications, and compatibility of all submittals, the Engineer's approval notwithstanding.
- (3) Site Visit

Visit job site prior to bid date to determine actual conditions under which work shall be done, to familiarize oneself with project and to verify total scope of work required. Failure to do so shall not constitute reason for extra charge.

16.02 BASIC MATERIALS AND METHODS

a. General

(1) Quality Assurance

Qualifications of Manufacturer: Products used in work of this Section shall be produced by manufacturers regularly engaged in successful manufacture of similar items and with history acceptable to Engineer.

Qualifications of Installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in necessary crafts and who are completely familiar with specified requirements and methods needed for proper performance of work of this Section.

b. Products

(1) Substitutions

Where specifications list one or more manufacturers and do not include "or equal", furnish materials made by one of manufacturers listed. Where "or equal" is included, electrical sub-contractor may substitute equal

products by another manufacturer subject to approval by the Engineer.

Substitution must be approved by Engineer before purchase and/or installation. If unapproved materials are installed, work required to remove and replace unapproved items shall be done at electrical sub-contractor's expense.

c. Execution

(1) Installation

Electrical plans are diagrammatic and shall not be scaled for exact sizes or locations. They are not intended to disclose absolute or unconditional knowledge of actual field conditions. This Section covers installation or relocation of outlets and miscellaneous devices shown on the Plans. Any outlet or device may be installed or relocated a maximum of 10 feet in any direction from locations shown on the Plans without additional charge to the Owner.

All electrical equipment supports and conduit supports, anchors, bolts, locknuts, screws, washers, and mounting hardware including unistrut, angle iron, and structural members shall be Type 316 stainless steel.

All locknuts, hangers, straps, bolts, washer and mounting hardware for PVC coated rigid galvanized steel conduit shall be factory coated with plasti-bond compound to provide a minimum 40 mil thickness of protection.

Equipment shall be installed in accordance with manufacturer's recommendations.

Protect work and materials from damage by weather, entrance of water and dirt. Cap conduit during installation. Avoid damage to materials and equipment in place. Satisfactorily repair or remove and replace damaged work with new materials. Deliver equipment and materials to job site in original, unopened, labeled containers. Store ferrous materials to prevent rusting and finished materials and equipment to prevent staining and discoloring.

Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit and fixtures shall fit into available spaces in building and shall not be introduced into building at such times and manner as to cause damage to structure. Equipment requiring service shall be readily accessible.

(2) Testing and Equipment Servicing

Entire installation shall be free from improper grounds and short and open circuits. Make test on conductors as required before energizing circuit. Make test to insure that entire system is in proper operating condition, and that adjustments and apparatus setting of circuit breakers, fuses, control equipment and apparatus have been made. Correct defects discovered during tests.

Equipment shall be turned over to Owner in lubricated condition. Instruction on further lubrication shall be included in operating instructions.

At termination of work under this Section, furnish Engineer with three complete bound sets of equipment catalog sheets, manufacturer's specifications and service and operating instructions on equipment furnished under this Section. Instruct Owner on proper usage, care and maintenance of entire electrical system including all special systems or apparatus.

(3) Removal of Debris

Remove surplus materials and debris caused by, or incidental to, electrical work. Remove such debris at frequent intervals. Keep job clean during construction.

(4) Salvageable Materials

The electrical sub-contractor shall be solely responsible for the disposition of waste material. The Owner shall have rights to all salvageable material.

(5) Cutting and Patching

The electrical sub-contractor shall so organize and execute his work so as to avoid all unnecessary cutting and patching of building surfaces. Preparatory work, including accurate installation of sleeves, wall and floor openings and construction of equipment foundations and supports shall be coordinated with the building progress. Cutting, patching and repairs to damaged building surfaces, as a result of the installation, shall be provided without additional cost to the Owner.

Certain work of a general construction nature related to the work under this section of the specifications will be provided by the electrical sub-contractor and will include preparation of building surfaces at points of

raceway and duct penetrations, necessary masonry and concrete work, etc. The electrical sub-contractor shall be completely responsible for the correct dimensions and general scope of all general construction requirements related to his work. All corrections to such related work, determined to be improperly executed due to the negligence of the electrical sub-contractor shall be made at the electrical sub-contractor's expense.

(6) Identification of Wire and Cable

All abandoned power, control, and signal wire and cable shall be properly insulated, terminated, and tagged as "spare" with identification as to source and destination at all locations.

All proposed power, control, and signal wire and cable shall be properly terminated and consistently numbered in all junction and pullboxes, panels, devices, and all locations where wire and cable leave raceways.

(7) Identification of Equipment

Identify the following electrical equipment with laminated plastic nameplates, engraved with 1/4" high letters.

All nameplates shall be black and white letters except nameplates for emergency panelboards and transfer switches; which shall be red with white letters. Nameplates shall be attached to metal enclosure with two screws. Nameplates attached with adhesive are not acceptable.

- (a) Automatic transfer switches.
- (b) Main switchboard and feeder circuit breakers.
- (b) Motor control centers and each device in motor control center.
- (c) Panelboards.
- (d) Safety switches and disconnects.
- (e) Variable frequency drives.
- (f) Solid state reduced voltage motor starters.
- (g) Magnetic motor starters.
- (h) Dry type transformers.
- (i) Starters, variable frequency drives and control panels furnished under other sections of these specifications.

(8) Record Drawings

THE CONTRACTOR SHALL MAINTAIN ONE SET OF ELECTRICAL PRINTS ON SITE, MARKED TO SHOW ACTUAL AS CONSTRUCTED CONDITIONS AND INSTALLATIONS, PRINTS TO BE TURNED OVER TO

ENGINEER AFTER JOB IS COMPLETE. Installed location of all exterior buried conduit shall be accurately shown and referenced to above ground structures.

(9) Temporary Lighting and Power

Provide, maintain and remove after construction is completed, temporary lighting adequate for workman safety and temporary power for all trades including any 3 phase power required with a minimum as shown on the plans.

Provide and maintain barricade lighting where required to adequately protect Owner against liability for damage to public or personnel. All lamps used in barricade shall be 70 watt red installed in weatherproof socket with wire guard. All wiring shall be approved for weatherproof installation.

(10) Power Outages

Coordinate all power outages with Owner and submit for approval proposed schedule of work indicating extent, number and length of outages required to perform work. Include in bid cost of overtime labor required for power outage to occur after electrical sub-contractor's normal working hours.

(11) Other Materials

Work of this Section shall also include those items not specifically mentioned or described, but which are obviously necessary to conform to the design intent, applicable codes and to produce complete electrical system that functions properly. These materials shall be as selected by electrical sub-contractor but subject to approval of Engineer.

(12) Guarantee-Warranty

Guarantee work to be free from defects of materials and workmanship for a period of one year from date of final acceptance of all work. Repair and replace defective work and other work damaged thereby which becomes defective during term of Guarantee-Warranty. Furnish Owner with three written copies of Guarantee-Warranty.

16.03 CONDUIT

a. General

(1) Work Included

(a) Conduit

(b) Fittings

b. Products

(1) Conduit

(a) Polyvinyl chloride (PVC) coated rigid galvanized steel conduit with minimum 40 mil polyvinyl chloride (PVC) exterior coating and polyurethane interior coating: Robroy Industries plasti-bond REDH₂OT or equal.

(b) Rigid Galvanized Steel Conduit: Allied, Wheatland, Republic or equal.

(c) Flexible Steel Conduit (Greenfield): Triangle, Anaconda, International Metal Hose or equal.

(d) Liquidtight flexible metallic conduit (Sealtite): Triangle, Anaconda, International Metal Hose or equal.

(e) Rigid Non-Metallic (PVC) Conduit: Carlon, Schedule 80, extra heavy wall or equal.

(2) Conduit Fittings

(a) Galvanized Rigid Steel Couplings and Connectors: Raco, Thomas & Betts or equal.

(b) Bushings: Raco, Thomas & Betts or equal.

(c) Malleable Iron Straps and Hangers: Crouse Hinds, Appleton, Steel City or equal. Exposed: Robroy Industries Plasti-Bond REDH₂OT or equal.

(d) Group Pipe Supports: Unistrut, Kindorf or equal. **Refer to paragraph 2.C.(1) for material type.** PVC coated rigid conduit shall be supported by use of PVC coated unistrut and clamps.

(e) Expansion Fittings: O.Z. Type AX, Crouse-Hinds, Carlon or equal. Exposed: Robroy Industries Plasti-Bond REDH₂OT or equal.

- (f) PVC Coated Rigid Conduit Fittings: Robroy Industries Plasti-Bond REDH₂OT or equal.
- (g) Liquid-tight flexible metallic conduit fittings: Raco, Thomas & Betts or equal. PVC Coated Rigid: Robroy Industries Plasti-Bond REDH₂OT or equal.
- (h) Wall penetration seals: The pipe to wall penetration closures shall be “Link-Seal” as manufactured by Thunderline Corporation – Belleville, Mich. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members.

c. Execution

(1) Conduit

In general, conduit installation shall follow layout shown on Plans. However, this layout is diagrammatic only and where changes are necessary due to structural conditions, other apparatus or other causes, such changes shall be made without cost to Owner. Offsets in conduits are not indicated and must be furnished as required.

Use polyvinyl chloride (PVC) coated rigid galvanized steel conduit throughout except as noted herein.

Use only rigid galvanized steel conduit in all areas inside Proposed Raw Water Intake Building and inside Electrical/Mechanical Room, Lab and Office Areas of the Proposed Treatment Facilities Building. Use rigid galvanized steel conduit for turn-ups in these areas whether exposed or entering electrical equipment or other devices.

Use only polyvinyl chloride (PVC) coated rigid galvanized conduit for exposed turn-ups.

For underground installations or under concrete slabs resting on earth, use Schedule 80 PVC conduit. For exposed indoor conduit including

turn-ups through slabs and entering all electrical devices, use rigid galvanized steel conduit. For all conduit installed in or penetrating through concrete slabs or walls, use rigid galvanized steel conduit indoors and polyvinyl chloride (PVC) coated rigid galvanized steel conduit outdoors.

When PVC conduit is used, turn up with polyvinyl chloride (PVC) coated rigid galvanized elbows and provide equipment grounding conductor in accordance with NEC Article 250. **Where PVC conduit is used outside of building line, install in minimum three (3) inch concrete encasement.**

Underground conduit separation shall be maintained by use of PVC conduit spacers with horizontal and vertical locking at intervals of seven (7) feet maximum.

Use rigid galvanized steel factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs, which have more than two bends regardless of length.

Coat metallic conduit placed in fill below concrete or underground with two heavy coats of asphaltum. Recoat any damage to asphaltum coating prior to backfilling.

Support conduit and secure to forms when cast in concrete so that conduit will not be displaced during pouring of concrete. Stuff boxes and cork fittings to prevent entrance of water during concrete pouring and at other times during construction, prior to completion of conduit installation.

All conduit shall be concealed wherever possible. All devices shall be flush mounted where possible. Exposed conduit and device installations must be approved by the Engineer prior to rough-in.

Route exposed conduit at right angles or parallel to walls of building.

Use proper sized tools for bending. Do not heat conduit. Dents and flat spots will be rejected. Cut and thread conduit so ends will butt in couplings. Make threads no longer than necessary and ream pipe free of burrs.

Minimum conduit size 3/4" unless otherwise required by system.

Leave one #10 or equivalent nylon pull wire in empty conduits.

Use short pieces, approximately 2 feet of liquid-tight flexible metallic conduit to connect motors and other devices subject to motion and vibration. Use liquid-tight flexible metallic conduit where subject to water spray and installed outdoors. All liquid-tight flexible conduit fittings shall be metal type for rigid galvanized steel conduit installations and factory coated PVC, Robroy Industries Plasti-Bond REDH₂OT or equal for polyvinyl chloride (PVC) coated rigid conduit installations.

All exposed conduit shall be coated and painted to match walls and mounting surfaces.

(2) Conduit Fittings

PVC coated rigid galvanized steel conduit threads shall be painted with Fel-Pro at all fittings and where entering equipment. Exposed surfaces, such as bushings, ground conductor connections, etc., shall be coated with a Gaco-N-700 neoprene paint or "Glyptal," all irregular surfaces filled with Aconite filler to provide a smooth surface, and painted with Plasti-Bond paint to provide minimum 40 mil thickness.

All locknuts, hangers, straps, bolts, washers and mounting hardware for PVC coated rigid conduit shall be factory coated with plasti-bond compound to provide a minimum 40 mil thickness or protection.

Use factory polyvinyl chloride (PVC) coated cast metal corrosive resistant conduit fittings similar to "Condulets" and "Unilets" with threaded hubs for exposed boxes.

Support conduit vertically and horizontally by straps or hangers. Do not exceed these intervals as described in NEC Section 344.30 for rigid metal conduit and in NEC Section 352.30 for PVC.

Use factory PVC coated expansion fittings, properly bonded to assure ground continuity, across expansion joints in floors and ceilings. Use factory coated PVC hubs at conduit entrance into all pullboxes, junction boxes, devices in exposed areas where knockout installations occur.

When connections are made to motors or other equipment, not near walls or columns, provide vertical conduit, minimum 3/4", attached to floor with floor flange bring wiring out of conduit by means of conduit and flexible conduit extending to equipment junction box.

16.04 WIRE AND CABLE

a. General

(1) Work Included

Wire and Cable

b. Products

(1) Materials

Wire and cable shall be 600 volt by Anaconda, General Cable, Habirshaw, Okonite, Rome, Triangle, Southwire or equal unless otherwise noted on Plans.

For line voltage control wiring, use #14 type THHN/THWN copper by one of the manufacturers listed above. For low voltage control wiring, use type wiring recommended by equipment manufacturer.

Use stranded copper type THHN/THWN for branch circuit wiring #10 and smaller. No conductor for branch circuit wiring shall be smaller than #12.

Use stranded copper, type THHN/THWN for feeder and power circuits #8 and larger.

Fixture wire shall be in accordance with Article 402 of the National Electrical Code.

Provide color coded wire and with a different color for each phase and neutral and ground as follows: 120/208 volts circuits-phases A, B and C: black, red and blue respectively; neutral: white; ground: green; 277/480 volt circuits - phases A, B and C: brown, orange and yellow respectively; neutral gray; ground: green. Approved color tape is acceptable for feeders. Also provide color coded wire for control circuits.

Use Scotchlok or Ideal wire connectors for #14 through #18 conductors. Use Burndy or equivalent by T&B, compression connectors with crimp cover, type CC, for #6-600 MCM conductors.

Where branch circuits homeruns exceed 70' in length for 120 volt and 150' in length for 208 volt, No. 10 wire shall be used to first outlet.

c. Execution

(1) Installation

Complete conduit system before pulling any wire or cable. Only approved cable lubricants (such as soaptone) shall be used as necessary.

Conductors shall be continuous from outlet to outlet or to branch circuit overcurrent devices. Make splices only in junction boxes. Splices shall not be made in panelboards. Sufficient slack shall be left at terminations to make proper connections.

Connect No. 10 wire and smaller with Type R, 3M Scotchlock or Ideal 400 Series tapeless connectors or equal.

Connect No. 8 wire and larger with Lock-Tite type silicon bronze type connectors, T&B Series 35000 or 54000, or equal. Insulate connections of No. 8 wire and larger with 3M #33 or Scotch 33+ tape.

16.05 OUTLET AND JUNCTION BOXES

a. General

(1) Work Included

- (a) Outlet Boxes
- (b) Junction Boxes

b. Products

(1) Outlet Boxes, Junction Boxes, and Wireways

Outlet and junction boxes concealed in ceilings and walls shall be galvanized steel by National, Appleton, General Electric, Raco, Steel City or equal 1-1/2" deep minimum.

Outlet boxes for lighting, switches and receptacles in areas with exposed rigid galvanized steel conduit shall be cast metal condulets and unilets with threaded hubs, Type FS or FD.

Outlet boxes for lighting, switches and receptacles in areas with exposed PVC coated rigid galvanized steel conduit shall be factory polyvinyl chloride (PVC) coated cast metal condulets and unilets with threaded hubs.

Except as noted otherwise all junction boxes, pull boxes, and wireways shall be NEMA 4X corrosion resistant stainless steel.

c. Execution

(1) Outlet Boxes

Use galvanized steel for concealed boxes. All boxes shall be concealed wherever possible.) Use cast metal conduit fittings similar to "Condulets" and "Unilets" with threaded hubs, Type FS or FD for exposed boxes.

Outlet boxes shall be securely anchored, set true and plumb and no part of box or cover shall extend beyond finished wall or ceiling.

Select boxes according to intended use and type of outlet. Use minimum 4" diameter boxes for ceiling or wall mounted lighting fixtures. Use 4" square boxes to contain flush mounted outlets. Provide plaster or masonry rings for flush mounted outlets to conceal joint between box and wall finish material. Nongangable switch boxes may be used only for single gang switches.

Mount outlet boxes worked to nearest block course.

(2) Junction Boxes

Junction boxes shall be sized according to number of conductors in box or type of service to be provided. Minimum junction box size 4-11/16" square and 2-1/8" deep. Provide screw covers for junction boxes.

Use corrosion resistant NEMA 4X stainless steel with clamp covers for pull boxes. Size pull boxes according to the NEC.

All junction boxes shall be corrosion resistant, NEMA 4X stainless steel.

Provide pull box every 100' of conduit run or where excessive number of bends necessitates a box for ease of wire installation.

(3) Wireways

All wireways and wiring troughs shall be NEMA 4X corrosion resistant stainless steel.

16.06 WIRING DEVICES, PLATES AND CONTROL SWITCHES

a. General

(1) Work Included

- (a) Switches
- (b) Receptacles
- (c) Plates
- (d) Selector Switches
- (e) Pushbutton Switches

b. Products

(1) Materials

Wiring devices shall be Hubbell, Leviton or equal.

(2) Switches: Single pole 20 amp., 120/277 volt AC:

Single Pole	Hubbell #1221 or equal
Two Pole	Hubbell #1222 or equal
Three Way	Hubbell #1223 or equal

Install switches on lock side and clear of door frame a minimum of 3". Prior to rough-in, coordinate with Building Details on Plans to determine lockside of door.

(3) Time Switches: Paragon Electric Co., Inc. Electronic Time Control Series EC7000.

(4) Receptacles

General Purpose, Duplex, 20 Amp, 125 Volt: Hubbell #5362 or equal.

Corrosion Resistant, Duplex, 20 Amp, 125 Volt: Hubbell #53CM62 or equal.

Ground Fault Interrupter Receptacles, Duplex, 20 Amp, 125 Volt: Hubbell #GF5362 or equal.

Special Receptacles: As indicated.

(5) Manual Motor Starting Switches

Cutler Hammer MS Series or equal with thermal overload.

(6) Device Plates

Stainless Steel: Hubbell, Leviton or equal.

Use weatherproof polyvinyl chloride (PVC) factory coated covers for outside duplex receptacles: Robroy Industries #WLRD or #WLRS.

Provide properly designed plates and covers when devices are installed in exposed boxes or conduit fittings.

(7) Selector Switches

Selector switches shall be installed on the front of NEMA 4X enclosures as depicted on the Plans. Selector switches shall be Model CR 104 P heavy-duty, non-illuminating lever operated selector switches manufactured by General Electric Company, Cutler Hammer or approved equal.

(8) Pushbutton Switches

Pushbutton switches shall be heavy duty, oil-tight units installed in NEMA 4X enclosures as depicted on the plans. Pushbutton switches shall be Model CR 104 P manufactured by General Electric Company, Cutler Hammer or approved equal.

c. Execution

(1) Installation

Provide proper size outlet boxes for all wiring devices of types specified in outlet and junction box section of these specifications.

All receptacles installed outdoors shall be corrosion resistant.

16.07 MAIN SWITCHBOARD (MSB)

a. General

(1) Work Included

(a) Main Switchboard

b. Products

(1) General

Main switchboard, 277/480 volt, 3 phase, 4 wire shall be equal to free standing switchboard, Type POW-R-LINE C, as manufactured by Cutler Hammer, or equal by Square D Co. and in accordance with details shown on the drawings. The entire switchboard assembly shall be uniform in both height and depth. The switchboard assembly and components shall be designed, manufactured and tested in accordance with the latest applicable standards of the IEEE, ASA, NEMA and shall be U.L. labeled for service entrance equipment.

(2) Pull Section

Bottom feed pull section to house main lug section.

(3) Distribution Section

Distribution sections to house 3 pole distribution circuit breakers. Circuit breakers and sizes to be as required by schedules and details on the drawings. Branch circuit breakers shall be group mounted of the type and size scheduled on drawings. Circuit breaker spaces shall have all busbars, straps, braces, etc., necessary for accepting future circuit breakers. Each circuit breaker and space shall be provided with an engraved nameplate. All circuit breakers shall have "lock-off" provisions.

Feeder circuit breakers shall be equipped with ground fault and anti-single phase (under voltage/phase reversal) protection through shunt trip and all required control wiring. Provide additional set of relay contacts on phase monitor relay wired to terminal block to provide an alarm signal to the facilities control panel when single phase shunt trip occurs.

(4) Bussing

Switchboard bussing shall be full-rated, amperage rating as shown on drawings, horizontal phase and neutral with full rated ground bus. All bus bars shall be plated copper. All bus connections shall be made with hardened steel bolts and pressure (Belleville) washers. Busses shall be braced for 65,000 amperes "RMS" symmetrical.

(5) Metering

Provide electronic metering equivalent to Cutler-Hammer IQ300.

The electronic metering shall meet the accuracy portion of ANSI C12.16 Class 10 for revenue metering. All monitoring parameters shall be viewable at the display.

1. Metered values shall be as follows with accuracy in percent of full scale as indicated:

(a)	AC Phase Amperes	+/- 0.5%
(b)	AC Phase Voltage	+/- 0.5%
(c)	Watts	+/- 1.0%
(d)	VA	+/- 1.0%
(e)	Vars	+/- 1.0%
(f)	Power Factor	+/- 2.0%
(g)	Frequency	+/- 0.1%
(h)	Watthours	+/- 1.0%
(i)	Varhours	+/- 1.0%
(j)	VA hours	+/- 1.0%
(k)	Watt Demand with 10-, 15-, 20-, 25-, 30-, 45-, 60-minute interval.	
(l)	Voltage	minimum/maximum
(m)	Current	minimum/maximum
(n)	Power	minimum/maximum
(o)	Power Factor	minimum/maximum
(p)	Frequency	minimum/maximum
(q)	Peak Demand	

c. Execution

Install switchboard per manufacturer's detailed installation guidelines. All testing, startup, training and setup shall be performed by a factory trained manufacturer representative.

ALL REQUIRED OPERATIONAL DATA SETTINGS FOR THE MAIN SWITCHBOARD AND APPLICABLE FEEDER CIRCUIT BREAKERS SHALL BE CALCULATED AND PROVIDED BY THE MANUFACTURER'S APPLICATION ENGINEER. ALL SETTINGS ARE TO BE PROGRAMMED, SET AND CHECKED BY THE MANUFACTURER'S FIELD ENGINEER PRIOR TO STARTUP.

Provide lamicoïd nameplates for each circuit breaker in main switchboards.

16.08 PANELBOARDS

a. General

(1) Work Included

Provide all materials, labor and equipment required to furnish and install a complete electrical system as indicated on Plans and as specified herein.

b. Products

(1) Panelboards

120/208 or 277/480 volts, 3 phase, 4 wire as indicated on Plans: Cutler Hammer, Square D or approved equal.

Panelboards shall be factory assembled, dead front type with copper bus, lugs, finish trim and thermal-magnetic molded case circuit breakers of frame and trip ratings shown on the Plans.

Provide single door with spring latch lock. Key panel locks alike.

Circuit breakers shall be HACR rated as required.

277/480 volt AC, 3 phase, 4 wire S/N, Lighting and Appliance Panelboards shall be Cutler Hammer, Type POW-R-LINE, or equal by Square D, equipped with bolt-on thermal-magnetic circuit breakers. Breakers shall be 1, 2, or 3 pole with an integral crossbar to assure simultaneous opening of all poles in multipole circuit breakers. Bolt-on circuit breakers shall be able to be installed in same panelboard without requiring additional mounting hardware. Circuit breakers shall be rated 277 volts AC (single pole, 15-30 amperes) or 480Y/277 volts AC (2 and 3 pole, 15-200 amperes) with continuous current ratings as noted on the plans. Interrupting rating shall be 22,000 rms symmetrical amperes. Single pole 15 and 20 ampere circuit breakers shall carry the SWD marking and H.I.D. rating. Each panelboard shall be equipped with a bare uninsulated equipment grounding bar for use in terminating separate equipment grounding conductors. Panelboards shall be equipped with full or 200 percent neutral bars as scheduled.

120/208 volt AC, 3 phase, 4 wire S/N, Branch Circuit Panelboards shall be Cutler Hammer, Type POW-R-LINE, or equal by Square D, equipped with bolt on thermal-magnetic circuit breakers. Breakers shall be 1, 2 or 3 pole with integral crossbar to assure simultaneous opening of all poles in multipole circuit breakers. Bolt on circuit breakers shall be able to be installed in the same panelboard without requiring additional hardware. Circuit breakers shall be rated 120/240 volts AC single pole 15-50 ampere) or 240 volt AC (2 and 3 pole, 15-50 amperes) with continuous current ratings as noted on the plans. Interrupting rating shall be 10,000 RMS symmetrical amperes. Single pole 15 and 20 ampere circuit

breakers shall carry the SWD marking and H.I.D rating. Each panelboard shall be equipped with a bare uninsulated equipment grounding bar for use in terminating separate equipment grounding conductors. Panelboards shall be equipped with full or 200 percent neutral bars as scheduled.

c. Execution

(a) Panelboards

Provide typewritten directory cards listing location of circuit controlled. Insert with plastic cover into directory frame on door.

Provide arc flash marking for all switchboards, panelboards and control panels per NEC Article 110.16.

Provide identification indicating voltage, phase, device designation, source fed from and other required marking per NEC Article 110.21.

16.09 DISCONNECTS (MOTOR AND CIRCUIT)

a. General

(1) Work Included

- (a) Disconnects
- (b) Fuses

b. Products

(1) Disconnects (Motors and Circuits)

Switches shall be Cutler Hammer or Square D.

- (a) All switches shall have interlocking cover.
- (b) Use heavy duty type, quick make, quick break.
- (c) Provide NEMA 4X stainless steel, corrosion resistant enclosure for installations throughout except as noted herein and as shown on the Plans.
- (d) Fusible switches if indicated on plans shall be equipped with Class 'R' fuse kits.
- (e) Provide equipment ground lug in each switch.
- (f) All disconnect switches used in motor circuits controlled by solid state reduced voltage (SSRV) motor starters or variable frequency drives (VFD) shall be equipped with auxiliary contacts wired back to the respective SSRV or VFD control circuit.

(2) Fuses

In fusible safety switches provide Bussman fusetrons or equal, dual element, time delay fuses for motor loads and one time fuses for non-motor loads.

c. Execution

(1) Installation

Provide safety switches, enclosures and sizes as indicated on Plans.

16.10 TRANSFORMERS

a. General

(1) Work Included

Provide all materials, labor and equipment required to furnish and install a complete electrical system as indicated on Plans and as specified herein.

b. Products

(1) Dry Type Transformers

Transformers shall be manufactured by Cutler Hammer or Square D.

Transformers shall be 3 phase, 480 volts Delta to 208Y/120 volts as indicated on Plans, 150 degree C rise, Class H insulation. Provide standard taps.

Transformer sound levels shall be guaranteed by the manufacturer to be no greater than NEMA standard sound levels.

(2) Dry Type Transformers

Ceiling hung transformers shall be supported by 1/2" (minimum) 316 stainless steel rod hangers and braced per Seismic Requirements.

All floor mounted dry type transformers shall be installed on a minimum 4" high concrete pad.

Mounting of transformers on floor in damp or wet locations, and where exposed to possible flooding is prohibited.

Install transformers to provide working clearances required in NEC 110.26(A) and 450.

16.11 LIGHTING FIXTURES

a. Scope of Work

(1) Work Included

- (a) Fixtures
- (b) Lamps
- (c) Ballasts
- (d) Exterior Fixtures

(2) Submittals

Submit shop drawings and product data in accordance with this Section, Paragraph 1.

Submit performance data for luminaries.

Submit shop drawings and/or cut sheets for luminaries showing pertinent physical characteristics.

Submit samples of luminaries prior to final production at Engineer's request on any proposed fixture substitution.

b. General

(1) Acceptable Manufacturers

Provide fixtures as scheduled on Plans, or approved equal.

(2) Fixtures

All ballasts for 2' x 4' lay-in, industrial and strip type fluorescent fixtures shall be electronic type, equal to Advance, Mark V, G.E. or Jefferson. Ballast shall be Class "P", ETL-CBM approved and UL labeled. All ballasts shall have an "A" sound rating. All ballasts for outdoor installations shall be rated for low temperature conditions.

Ballast for all H.I.D. Luminaires shall be High Power Factor, equal to the product as manufactured by Advance, G.E. or Jefferson.

LED lighting fixtures shall be in accordance with IES, NFPA, UL listed shall be reduction of hazardous substances (ROHS) compliant with a minimum rated life of 50,000 hours per IE L70.

Lamps shall be Sylvania, Philips, G.E., or approved equal.

Provide 130 volt incandescent lamps by Sylvania, Philips or G.E.
Provide HID lamps by same manufacturers.

c. Execution

(1) General

Furnish, locate and install fixtures as indicated on Plans.

(2) Installation

Mount fixtures as called for in schedule on Plans.

Lighting fixtures shall be structurally supported.

Surface mounted fixtures shall be supported from building structural system by rods or rods and clamps or by fixture outlet box which in turn shall be supported by rods.

Receive, store, uncrate, install and lamp fixtures shown in schedule on Plans to be furnished by others.

Adjust lighting fixtures to illuminate intended area.

Wire incandescent or HID luminaries with medium base sockets with wire not smaller than No. 16 and mogul sockets with wire not smaller than No. 14, Type AF asbestos covered wire in accord with current edition of NEC.

Wire surface mounted fluorescent luminaries with Type THHN wire not smaller than No. 12 from outlet boxes to fixture and through fixture channels.

Locate no splice or tap within an arm or stem. Wire shall be continuous from splice in outlet box of building wiring system to lamp socket or ballast terminals.

16.12 SERVICE AND DISTRIBUTION SYSTEM AND GROUNDING

a. General

(1) Work Included

- (a) Service system
- (b) Distribution system
- (c) Grounding
- (d) Bonding to lightning protection system

b. Products

(1) Materials

Furnish service entrance conduit and cable and miscellaneous hardware required.

c. Execution

(1) Service and Distribution System

- (a) At the Proposed Raw Water Intake Building system secondary shall commence at pole mounted transformers and continue through service entrance rated automatic transfer switch, motor control center, transformers, panelboards, feeder circuits and branch circuits to wiring devices, appliances, apparatus and other utilization equipment.

Service shall be 277/480 volts, three phase, four wire, Wye from power company overhead transformers.

Metering will be provided by power company.

- (b) At the Proposed Treatment Facilities Building system primary shall commence at pole mounted switches and run underground to pad mounted transformer. System secondary shall run from pad mounted transformer secondary and continue through service entrance rated automatic transfer switch, main switchboard, motor control center, transformers, panelboards, feeder circuits and branch circuits to wiring devices, appliances, apparatus and other utilization equipment.

Service shall be 277/480 volts, three phase, four wire, Wye from power company pad mounted transformer.

Metering will be provided by power company.

(2) Grounding

Ground electrical system in accordance with Article 250, National Electrical Code local authorities having jurisdiction, and as indicated on the Plans.

Do not use flexible metal conduit and fittings as a grounding means. Pull a green wire in each piece of flexible and conduit and screw to conduit system with lugs at both ends.

Install green bonding jumpers in flush mounted receptacle ground terminal. Install green bonding jumpers between outlet box and wall bracket mounted lighting fixtures. Screw jumpers to fixture chassis with lugs.

Install code size green grounding conductors in all branch circuits feeding receptacles, motors or other permanently wired fixed equipment and all feeder circuits. Bond conductors to chassis of fixed equipment. All grounding conductors shall be bonded to multi-terminal ground bus at panelboard. Grouping of grounding conductors under a single lug is not acceptable.

Install a #4/0 bare copper conductor grounded to main metal water piping and concrete reinforcing steel.

Install a #4/0 bare copper conductor area grounding loop 3 feet minimum depth below finished grade, a #4/0 bare copper conductor to each building or structure lightning protection system and main service entrance grounding system and a #1/0 bare copper wire fence ground as shown on plans. Provide a 3/4" dia. X 10 ft. long copperweld ground rod cadwelded at each area ground loop tap point.

All separate grounding electrodes shall be bonded together to limit potential differences between them and between their associated wiring systems. This includes the power system and lightning protection system grounding electrodes.

16.13 MOTOR CONTROL CENTERS

a. General

(1) Scope

(a) The electrical sub-contractor shall furnish and install the motor control center including all hardware, mounting equipment, necessary fittings and accessories as specified herein and as shown on the contract drawings.

(2) Submittals-For Review/Approval

(a) The following information shall be submitted to the Engineer.

1. Complete shop drawings including schematics.

b. Products

(1) General

Motor Control Center shall be Cutler Hammer Type F2100 unless other manufacturer approved by addendum. Motor control center shall consist of vertical enclosed sections joined together to form rigid, free standing assembly. Construction of Motor Control Center shall meet requirements set forth by UL publication UL-845, NEMA publication number ICS-2-322 and the NEC.

(2) Enclosure

Motor Control Center enclosure types shall be in accordance with NEMA standards for Type 1 or 12 enclosures as indicated on the Plans.

(3) Service

Motor Control Center shall be suitable for operation for 277/480 volt, 3 phase, 4 wire, 60 HZ WYE service as shown on Plans.

Motor control center shall be suitable for connection to an available fault of RMS symmetrical amperes as shown on the Plans.

(4) Vertical Sections

Vertical sections shall support horizontal and vertical buses, combination starter units, covers and doors, and shall be designed to allow for easy rearrangement of units by purchaser.

Vertical sections shall have structural supporting members formed of a minimum of 13 gauge hot-rolled steel. All finished surfaces shall be blemish-free. Where needed reinforcement structural parts shall be of 10 gauge steel to provide a strong, rigid assembly.

Each section shall be 90" high and shall have 7 gauge steel, 3" high removable lifting angle and two 1-1/2" high base channels. Complete control center line-ups shall be divided into shipping splits no wider than approximately 60".

Lifting angle shall be provided on top of each shipping split and shall extend the entire width of shipping split. Lifting angles shall be designed to support the entire weight of MCC section. Base channels shall be provided with holes to permit bolting Motor Control Center(s) to the floor.

Entire assembly shall be constructed and packaged to withstand all stresses induced in transit and during installation.

Motor Control Centers shall be designed so that matching vertical sections of same current rating and manufacture can be added later at either end of line-up without use of transition sections, difficulty or undue expense.

Removable end closing plates shall be provided to close off openings on end of Motor Control Center line-up. A removable top plate shall be provided on each vertical section and shall be of one-piece construction for added convenience in cutting conduit holes.

Design shall allow use of standard conduit entrance area without significant sag or deformation of top plate.

Vertical sections shall be designed to accommodate plug-on units in front-of-board construction. Vertical sections housing plug-on units shall be 20" wide and shall be 21" deep. Wider sections will be permitted only for bolted connection type units not fitting the 20" wide sections.

Unit mounting area shall be divided into 1/2 space factor sections, each approximately 6". NEMA Size 1 and 2 combination starter units shall use only 1 space factor, or 12" of unit mounting space. Vertical sections shall allow for 6 space factors of unit mounting space. Removable blank plates shall cover all unused unit mounting spaces. Blank plates shall be flanged on all four sides and shall be mounted with captive screws.

Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in horizontal wireway so that no restriction is encountered in running wires from vertical to horizontal wireway. Wireways shall be in accordance with wireway sections contained in this document.

(5) Wireways

Horizontal wireways shall be provided in the top of each vertical section and shall be arranged to provide full length continuity throughout the entire assembly. Top horizontal wireway shall have a cross sectional area of not less than 20 square inches with openings between sections of not less than 11-1/2 square inches.

Covers for all wireways shall be equipped with captive type screws to prevent loss of hardware during installation. All wireways shall be isolated from the bus bars.

Vertical wire trough shall be located on the right-hand side of each vertical section and shall extend from top horizontal wireway to bottom of available unit mounting space. Each vertical wireway trough shall have a cross sectional area of not less than 19 square inches and shall be isolated from bus bars to guard against accidental contact.

Separately hinged door having captive type screws shall cover vertical wire trough to provide easy access to control wiring without disturbing control units.

Reusable wire ties shall be furnished in each vertical wire trough for purpose of grouping and securely holding wires in place for neat and orderly installation.

(6) Bus Bars

Continuous main three conductor horizontal bus and a fully rated horizontal neutral bus shall be provided over the full length of control center. When necessary, bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join bus whenever split has been made. All splice connections shall be made with at least two bolts and shall employ use of Belleville washers in connection. Horizontal bus bars shall be mounted edgewise and supported by insulated bus supports.

For distribution of power from main horizontal bus to each unit compartment, a three-phase vertical bus shall be provided. Vertical bus shall be firmly bolted to horizontal bus for permanent contact.

Main horizontal and vertical buses shall be made of copper and entire length shall be tin plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions.

Bus supports shall be formed on high strength glass reinforced alkylid material. Bus supports shall have generous surface clearances in the vertical plane to shed dust and maintain dielectric integrity. Bus supports and insulators shall be red to indicate proximity of energized bus parts.

Main horizontal bus rating shall be minimum as indicated on the plans. Vertical bus rating shall be a minimum as required for continuous load in each section (300 amp minimum). Neutral bus capacity shall be 50% of main horizontal bus. Bus bracing shall be a minimum of 65,000 amperes RMS symmetrical fault withstandability. Continuous current ratings shall be in accordance with temperature rise specifications set forth by UL, ANSI and NEMA Standards.

Copper ground lug shall be provided in each incoming line vertical section capable of accepting a #8 to 250 MCM cable. Horizontal copper ground bus shall be provided in each section of Motor Control Center. Horizontal ground bus shall run continuously throughout control center except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Ground bus shall be tin plated copper and have cross sectional area of equal to 28% of main horizontal bus cross sectional area. Horizontal ground bus shall be located at bottom of Motor Control Center.

(7) Bus Barriers

Insulated horizontal and vertical bus shall be furnished to reduce the hazard of accidental contact with bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental "flash over". Small, separate openings in vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars.

Bottom bus covers shall be provided below vertical bus to protect ends of bus from accidental contact with fish tapes or other items entering from bottom of enclosure.

(8) Units

Combination starter units shall consist of full voltage magnetic starters, molded case circuit breakers and auxiliary control devices as required and/or shown on user's one-line and elementary diagrams. All auxiliary equipment, except that which is specified for mounting on door, shall be mounted with compartment.

All units shall be provided with unit doors, unit support pans, unit saddles and unit disconnect operators as outlined in this Specification. Each unit compartment shall be enclosed and isolated from adjacent units, buses and wireways except for openings for conductor entrance into units.

Units shall be designed and constructed so that any fault will be localized within the compartment. All units shall be UL listed for a minimum of 65,000 amperes RMS symmetrical fault withstandability.

Plug-on combination starter units of same NEMA size and branch feeder units of same trip size shall be readily interchangeable with each other. It shall be possible to withdraw each plug-on unit to de-energized position with unit still being supported by structure. It shall be possible to lock unit in this position with one padlock.

Unit Plug-On:

- (a) For convenient unit connection to bus bars, unit plug-on contacts shall be provided on the following units:

For circuit breaker type units: full voltage starters; branch circuit units, 225 ampere and smaller.

- (b) Plug-on connection for each phase shall be of high quality two point connection and shall be designed to tighten around vertical bus bar during a heavy current surge. For trouble-free connections, plug-on fingers shall be silver plated and coated with compound to assure low resistance connection. Contact fingers shall be of floating and self-aligning design to allow solid seating onto vertical bus bars.

Unit Doors:

- (a) Each unit shall have a door securely mounted with rugged concealed-type hinges, which allow door to swing open a minimum of 112 degrees for ease of unit maintenance and withdrawal.
- (b) Doors shall be fastened to structure so that they remain in place when a unit is withdrawn and may be closed to cover unit space when unit has been temporarily removed. Doors shall be held closed with adaptive type screws, which engage self-aligning cage nuts. These screws shall provide at least two threads of engagement to hold doors closed under fault conditions.

- (c) Each unit door shall be interlocked with disconnect mechanism to prevent door from opening when unit is energized. Defeater mechanism shall be provided for defeating this interlock by authorized personnel. Removable door panels held with captive type screws shall be provided on starter unit doors for mounting push button, selector switches or pilot lights.
- (d) Blank door panels capable of accepting future pilot devices shall be furnished when pilot devices are not originally specified for starter units.
- (e) Each starter unit door shall house an external low-profile overload reset button for resetting overload relay in the event of tripping.

Unit Support Pan:

- (a) Each plug-on unit shall be supported and guided by tilt and lift-out removable pan so that unit rearrangement can be easily accomplished.
- (b) For easy unit installation and rearrangement, transfer of this unit support pan from one location to another shall be accomplished with ease after control unit and door have been removed.

Unit Saddles:

- (a) Each plug-on unit shall have a saddle of 14 gauge hot rolled steel designed and constructed to physically isolate the unit from the bus compartment and adjacent units. Saddles shall be equipped with captive, self-aligning mounting screws which shall hold the unit securely in place during shipment. Flanged edges shall be provided on each saddle to facilitate unit removal.

(9) Disconnect Operators

An external operator handle shall be supplied for each breaker. This mechanism shall be engaged with breaker at all times regardless of unit door position to prevent false circuit indication. Operator handle shall be color coded to display red in ON position and black in OFF position. Operator handle shall have a conventional up-down motion and designed so that down position will indicate unit is OFF. For added safety, it shall be possible to lock this handle in the OFF position with up to three padlocks.

Operator handle shall be interlocked with unit door to prevent switching unit to ON while unit door is open. Defeater mechanism shall be provided for purpose of defeating this interlock by deliberate act of electrician should he desire to observe operation of operator handle assembly or unit components.

(10) Magnetic Starters

Magnetic Starters equal to Cutler Hammer Type CEP7B shall be furnished in all combination starter units. Thermal overload relays on starters shall be solid state type with selector for either auto or manual reset. Overload heater units shall be provided in each starter unit.

(11) Solid State Reduced – Voltage Starters

Where shown on plans solid-state reduced-voltage starters shall be Cutler Hammer Type S811 with pump control software unless other manufacturer approved by addendum. The solid-state reduced voltage starter shall be UL and CSA listed in the motor control center, and consist of an SCR based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed. Heat sinks shall not be allowed in the MCC structure.

- (a) The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing.
- (b) The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV.
- (c) Units using triacs or SCR/diode combinations shall not be acceptable.
- (d) Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects.
- (e) The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits.

- (f) The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns.
- (g) The paralleling run bypass contactor shall energize when the motor reaches 90% of full speed and close/open under one (1) times motor current.
- (h) The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions.
- (i) The coil shall have a lifetime warranty.
- (j) Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad.
- (k) Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter.
- (l) Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad.
- (m) Starter shall be capable of either an electronic or mechanical reset after a fault.
- (n) Units using bimetal overload relays are not acceptable.
- (o) Overtemperature protection (on heat sink) shall be standard.
- (p) Starters shall provide protection against improper line-side phase rotation as standard. Starter will shut down if a line-side phase rotation other than A-B-C exists. This feature can be disabled via a DIP switch on the device keypad.
- (q) Starters shall provide protection against a phase loss or unbalance condition as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the device keypad.

- (r) Starter shall provide protection against a motor stall condition as standard. This feature can be disabled via a DIP switch on the device keypad.
- (s) Starter shall provide protection against a motor jam condition as standard. This feature can be disabled via a DIP switch on the device keypad.
- (t) Starter shall be provided with a form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).
- (u) The following control function adjustments on the device keypad are required:
- Selectable Torque Ramp Start or Current Limit Start
 - Adjustable Kick Start Time, 0-2 seconds
 - Adjustable Kick Start torque, 0-85%
 - Adjustable Ramp Start Time; 0.5-180 seconds
 - Adjustable Initial Starting Ramp Torque; 0-85%
 - Adjustable Smooth Stop Ramp Time; 0-60 seconds.
 - Initial timing for 200 HP High Service Pumps will be ramp up in 30 seconds and ramp down in 30 seconds.
- (v) The keypad operator interface shall be able to communicate to other devices and provide the following monitoring:
- Line Current
 - Line Voltage
 - Control Voltage
 - Thermal Memory
 - Pole Temperature
 - Device Temperature
 - Number of Starts
 - Current Fault
 - Fault History
- (w) Solid state reduced voltage starters shall be provided with a microprocessor based motor protection relay. Motor protection relay shall be Cutler Hammer MP3000 with universal RTD module unless other manufacturer approved by addendum.

- (x) Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues.
- (y) Maximum continuous operation shall be at 115% of continuous ampere rating.

Power factor correction capacitors for the Air Scour Blower motor shall be furnished along with the SSRV motor starter and installed in motor control center section. Capacitors to be energized by a properly sized 3 pole contactor once SSRV is at full speed. The motor manufacturer shall recommend and size power factor capacitors to improve the power factor to a minimum of 95.0 percent.

(12) Frequency Drives

Adjustable frequency drives shall be provided in MCC(s) where scheduled. Adjustable frequency drives shall be Cutler Hammer type Power XL GT1 for variable torque loads unless otherwise indicated on the drawings.

- (a) All controllers shall be combination type and shall include options as specified.
- (b) Drives for variable torque loads shall be rated a minimum of 110% overcurrent for one (1) minute.
- (c) Drives shall have identical keypads, control terminals and programmable parameters.
- (d) Drives shall be capable of providing 200% starting torque.
- (e) Drives over 150 HP shall be located next to the main section to reduce bus loading and heating.
- (f) Drives shall include two (2) analog inputs, six (6) programmable digital inputs, one (1) programmable digital output and one (1) programmable Form C relay.
- (g) Drives shall operate on an input voltage range of 380 – 480v +/- 10%. 460v rated drives are not acceptable.
- (h) Drives shall have communication cards capable of communication using Modbus RTU.

- (i) Provide HOA control on each drive. In Hand, operation shall be from the keypad on the front of the drive. In Auto, operation shall be across the Modbus RTU serial communication network.
- (j) Drives shall be capable of V/Hz and auto tuning sensorless vector control.
- (k) All drives supplied in Motor Control Centers shall include 1% line reactors and 1.5% load reactors.

(13) Circuit Breakers

Molded case circuit breakers equal to Cutler Hammer Series C shall be furnished in all starters and branch feeder units using circuit breakers. Individual feeder breakers shall have a minimum interrupting capacity of 42kAIC at rated voltage or as scheduled on the drawings.

(14) Control Relays

Industrial Control Relays equal to Cutler Hammer D7 shall be provided in the Motor Control Center to accomplish control functions as indicated on the Plans.

(15) Control Transformers

Provide control transformer for each starter unit for control circuit power. Control circuit transformer shall be provided with two fuses in primary and one fuse in the secondary circuit. Transformer shall be 480 volt single phase primary, 120 volt single phase secondary with volt amp capacity to provide control voltage power for each control circuit as required by the Plans and NEC 725.

(16) Identification

Control center identification nameplate with factory identification numbers and characteristics shall be fastened on vertical wire trough door of every section. Each control center unit shall have its own identification nameplate fastened to unit saddle, with suitable references to factory records for efficient communication with supplier. Each control center unit shall also have an engraved bakelite nameplate fastened to outside of unit door for ease in identification and for making changes when regrouping units.

(17) Wiring

Control center wiring shall be NEMA Class II, Type B.

As defined by NEMA Standard ISC-2-322, Class II control centers shall include necessary electrical interlocking and interwiring between units.

Type B wiring shall include terminal blocks mounted on lift out brackets in the units.

Terminal blocks shall be conventional track mounted solderless box lug type.

(18) Metering

Provide electronic metering equivalent to Cutler-Hammer IQ300.

The electronic metering shall meet the accuracy portion of ANSI C12.16 Class 10 for revenue metering. All monitoring parameters shall be viewable at the display.

Metered values shall be as follows with accuracy in percent of full scale as indicated:

(a)	AC Phase Amperes	+/- 0.5%
(b)	AC Phase Voltage	+/- 0.5%
(c)	Watts	+/- 1.0%
(d)	VA	+/- 1.0%
(e)	Vars	+/- 1.0%
(f)	Power Factor	+/- 2.0%
(g)	Frequency	+/- 0.1%
(h)	Watthours	+/- 1.0%
(i)	Varhours	+/- 1.0%
(j)	VA hours	+/- 1.0%
(k)	Watt Demand with 10-, 15-, 20-, 25-, 30-, 45-, 60-minute interval.	
(l)	Voltage	minimum/maximum
(r)	Current	minimum/maximum
(s)	Power	minimum/maximum
(t)	Power Factor	minimum/maximum
(u)	Frequency	minimum/maximum
(v)	Peak Demand	

(19) Finish

All metal structural and unit parts shall be completely painted using an electrode position process so that interior and exterior surfaces as well as bolted joints have complete finish coat on and between them. Basic process shall consist of using iron phosphate pretreatment for

improvement of paint adhesion and chromic acid rinse to increase salt spray life. Paint process shall consist of cleaning, rinsing, iron phosphating, chromic acid rinse, two prepaint rinses, painting, two post paint rinses, bake cure and cool down.

Paint shall be Acrylic-Melamine Electrode position Baked Enamel, No. 49 medium light gray per ANSI Z55, 1-1967. Removable push button operator plates, flange mounted operator handles and trim plates and top horizontal wire through cover plates shall be painted a contrasting light gray.

c. Execution

(1) Installation

Provide lamicoïd nameplates for each circuit breaker/starter or circuit breaker only in motor control center.

Provide all interlock and control wiring for motor starters in motor control center as indicated on Plans and as required for proper operation of equipment. Submit control diagrams for approval by Engineer for all motor control center starter controls.

Provide control components (including, but not limited to, start-stop pushbutton station, hand-off-automatic selector switches, relays, pilot lights, etc.), both those mounted in the starter and those remotely mounted as indicated on Plans if so indicated on Plans.

(2) Start-up and Field Service

ALL OPERATIONAL DATA AND SETTINGS FOR THE FEEDER CIRCUIT BREAKERS AND SOLID STATE REDUCED VOLTAGE MOTOR STARTERS, VARIABLE FREQUENCY DRIVES AND ASSOCIATED PROTECTION DEVICES SHALL BE CALCULATED AND PROVIDED BY THE MANUFACTURER'S APPLICATION ENGINEER BASED ON THE ACTUAL MOTOR AND LOAD REQUIREMENTS AND CHARACTERISTICS. THESE SETTINGS ARE TO BE PROGRAMMED, SET AND CHECKED BY THE MANUFACTURER'S FIELD ENGINEER PRIOR TO STARTUP. ALL STARTUP AND ADJUSTMENTS ARE TO BE PERFORMED BY THE MANUFACTURER'S FIELD ENGINEER.

The electrical sub-contractor shall take care in the installation of all equipment specified under this Sub-Section of these Detailed Specifications.

The manufacturer's field engineer or representative shall inspect and check the installation after erection and provide instruction and start-up service including but not limited to adjustment of any and all control functions and setting of all equipment to provide a complete and operable system. THE ELECTRICAL SUB-CONTRACTOR SHALL PROVIDE THE ENGINEER WITH COPIES OF THE MANUFACTURER'S REPRESENTATIVE FIELD SERVICE AND START-UP REPORT. FAILURE TO SUBMIT THIS INFORMATION WILL PREVENT PAYMENT FOR EQUIPMENT BEYOND NINETY (90) PERCENT OF THE EQUIPMENT COST.

16.14 LIGHTNING PROTECTION SYSTEM

a. General

(1) Work Included

(a) Lightning protection systems

(2) System Description

Furnish all labor, materials and service items required for completion of functional and unobtrusive system of air terminals, conductors, grounds and other components necessary for protection of the Proposed Raw Water Intake Building, Treatment Facilities Building and Backwash Basin Building against lightning damage as described herein and/or shown on the Plans.

(3) Submittals

Before starting any part of installation, electrical sub-contractor shall submit for approval of Engineer, seven (7) sets of layout plans of complete system, supplementing any Plans and Details shown on Plans.

b. Products

(1) Components

System shall be semi-concealed type with only air terminals and roof conductors visible, and shall comply in all respects with National Fire Protection Association Standard No. NFPA 78 and one of the following codes:

(a) Underwriters Laboratories, Inc. (UL) No. UL96A, or

(b) Lightning Protection Institute (LPI) No. LPI-175.

c. Execution

(1) Installation

The installing electrical sub-contractor shall be engaged actively in installation of approved lightning protection systems, and shall be so listed by UL or certified by LPI with a minimum of three years of experience in this work.

All materials used shall be in factory inspected and labeled by testing agency acceptable, to UL or LPI.

- (a) A conductor bend shall not form a sharper angle than 90 degrees or have a radius less than 8 inches.
- (b) Metal bodies of inductance located within 6 feet of a main lightning component shall be bonded to the lightning protection system. (Including but not limited to metal vents, flashing, louvers & roof drains.)
- (c) Connections to ground and/or counterpoise shall be made at a point not less than 2 feet below grade, and 3 feet to 8 feet away from foundation wall.
- (d) Air terminals shall be placed at the locations indicated, not more than 2 feet from the ends of ridges, outside corners, or outside edges of main roofs, and must extend a minimum of 10 inches above the object to be protected.
- (e) Mid-roof air terminals shall be spaced at 50 feet on center max. spacing.
- (f) Perimeter air terminals that are less than 24 inches in height shall be spaced at 20 feet on center max. Perimeter air terminals that are 24 inches in height or greater shall be spaced at 25 feet on center max.
- (g) Job conditions may dictate slight variations in air terminal and ground rod locations, but in no instance shall a variation break compliance with these notes and requirements.
- (h) Conductors shall maintain a horizontal or downward path free from “U” and “V” pockets. No rise in conductors shall occur.

- (i) Copper lightning protection materials shall not be placed on aluminum, galvalum, or bare galvanized steel surfaces. Aluminum materials shall not be placed on copper surfaces.
 - (j) Electric, telephone, antenna system and other miscellaneous grounds shall be connected with main sized conductor to any lightning protection ground.
 - (k) All adhesive fixtures shall be set with an adhesive compound compatible with the roofing material. Adhesives shall be approved in advance by the roofing contractor.
 - (l) Bond all metal pipes such as water, gas, fire, storm, sewer which enter the structure to the nearest downlead, ground rod or counterpoise.
 - (m) Cable must be fastened every 3 feet on center max.
 - (n) The lightning protection installer is to check and verify all dimensions and conditions before the work is started. Installers who fail to verify, review, and coordinate the work shall take full responsibility for the work and any portion of the work that is improperly installed or located. The installer shall notify the designer if dimensional errors or design conflicts occur and shall proceed only upon clarification or revision as issued by lightning protection system suppliers engineer.
 - (o) All lightning protection systems require properly installed surge protective devices as outlined in paragraph 13 of UL 96A.
 - (p) **Pictures need to be taken where bonds are going to be concealed or buried such as water, gas and electric bonds; ground rods; thru walls and thru roofs.**
 - (q) Lightning protection systems shall be installed in a neat, professional manner.
 - (r) When anchoring in masonry, holes made to receive the body of the anchor shall be made in the brick, stone, or other masonry unit rather than in mortar joints.
- (2) Master Label or LPI Certification

Upon completion of installation, electrical sub-contractor shall complete application for UL "Master Label" or "LPI Certification" and forward to

manufacturer for processing and completion before forwarding to UL or LPI.

16.15 TELEPHONE CONDUIT SYSTEM

a. Description of Work

- (1) Work included under this section shall consist of, but is not limited to, the furnishing of all labor, materials, equipment and related items required to place into service the telephone conduit system as specified herein and shown on the drawings.
- (2) Related work not included in these specifications:
 - (a) Furnishing and installation of telephone equipment and wiring.

b. Related Work Specified in Other Sections or Divisions

- (1) General Conditions of the contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this section.
- (2) Applicable requirements of Section 1 of the Detailed Specifications apply to the work specified in this section.

c. Electrical General Provisions

Comply with Basic Materials and Methods-General.

d. Products

(1) General

Comply with Basic Materials and Methods-Products (Part a).

e. Execution

- (1) Furnish and install a conduit system for the telephone installation as shown on the drawings. Conduit system shall include all outlet boxes, conduits, and covers.
- (2) The quantity and location of telephone outlets shall be as noted on the drawings.

- (3) The telephone company or independent supplier will furnish and install all telephone operating equipment, wiring, and terminating boards as required to place the system into operation.
- (4) The telephone conduit system shall include an empty 3/4-inch conduit system, unless otherwise noted from individual phone outlets to the telephone service junction box.
- (5) Outlet boxes shall have cover plate matching the other wiring devices in the room as specified earlier.
- (6) Pulling wires shall be installed and left in all telephone conduits.
- (7) Electrical sub-contractor shall coordinate with the telephone system supplier in routing all conduits, raceways, etc., as required to facilitate the installation of their equipment. Coordinate with the telephone system supplier for specific information prior to roughing-in.

16.16 STANDBY DIESEL ENGINE GENERATOR SYSTEMS

a. General

(1) Scope

Under this section of Specifications, Contractor shall furnish and install a diesel engine driven generator designed for outdoor installation adjacent to the Raw Water Intake Building and Treatment Facilities Building. Systems shall consist of:

- (a) Diesel engine driven electric generating set to provide standby power.
- (b) Automatic load transfer control to provide automatic starting and stopping.
- (c) Mounted accessories as specified.

(2) Rating

At the Proposed Treatment Facilities Building diesel engine generating set shall be rated for 800 kW at 0.80 power factor, 1,000 KVA standby service. Set output shall be at voltage, phase and frequency shown on Plans.

At the Proposed Raw Water Intake Building diesel engine generating set shall be rated for 150 kW at 0.80 power factor, 187.5 KVA standby

service. Set output shall be at voltage, phase and frequency shown on Plans.

Power plant shall be standard product of Caterpillar or approved equal conforming to these Specifications and rated not less than specified. Generator set shall be factory assembled.

(3) Submittals

Shop plans for standby power plant shall contain not less than the information listed as follows:

- (a) **Certification that power plant furnished will serve electrical loads indicated including motor starting loads with type of starting indicated.**
- (b) Continuous and standby rating of plant including voltage and phase.
- (c) Frequency and voltage regulation with maximum instantaneous voltage dip and time of recovery to stable operation.
- (d) Output voltage adjustment range in percentage of rated plant voltage.
- (e) Alternator type and method of connection to prime mover.
- (f) Components contained in alternator instrument panel.
- (g) Rating of engine at operating speed, engine cycle and number of cylinders.
- (h) Type of engine lubrication system and verification of components.
- (i) Type of engine governor.
- (j) Fuel consumption at rated load.
- (k) Verification that all accessories specified is to be provided. This includes day tank with capacity indicated, cold weather starting aid with rating and voltage indicated, exhaust system with muffler type indicated, outdoor housing with verification of space available within housing for batteries and day tank.
- (l) Starting batteries including ampere hour rating.

(4) Regulatory Requirements

Conform to latest edition of NEC and applicable inspection authority.

Generator manufactured to NEMA standards.

b. Products

(1) Engine

Engine shall be diesel-fueled, turbocharged, water cooled with unit mounted 122 degrees Fahrenheit radiator, fan and water pump. At 1800 RPM, engine shall develop not less than horsepower indicated on schedule on drawings.

Full pressure lubrication shall be provided by lube oil pump. Engine shall have an air cleaner and oil filter with replaceable elements, a lube oil cooler, fuel filters and carburetor replaceable air cleaner and automatic choke. Radiator shall be 122 degrees Fahrenheit high ambient rated.

Engine speed shall be governed by electronic governor to maintain alternator frequency within 0.25 Hertz from no load to full load alternator output. Engine shall have a 24 volt D.C. battery charging alternator and voltage regulator. Remote starting shall be 24 volt electric starter.

Power plant shall contain engine start-stop controls and cranking limiter to cycle engine starting circuit for 15 second intervals with 5 seconds between starts and shall open engine starting circuit in 90 seconds if engine is not started within that time. Engine control panel shall contain solid state engine monitor with individual fault pilot lamps and shut down for overcrank, over speed, high engine temperature and low oil pressure per NFPA 110.

(2) Alternator

Alternator shall be 125 degrees C. rise four pole revolving field design, three phase with temperature compensated solid state voltage regulator and brushless rectifier exciter system.

Stator shall be directly connected to engine flywheel housing. Rotor shall be driven through a semi-flexible driving flange. Alternator insulation shall be Class F.

Frequency regulation shall not exceed 0.25 Hz. Voltage regulation shall be within plus or minus 0.5% of rated voltage. Following application of full load via transfer switch to generator set, RMS voltage determined on symmetrical basis for each complete cycle starting at first zero crossing after load application through 6th cycle must not drop below 65% of RMS voltage prior to application of load. RMS voltage starting at seventh cycle from first zero crossing after load application shall be sustained at no less than 90% of RMS voltage before load application. This voltage must be maintainable for a period of at least 30 seconds without tripping overcurrent devices in generator or causing overheating of any component beyond its design limits. Recovery to stable operation shall be within two seconds. Rheostat shall be provided to allow adjustment of rated voltage through +5%.

(3) Engine-Generator Set Control

The generator set shall be provided with a microprocessor-based control system, which is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification. The control shall be mounted at the location shown on the project drawings for medium voltage applications, and on the generator set for 600 volt and lower applications. When mounted on the generator set the control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. **The control shall be mounted at a maximum height of 5 feet 6 inches above concrete pad or access platform/walkway for operator viewing per NFPA 110.** The control shall be UL508 labeled, CSA282-M1989 certified, and meets IEC8528 part 4. All switches, lamps, and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance. The generator set mounted control shall include the following features and functions:

- (a) Three position control switch labeled RUN/OFF/AUTO.

In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to

accept a signal from a remote device to start and accelerate to rated speed and voltage.

- (b) Red "mushroom-head" push-button EMERGENCY STOP switch.

Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

- (c) Push-button RESET switch.

The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

- (d) Push-button PANEL LAMP switch.

Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

- (e) Generator Set Metering:

The generator set shall be provided with a metering set with the following features and functions:

2.5 inch, 90 degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (kW) meters. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and kW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.

Digital metering set, 0.5% accuracy, RMS type, to indicate generator voltage, frequency, output current, output kW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.

(f) Generator Set Alarm and Status Indication:

The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:

- low oil pressure (alarm)
- low oil pressure (shutdown)
- oil pressure sender failure (alarm)
- low engine temperature (alarm)
- high engine temperature (alarm)
- high engine temperature (shutdown)
- engine temperature sender failure (alarm)
- low coolant level (alarm or shutdown-selectable)
- fail to crank (shutdown)
- overcrank (shutdown)
- overspeed (shutdown)
- low DC voltage (alarm)
- high DC voltage (alarm)
- weak battery (alarm)
- low fuel-daytank (alarm)
- high AC voltage (shutdown)
- low AC voltage (shutdown)
- under frequency (shutdown)
- over current (warning)
- over current (shutdown)
- short circuit (shutdown)
- ground fault (alarm)(optional-when required by code or specified)
- over load (alarm)
- under frequency (alarm)

In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

(g) Engine Status Information:

The following information shall be available from a digital status panel on the generator set control:

engine oil pressure (psi or kPA)
engine coolant temperature (degrees F or C; Both left and right bank temperature shall be indicated on V-block engines.)
engine oil temperature (degrees F or C)
engine speed (rpm)
number of hours of operation (hours)
number of start attempts
battery voltage (DC volts)

(h) Control Functions

The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 5 seconds each, with 15 second rest period between cranking periods.

The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

The control system shall include sender failure monitoring logic, which is capable of discriminating between failed sender or wiring components and an actual failure conditions.

(i) Alternator Control Functions:

The generator set shall include an automatic voltage regulator. The voltage regulator shall be immune from misoperation due to load-induced voltage waveform distortion. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include a torque-

matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. The regulator shall include provisions reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 5 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.

Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

An AC over/under voltage monitoring system shall be provided which initiates shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or instantaneously when voltage exceeds 130%. Under voltage shall be indicated when the output voltage of the alternator is less than 85% for more than 10 seconds.

A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25 VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

When required by National Electrical Code or indicated on project drawings, the control system shall include a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps, and include adjustable time delay of 0-1.0 seconds. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay, which will function correctly in system as installed.

(j) Control Interfaces for Remote Monitoring:

All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:

A Customer Interface Module (CIM) shall be provided to translate alarm, fault, and status conditions to a set of relay contacts. Contacts shall represent conditions of:

- EMCP diagnostic fault system not in automatic alarm
- High coolant temperature alarm
- Low coolant temperature alarm
- Low oil pressure alarm
- Low oil pressure fault
- High coolant temperature fault
- Overcrank fault
- Overspeed fault

Form "C": dry common alarm contact set to indicate existence of any alarm or shutdown condition on the generator set.

A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

The control shall be provided with provisions for connection of remote monitoring equipment as described herein or shown on the drawings.

(4) Remote Annunciator Panel

Provide generator remote annunciator panel Caterpillar #EMCP3 or equal to be located as shown on the plans.

(5) Main Line Circuit Breaker

Type: A main-line, molded case circuit breaker mounted upon and sized to the output of the generator shall be installed as load circuit interrupting and protection device. It shall operate both manually for

normal switching functions and automatically during overload and short circuit conditions.

The circuit breaker shall be mounted at a height not exceeding 6 feet 7 inches above the concrete pad or working platform per NEC Article 380.8. This height is to include sub-base fuel tank if applicable. Provide access steps and working platform as required for accessibility.

(6) Coolant Heater

Provide a 3000 watt, 208 volts, A.C., 1 phase heater, thermostatically controlled in engine coolant system as cold weather starting aid.

Electric heater shall be permanently connected to circuit extended from building electrical system.

(7) Antifreeze

Provide antifreeze to protect coolant to -35 degrees F.

(8) Starting Battery

Wet cell batteries, lead-acid type shall be provided with stand-by power plant. Batteries shall be selected for starting requirements of stand-by power plant and shall be rack mounted within plant housing. Batteries shall be permanently connected to two step battery charger.

(9) Muffler

Provide residential rated muffler complete with raincap and supports, installed inside weatherproof housing.

(10) Battery Charger

Provide a ten (10) amp voltage regulated battery charger for engine starting battery. Charger shall be equipped with float, taper, and equalize charge settings. Charger shall automatically taper amps to zero when battery approaches full charge.

(11) Housing

Stand-by power plant shall be provided in outdoor, weatherproof housing with removable panels for access to equipment. Starting batteries shall be rack mounted within housing.

(12) Access Platform/Walkway

Stand-by power plant shall be provided with a dual walkaround platform/walkway equal to Tramont Option No. KMWA with required steps, handrails and all accessories required to meet the standards of OSHA 3124 and 1910.24 to allow readily observation of the control panel per NFPA 110. The platform shall provide for operator/maintenance personnel viewing of the engine-generator set control and monitoring panel at a maximum height of 5 feet 6 inches above platform or concrete pad. The platform shall be designed shall be designed to allow opening and closing of outward swinging doors while standing on the platform. The access platform/walkway shall be equivalent to that manufactured by Tramont KM Walkway, Milwaukee, WI.

(13) Fuel Tank

Fuel tank shall be a skid base mounted double wall tank with minimum capacity to provide 48 hours operation at full diesel engine-generator set capacity. Fuel tank shall be equipped with a fuel leak detector.

The fuel tank shall be designed and constructed to prevent the collection and standing of water on top of the tank.

Provide single pole, double throw low level alarm switch that senses the fuel level by pressure changes. When activated, circuit shall sound alarm at remote annunciator. Provide fuel level gauge on skid base mounted tank.

At completion and final acceptance of installation, Contractor shall fill fuel tank to full capacity with No. 2 diesel fuel.

(14) Venting and Piping

Venting for fuel tank and piping between engine, fuel tank, levelometer, fuel pumps, etc. shall be furnished and installed in accordance with NFPA Standard 37.

c. Execution

(1) Stand-by Electric Power System

Performance of plant shall be certified in writing, with respect to full power rating, voltage and frequency regulation and motor starting capability. Certifications shall be submitted with submittal.

Plant shall be provided with spring type, vibration isolators and mounted on a welded steel base. Plant shall be anchored to concrete base per manufacturer's recommendations.

Install standby generator in accordance with manufacturer's recommendations.

(2) Testing

The actual performance of each unit shall be certified in writing, with respect to full power rating, voltage and frequency regulation and motor starting capability.

On completion of installation, start-up shall be performed by the engine manufacturer's trained service representative.

Prior to acceptance of installation, equipment shall be tested for any defects and will start automatically and be subjected to full load test through the use of portable dry type load banks supplied for this purpose at job site by generator set supplied.

Load bank test shall be witnessed by project Engineer, Project Inspector or designated representative and generator set installation approved prior to acceptance. Load bank test shall be scheduled two (2) weeks in advance to confirm day and time of test.

Operating and maintenance instruction manuals shall be supplied and procedures explained to operating personnel.

The Contractor shall be responsible for the complete installation and start-up of standby generator system for proper operation under standby power. This includes the proper setup of all connected load control devices including automatic transfer switch, circuit breakers, variable frequency drives, etc.

(3) Warranty

Equipment furnished under this Section shall be guaranteed against defective parts and workmanship under terms of manufacturer's and dealer's standard five (5) year comprehensive warranty.

16.17 AUTOMATIC LOAD TRANSFER SWITCH (SERVICE ENTRANCE RATED)

a. General

Amperage rating and NEMA enclosure type of automatic load transfer switch shall be as indicated on plans.

b. Products

- (1) Automatic transfer switch shall be service entrance rated with overcurrent protection on both sources. Lugs shall be suitable for wire size specified.
- (2) Automatic transfer switches shall be mechanically held on both standby and normal side and rated for continuous duty in an unventilated enclosure. Switch shall be double throw with main contacts rigidly and mechanically interlocked to insure only two possible positions: Normal or Standby. Manual operator must be provided to enable manual operation.
- (3) Transfer switches shall be listed under UL 1008. Switches utilizing reversing contactor mechanism as means to transfer load are disallowed and will not be considered.
- (4) Accessories For Transfer Switches: The automatic load transfer switch shall include the following accessories:
 - (a) Engine starting contacts to provide for generator starting.
 - (b) Full phase protection: Three phase relays shall be field adjustable, close differential type with 95-95% pickup and 82-85% drop out. Relays are to be connected across live lines.
 - (c) Test switch, to simulate power outage.
 - (d) Adjustable time delay (1-300 seconds) on transfer switch so designated on Plans only for delayed automatic transfer of load to generator.
 - (e) Adjustable time delay on retransfer to load to normal with five minute cooldown timer wherein generator set runs unloaded after transfer to line.
 - (f) Programmed transition controls for transfer and retransfer of load connection.

- (g) Plant exerciser to start and run generator set each 168 hours for a 30 minute interval.
- (h) One auxiliary contact closed and one auxiliary contact open on emergency.
- (i) Pilot lights to indicate normal and standby position of transfer switch.
- (j) Isolated (ungrounded) neutral bar.
- (k) Disconnect plug.
- (l) Automatic transfer switch shall be Cutler Hammer type ATV Series or approved equal.

c. Execution

(1) Factory Testing

- (a) Each switch shall be factory tested in accordance with UL and NEMA standards. In addition the manufacturer shall perform the following tests:
 - 1. Insulation check to ensure the integrity of insulation and continuity of the entire system.
 - 2. Visual inspection to ensure that the switch matches the specification requirements and to verify that the fit and finish meet quality standards.
 - 3. Mechanical tests to confirm compatibility of the switch's logic and power sections and to verify that they are free of mechanical hindrances. Switches shall be cycled through a minimum of 50 operations by alternately removing normal and emergency power sources.
 - 4. Electrical tests to verify the complete electrical operation of the switch and to set up the time delays and voltage sensing settings of the logic.

(2) Installation

- (a) Installation of all switches shall be in accordance with all applicable codes, standards, and practices as well as in accordance with the recommendations of the manufacturer.
- (b) The contractor's field wiring terminating within the enclosure shall comply with NFPA 70. If wiring is not color coded, wires

shall be permanently marked near the terminal at each end with the wire number shown on the approved shop drawings.

- (c) The contractor shall supply grounding lugs as required to meet with the local inspection and applicable codes.
- (3) Start-up and Field Service
- (a) ALL OPERATIONAL DATA AND SETTINGS FOR THE AUTOMATIC TRANSFER SWITCH AND ASSOCIATED PROTECTION DEVICES SHALL BE CALCULATED AND PROVIDED BY THE MANUFACTURER'S APPLICATION ENGINEER. THESE SETTINGS ARE TO BE PROGRAMMED, SET AND CHECKED BY THE MANUFACTURER'S FIELD ENGINEER PRIOR TO STARTUP. ALL STARTUP AND ADJUSTMENTS ARE TO BE PERFORMED BY THE MANUFACTURER'S FIELD ENGINEER.
 - (b) The Contractor shall take care in the installation of all equipment specified under this Sub-Section of these Detailed Specifications.
 - (c) The manufacturer's field engineer or representative shall inspect and check the installation after erection and provide instruction and start-up service including but not limited to adjustment of any and all control functions and setting of all equipment to provide a complete and operable system. THE CONTRACTOR SHALL PROVIDE THE ENGINEER WITH COPIES OF THE MANUFACTURER'S REPRESENTATIVE FIELD SERVICE AND START-UP REPORT. FAILURE TO SUBMIT THIS INFORMATION WILL PREVENT PAYMENT FOR EQUIPMENT BEYOND NINETY (90) PERCENT OF THE EQUIPMENT COST.
 - (d) The contractor shall field adjust all timing and voltage settings of the transfer switch as necessary for proper operation of the unit.

16.18. SHORT-CIRCUIT/COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

a. General

(1) Scope

- (a) The electrical sub-contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer. Studies shall be prepared for

each electrical service and distribution system. **A study shall be provided for the Proposed Treatment Facilities and Raw Water Intake electrical distribution systems.**

- (b) The electrical sub-contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

(2) Related Sections

(3) References

- (a) Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

- (b) American National Standards Institute (ANSI):

- ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
- ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
- ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

- ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents
- (c) The National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code, latest edition
 2. NFPA 70E – Standard for Electrical Safety in the workplace
- (4) Submittals For Review/Approval
- (a) The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
- (5) Submittals For Construction
- (a) The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report.
- (b) THE REPORT SHALL INCLUDE THE FOLLOWING SECTIONS:
1. One-line diagram
 2. Descriptions, purpose, basis and scope of the study
 3. Tabulations of the worst-case calculated short circuit duties for each applied device rating (automatic transfer switches, circuit breakers, fuses, etc.);
 4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
 5. Fault study input data, case descriptions, and current calculations
 6. Incident energy and flash protection boundary calculations
 7. Comments and recommendations for system improvements, where needed
 8. Executive Summary including source of information and assumptions made

(6) Qualifications

- (a) The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

b. Studies

(1) General

- (a) The short circuit and coordination study shall begin with the utility company's transformer and feeder protective device and include all of the electrical protective devices down to and include the service entrance rated automatic transfer switches, switchboards, motor control centers, distribution panelboards, step-down transformers, branch circuit panelboards, feeder circuit breakers and all motor controlling devices. The study shall also include power factor correction equipment, solid state reduced voltage starters and all equipment associated with the standby generator systems. This shall include all applicable switchgear, motor starters, variable frequency drives, generator and distribution equipment whether or not furnished by the electrical sub-contractor.
- (b) The electrical sub-contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

(2) Data Collection

- (a) Electrical sub-contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the electrical sub-contractor with a listing of required data immediately after award of the contract. The electrical sub-contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- (b) Source combination may include present and future utility supplies, motors, and generators.
- (c) Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or electrical sub-contractor.

- (d) Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The electrical sub-contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
- (3) Short-Circuit and Protective Device Evaluation Study
- (a) Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.
 - (b) Transformer design impedances and standard X/R ratios shall be used when test values are not available.
 - (c) Provide the following:
 - 1. Calculation methods and assumptions
 - 2. Selected base per unit quantities
 - 3. One-line diagram of the system being evaluated
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics
 - 5. Typical calculations
 - 6. Tabulations of calculated quantities
 - 7. Results, conclusions, and recommendations
 - (d) Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point
 - 2. Incoming switchgear
 - 3. Low voltage switchgear
 - 4. Motor control centers
 - 5. Standby generators and automatic transfer switches
 - 6. Branch circuit panelboards
 - 7. Other significant locations throughout the system
 - (e) For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
 - (f) Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
 - 3. Adequacy of transformer windings to withstand short-circuit stresses

4. Cable and busway sizes for ability to withstand short-circuit heating
5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

(4) Protective Device Coordination Study

- (a) Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- (b) Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- (c) Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- (d) Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- (e) Plot the following characteristics on the curve sheets, where applicable:
 1. Electric utility's protective device
 2. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 3. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 4. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 5. Conductor damage curves
 6. Ground fault protective devices, as applicable
 7. Pertinent motor starting characteristics and motor damage points
 8. Pertinent generator short-circuit decrement curve and generator damage point
 9. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center
- (f) Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

(5) Arc Flash Hazard Analysis

- (a) The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- (b) When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- (c) The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- (d) The Arc-Flash Hazard Analysis shall include all 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
- (e) Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- (f) The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- (g) Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- (h) Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

(6) Report Sections

- (a) Input Data:
 - 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 - 2. Short-circuit reactance of rotating machines with associated X/R ratios

3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

(b) Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA
6. Symmetrical and asymmetrical fault currents

(c) Recommended Protective Device Settings:

1. Phase and Ground Relays:

- a. Current transformer ratio.
- b. Current setting.
- c. Time setting.
- d. Instantaneous setting.
- e. Specialty non-overcurrent device settings.
- f. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:

- a. Adjustable pickups and time delays (long time, short time, ground).
- b. Adjustable time-current characteristic.
- c. Adjustable instantaneous pickup.
- d. Recommendations on improved trip systems, if applicable.

(d) Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

c. Execution

(1) Field Adjustment

- (a) Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer.
- (b) Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- (c) Notify Owner in writing of any required major equipment modifications.

(2) Arc Flash Warning Labels

- (a) The vendor shall provide a 3.5 in. x 5 in. adhesive label for each work location analyzed.
- (b) The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date
- (c) Labels shall be machine printed, with no field markings
- (d) Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each automatic transfer switch, one arc flash label shall be provided.
 - 2. For each switchboard motor control center, one arc flash label shall be provided.
 - 3. For each 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided .
 - 4. For each variable frequency drive or solid state reduced voltage motor starter whether supplied by the electrical sub-contractor or not, one flash label shall be provided.

(e) Labels shall be field installed by the electrical sub-contractor.

(3) Arc Flash Training

(a) The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

16.19 SURGE PROTECTION DEVICES (SPD)

Competitive products submitting against this specification must provide a single impulse surge current test report issued by a nationally recognized testing facility. The test report should demonstrate that the competitive surge protection device (SPD) can withstand, in its installed configuration, the specified value surge current without failure of any internal component (MOV's, wiring, printed circuit board and disconnect).

a. Furnish and install surge protection device at the entrance of the primary power supply into the Proposed Treatment Facilities Building in the main switchboard "MSB". This unit shall be suitable for installation on a three phase 277/480 VAC, four wire plus ground type service. Surge protection device (SPD) shall be of a passive parallel, thermal stress reducing design with a response time of less than or equal to one nanosecond. The unit shall be UL 1449 Third Edition and CSA listed, and it shall have a full fifteen (15) year non-limited warranty. SPD shall have a peak surge current rating of no less than 250,000 amps per phase (L-N + L-G). The UL 1449 Third Edition let through voltage, line-to-neutral, shall not exceed 1,000 volts peak when the unit hit with an ANSI/IEEE 62.41 Category B 6,000 volt, 6,500 amp) impulse hit.

Surge protection device shall be equal to Current Technology Model No. TG3-250-480-3Y-PNB.

b. Furnish and install surge protection device at the entrance of the primary power supply into the Proposed Raw Water Intake Building motor control center "MCCP". This unit shall be suitable for installation on a three phase 277/480 VAC, four wire plus ground type service. Surge protection device (SPD) shall be of a passive parallel, thermal stress reducing design with a response time of less than or equal to one nanosecond. Each unit shall be UL 1449 Third Edition and CSA listed, and it shall have a full fifteen (15) year non-limited warranty. SPD shall have a peak surge current rating of no less than 150,000 amps per phase (L-N + L-G). The UL 1449 Third Edition let through voltage, line-to-

neutral, shall not exceed 1,000 volts peak when the unit hit with an ANSI/IEEE 62.41 Category B 6,000 volt, 5,500 amp) impulse hit.

Surge protection device shall be equal to Cutler Hammer Model No. SPD160480Y2J (integral to MCC).

- c. Furnish and install surge protection device (SPD) at the 120/208 volt panelboards "P", "LA", "LB" & "LC". Each unit shall be suitable for installation on a three phase 120/208 VAC, four wire plus ground type service. Each surge protection device (SPD) shall be of a passive parallel, thermal stress reducing design with a response time of less than or equal to one nanosecond. Each unit shall be UL 1449 Third Edition and CSA listed, and it shall have a full fifteen (15) year non-limited warranty. Each SPD shall have a peak surge current rating of no less than 100,000 amps per phase (L-N + L-G). The UL 1449 Third Edition let through voltage, line-to-neutral, shall not exceed 1,000 volts peak when the unit hit with an ANSI/IEEE 62.41 Category B (6,000 volt, 4,000 amp) impulse hit.

Surge protection devices shall be equal to Current Technology Model No. TG3-100-208-3Y-PNB.

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SECTION 16483C
ADJUSTABLE FREQUENCY DRIVE - CLEAN POWER (CPX)

PART 1 GENERAL

1.01 SCOPE

- A. This specification describes the electrical, mechanical, environmental, agency and reliability requirements for three-phase, 18-Pulse, Adjustable Frequency Drives (AFD) as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

1.03 REFERENCES

- A. The adjustable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of UL, CUL, and NEMA.\

1.04 SUBMITTALS - FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer.
 - 1. Dimensioned outline drawing.
 - 2. Schematic diagram.
 - 3. Power and control connection diagram(s)
- B. Submit four (4) copies of the above information.

1.05 SUBMITTALS-FOR INFORMATION

- A. When requested by the Engineer the following product information shall be submitted:
 - 1. Descriptive bulletins
 - 2. Product sheets
 - 3. Harmonic Analysis

1.06 SUBMITTALS-FOR CLOSE-OUT

- A. The following information shall be submitted for record purposes prior to final payment.
 - 1. Final as-built drawings and information for items listed in Section 1.04.
 - 2. Installation information.

1.07 QUALIFICATIONS

- A. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors when specified.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 certified.

- C. The supplier of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. Adjustable Frequency Drives shall be on the basis of Cutler-Hammer CPX9000 Series for function and quality. Products that are in compliance with the specification and manufactured by others will be considered as "Approved Equal" only if pre-approved by the Engineer fourteen (14) days prior to bid date. Alternate suppliers shall submit documentation showing itemized compliance to the specifications and experience specific to the proposed AFD including a list showing details of the installation, application, location, contact name and telephone number of at least 10 users.

1.08 REGULATORY REQUIREMENTS

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.10 FIELD MEASUREMENTS

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Five (5) copies of the equipment operation and maintenance manuals shall be provided.
- B. Operation and maintenance manuals shall include the following information:
 - 1. Instruction books
 - 2. Recommended renewal parts list.
 - 3. Drawings and information required by Section 1.06.

1.12 EXTRA PRODUCTS

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton
- B. _____
- C. _____

Naming specific vendors does not imply acceptance of their standard products nor relieve them from meeting these specifications in their entirety.

Note to Spec. Writer – Insert data in blanks

2.02 ADJUSTABLE FREQUENCY DRIVES (AFD)

- A. Where shown on the drawings, adjustable frequency drives 25 through 1000 Horsepower (HP), Variable Torque (VT) shall have the following features:
1. The AFD shall be rated for 480 Vac. The AFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 50 degree C ambient at 250HP and below and 40 degree ambient above 250HP VT and no less than a 3.6 kHz switching frequency to reduce motor noise and avoid increased motor losses. Drive shall have been tested to and UL listed as conforming to the requirements of UL508C at rated load currents and ambient temperature per this specification.
 2. Drive shall have a UL listed interrupting rating of 65kAIC.
 3. The AFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source AFD are not acceptable. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not acceptable. The AFD shall run at the above listed switching frequency.
 4. The AFD shall have an efficiency at full load and speed that exceeds 95%. The efficiency shall exceed 90% at 50% speed and load. The AFDs shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
 5. 18 pulse drive shall include the following protective features, as a minimum: Input line fuses, Metal Oxide Varistor (MOV), and Lineside choke rated 7.5% of rated line current.
 6. The AFDs shall have a one (1) minute overload current rating of 110% for variable torque loads [pick one] 150% for constant torque loads.
 7. The AFDs shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the AFD.
 8. The harmonics introduced by the adjustable frequency drives at the point of common coupling (PCC) shall meet the requirements of IEEE519-1992 for General Systems. For purposes of this specification the PCC shall be the utility feeder to the facility where multiple users are served. Short circuit amperes at this point and total demand load are noted on the system one line drawing. 18 pulse drives shall have manufacturer documented maximum current demand distortion of 5% to ensure harmonic compliance.
 9. For systems with a standby generator, the harmonic distortion shall meet the distortion levels shown in table 10.3 of IEEE519-1992 for ISC/IL<20. The contractor shall provide the following data for the standby generator in order to perform the calculations: Voltage, kW, kVA and Subtransient Reactance (X''_d), and total maximum demand ampere load for generator operation.
 10. A harmonic analysis of the system shall be made consisting of the current and voltage harmonics expected from the addition of the adjustable frequency drives for all harmonics through the 25th per tables 10-2 and 10-3 of IEEE519-1992. This analysis shall be included as part of the bid submittal. An integrally mounted 18 pulse rectifier with a pre-wired phase shifting transformer shall be required as part of this specification.

The transformer shall be a single wound transformer rated 480 Volts with a UL recognized 180 degree C insulation system. Required performance shall be obtained without exceeding the above indicated temperature rise in a 50 degree C ambient below 250HP and for 40° C maximum ambient above 250HP.

11. The use of harmonic filter traps, 12 pulse rectifiers, Active filters or Active converter sections is not an acceptable substitute to the 18 pulse drive. All system components including the 18 pulse rectifier and phase shifting transformer shall be integral to the drive enclosure and shipped from the factory as an assembly. Separate components do not meet the intent of this specification and will not be considered as equivalent.
12. The AFD shall be able to start into a spinning motor (flying start). The AFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the AFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Standard operating conditions shall be:
 - a. Incoming Power: Three phase, 480 Vac (+10% to -10%) and 60 Hz (+/-5 Hz) power is converted to a fixed potential DC bus level. Maximum input voltage unbalance shall be 0.5% as defined in NEMA MG 1 section 14.35.2
 - b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
 - c. Speed regulation of +/- 0.5% of base speed.
 - d. Load inertia dependant carry over (ride through) during utility loss.
 - e. Insensitive to input line rotation.
 - f. Humidity: 0 to 95% (non-condensing and non-corrosive).
 - g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
 - h. Ambient Temperature: 0 to 50 °C.
 - i. Storage Temperature: -40 to 60 °C.
14. Control Functions
 - a. Frequently accessed AFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the AFD. The AFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
 - b. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the AFD RS-232 port. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section through section 18. Provide one copy of the advanced programming software.
 - c. The operator shall be able to scroll through the keypad menu to choose between the following:
 1. Monitor
 2. Operate
 3. Parameter setup

4. Actual parameter values
 5. Active faults
 6. Fault history
 7. LCD contrast adjustment
 8. Information to indicate the standard software and optional features software loaded.
- d. The following setups and adjustments, at a minimum, are to be available:
1. Start command from keypad, remote or communications port
 2. Speed command from keypad, remote or communications port
 3. Motor direction selection
 4. Maximum and minimum speed limits
 5. Acceleration and deceleration times, two settable ranges
 6. Critical (skip) frequency avoidance
 7. Torque limit
 8. Multiple attempt restart function
 9. Multiple preset speeds adjustment
 10. Catch a spinning motor start or normal start selection
 11. Programmable analog output
 12. DC brake current magnitude and time
 13. Proportional/Integral/Differential (PID) process controller
15. The AFDs shall have the following common system interface input requirements:
- a. Inputs - A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:
 1. Remote manual/auto
 2. Remote start/stop
 3. Remote forward/reverse
 4. Remote preset speeds
 5. Remote external trip
 6. Remote fault reset
 7. Process control speed reference interface, 4-20m Adc
 8. Potentiometer and 0-10 Vdc speed reference interface
 9. RS-232 programming and operation interface port
 10. Serial communications capability
 - b. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
 1. Programmable relay outputs with one (1) set of form C contacts for each, selectable with the following available at minimum:
 - i. Fault
 - ii. Run
 - iii. Ready
 - iv. Reversing

- v. Jogging
 - vi. At speed
 - vii. In torque limit
 - viii. Motor rotation direction opposite of commanded
 - ix. Over-temperature
- c. Programmable open collector output with available 24VDC power supply and selectable with the following available at minimum:
- 1. Fault
 - 2. Run
 - 3. Ready
 - 4. Reversing
 - 5. Jogging
 - 6. At speed
 - 7. In torque limit
 - 8. Motor rotation direction opposite of commanded
 - 9. Over-temperature
- d. Programmable analog output signal, selectable with the following available at minimum:
- 1. Output current
 - 2. Output frequency
 - 3. Motor speed
 - 4. Motor torque
 - 5. Motor power
 - 6. Motor voltage
 - 7. DC link voltage
16. Monitoring and Displays
- a. The AFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:
- 1. Run
 - 2. Forward
 - 3. Reverse
 - 4. Stop
 - 5. Ready
 - 6. Alarm
 - 7. Fault
 - 8. Local
 - 9. Panel
 - 10. Remote
 - 11. Hand
 - 12. Auto
 - 13. Off
- b. The AFD keypad shall be capable of displaying the following monitoring functions at a minimum:

1. Output frequency
 2. Output speed
 3. Motor current
 4. Motor torque
 5. Motor power
 6. Motor voltage
 7. DC-link voltage
 8. Heatsink temperature
 9. Total operating days counter
 10. Operating hours (with reset function)
 11. Total megawatt hours
 12. Megawatt hours (with reset function)
 13. Voltage level of analog input
 14. Current level of analog input
 15. Digital inputs status
 16. Digital and relay outputs status
 17. Motor temperature rise, percentage of allowable.
17. Protective Functions
- a. The AFD shall include the following protective features at minimum:
 1. Over-current
 2. Over-voltage
 3. Inverter fault
 4. Under-voltage
 5. Phase loss
 6. Output phase loss
 7. Under-temperature
 8. Over-temperature
 9. Motor stalled
 10. Motor over-temperature
 11. Motor under-load
 12. Logic voltage failure
 13. Microprocessor failure
 14. DC injection braking
 - b. The AFD shall provide ground fault protection during power-up, starting, and running. AFD with no ground fault protection during running are not acceptable.
18. Diagnostic Features
- a. Fault History
 1. Record and log faults
 2. Indicate the most recent first, and store up to 9 faults.
19. Optional features to be included in the AFD:
- a. Each VFD shall include a motor dv/dt output filter to protect motors with motor cable runs exceeding 100 feet. The dv/dt filter shall be located as an integral part of the AFD assembly and shall reduce the dv/dt clamp any voltage overshoots of the AFD

output. The filter shall return the energy in the voltage overshoots to the AFD Dc bus. A power dissipating resistance device such as a reactor is not acceptable. Filter shall be equivalent to Eaton MotorRx.

b. Communication card for interface with Modbus TCP control system.

20. Enclosure

a. The AFD enclosure shall be UL listed type enclosure NEMA 1 filtered and gasketed. The AFD shall have complete front accessibility with easily removable assemblies.

21. The AFD manufacturer shall maintain, as part of a national network, engineering service facilities within 100 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

2.03 MAINTENANCE / WARRANTY SERVICE

A. Product shall be warranted to be free from defects for a period of **36 months from start-up, or 42 months from shipment**, whichever expires first.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
2. All inverter power sub-assemblies shall undergo a burn-in test.
3. After all pre-tests have been performed, each complete AFD shall undergo a burn-in test. The drive shall be burned in with a motor load without an unscheduled shutdown.

B. The manufacturer shall provide three (3) certified copies of complete AFD final test reports.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of AFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper AFD operation.

B. The Contractor under the technical direction of the manufacturer's service representative shall perform the following minimum work.

1. Inspection and final adjustments.
2. Operational and functional checks of AFD and spare parts.
3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the AFD in accordance with those instructions.

- C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.03 FIELD TESTING

A. Optional field testing

- 1. The AFD manufacturer shall perform harmonic measurements at the point where the utility feeds multiple customers (PCC) to verify compliance with IEEE519-1992. A report of the voltage THD and current TDD shall be sent to the engineer. The contractor shall provide labor, material, and protection as needed to access the test points. The readings shall be taken with all drives and all other loads at full load, or as close as field conditions allow.

3.04 TRAINING

- A. The Contractor shall provide a training session for up to 5 owner's representatives for 2 normal workdays with a maximum of 2 trips at a job site location determined by the owner. Training and instruction time shall be in addition to that required for start-up service.
- B. The manufacturer's qualified representative shall conduct the training.
- C. The training program shall consist of the following:
 - 1. Instructions on the proper operation of the equipment.
 - 2. Instructions on the proper maintenance of the equipment.

SECTION 16900 – SCADA
SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM

PART 1 - GENERAL

1.1 PROJECT DESCRIPTION

A. Description of Work

The work to be accomplished under this section shall consist of furnishing the equipment necessary for a complete automatic control and monitoring system to function as specified herein and as shown on the drawings. The system integrator shall furnish a completely integrated WTP Supervisory Control and Data Acquisition (SCADA) system, including interfacing with the proposed Actiflo Control Panel. It shall be the system integrator's responsibility to supply a system that is compatible with existing Micro-Comm (distribution) SCADA System, new equipment supplied by others as part of this contract, and equipment supplied in other contracts. The complete system shall be designed, fabricated, programmed, tested, started up, and warranted by a single supplier to insure a single source of responsibility.

B. Scope of Work

This section covers the proposed WTP SCADA and Instrumentation System to include:

- (1) Master WTP SCADA panel and Operator Display Console (Desktop Computer System)
- (1) WTP SCADA antenna tower, antennas, and coaxial cables
- (1) Interface with the proposed Actiflo WTP Panel
- (1) Interface to instrumentation items, chemical feeders, chemical analyzers, and flow meters (as shown on drawing E5).
- (1) Raw Water radio based SCADA panel, located at the Raw Water Building.
- (1) Raw Water antenna tower, antenna, and coaxial cable.

C. General/Electrical Contractor Shall Supply

1. Access and easements as needed for all sites.
2. All equipment required in other sections of the specifications.
3. All labor for installation of the SCADA system and instrumentation items.

D. System Integrator Shall Supply:

1. Engineering submittal and shop drawings prior to installation.
2. All the paper work and fees necessary to obtain a FCC radio license in the name of the Owner.
3. All user licenses and fees for software supplied in this system with licenses in the name of the owner.
4. Operation and maintenance manuals, as detailed in this section.
5. All start-up labor and services, as required for equipment specified in this section.
6. Operator training as detailed in this section.

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1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications

The system specified herein shall be the product of a manufacturer who can demonstrate at least ten (10) years of satisfactory experience in furnishing and installing comparable radio based telemetry/control systems for water and wastewater installations.

The manufacturer of this system shall maintain a 24-hour available inventory of all replaceable modules to assure the Owner of prompt maintenance service and a single source of responsibility. The manufacturer shall certify this to the Engineer in writing at the time of bidder pre-qualification.

B. Pre-bid Approval

The Base Bid approved systems integrator for this project is:

Micro-Comm, Inc.	Local Representative:
15895 S. Plfumm Rd	Brann and Whittemore, Inc.
Olathe, KS 66066	Tel: (615) 377-9444
Tel: 913-390-4500	
Fax: 913-390-4550	

Other integrators desiring to bid this project as "alternate" integrators must seek pre-bid approval by providing a submittal (14) days prior to the bid date. Submissions that fail to include a complete submittal as detailed shall be deemed unresponsive. The Consulting Engineer and the Owner shall be the sole judge as to whether the alternate equipment is considered an approved equal. Approval of an alternate system by the Engineer will not relieve the alternate system of strict adherence to these specifications. The pre-bid submittal shall include the following:

1. An installation list with the names and phone numbers of both the Owner and Consulting Engineer for at least ten projects of similar size and complexity.
2. A "statement of compliance" detailing paragraph by paragraph the bidders compliance to these specifications.
3. Block diagrams for the various sites in the proposed system showing the selected pieces of hardware equipment to be used.
4. Sample electrical drawings for typical sites proposed in this contract.
5. A product performance data sheet shall be included for each hardware component in the system (i.e. antennas, radios, coaxial cables & arrestors, programmable controllers, power supplies, time delays and relays, and the various sensors required) and each software component (programming & configuration software and operator display console software).

1.3 QUALITY ASSURANCE

C. Approval Agencies

The control system and its components shall comply will all applicable requirements of the following:

1. International Society of Automation (ISA) for instrumentation
2. National Electrical Code (NEC) Compliance for both National & Local standards
3. Underwriters Laboratories, Inc.

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- a. UL508 for Programmable Controllers. The Programmable Logic Controllers (PLCs) and Input/Output devices shall be UL listed for use in and Industrial Control Panel per UL508 per UL Category NRAQ.
 - b. UL508A for Industrial Control Panels. The System Integrator shall be a UL508A listed manufacture for Industrial Control Panels per UL Category NITW. All control panels shall have an interior mounted label that has the name, address, phone number, and UL 508A file number of the Control Panel Manufacture. All control panels shall have affixed to the panel a UL 508A serial numbered “UL Listed Enclosed Industrial Control Panel” label prior to shipment. Control Panel(s) without the affixed UL 508A “serial numbered” label shall be rejected and sent back to the Contractor’s factory.
4. National Electrical Manufactures Association (NEMA)
 - a. 250, Enclosures for Electrical Equipment (1000 Volts maximum)
 - b. ICS, Industrial Control & Systems
 5. Federal Communications Commission (FCC)

1.4 SUBMITTALS:

- A. Complete submittal shall be provided to the engineer for approval prior to equipment fabrication. The submittal data shall include the following:
 1. Product Data - Provide product data sheets for each instrument and component supplied in the system. The data sheets shall show the component name as used on reference drawings, manufacturer's model number or other product designator, input and output characteristics, scale or ranges selected, electrical or mechanical requirements, and materials compatibility.
 2. Shop Drawings - Provide drawings for each panel showing the wiring diagrams for control circuits and interconnections of all components. The drawings shall include wiring diagrams for all remote devices connected to the panel.
 3. Panel Layout Drawings - A front panel and sub-panel layout shall be included as part of each control panel drawing. Components shall be clearly labeled on the drawing.
 4. Installation Drawings - Typical installation drawings applicable to each site in the system shall be included.
 5. Operator Interface Software - The submittal shall include a generic but detailed technical description of the Operator's Interface Software as proposed for this system including:
 - a. Sample text screens and menus
 - b. Sample graphics screens
 - c. Sample report logs and printed graphs

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1.5 MAINTENANCE INFORMATION

A. Maintenance Data Manuals

Submit maintenance manuals and "as built" drawings on all items supplied with the system. The manuals and drawings are to be bound into one or more books as needed. In addition to "as built" engineering submittal data and drawings, the manual shall include trouble shooting guides and maintenance and calibration data for all adjustable items.

1.6 JOB CONDITIONS

A. All instruments and equipment shall be designed to operate under the environmental conditions where they are to perform their service. The equipment shall be designed to handle lightning and transient voltages as normal environmental hazards. The environmental conditions are as follows:

1. Outdoor - The equipment will be exposed to direct sunlight, dust, rain, snow, ambient temperatures from -20 to +120 degrees F, relative humidity of 10 to 100 percent, and other natural outdoor conditions. The installations shall be hardened to withstand normal vandalism.
2. Indoor - The equipment will be capable of operating in ambient temperatures of +32 to +130 degrees F and relative humidity of 20 to 100 percent.

1.7 DELIVERY, STORAGE, & HANDLING

A. All items shall be stored in a dry sheltered place, not exposed to the outside elements, until ready for installation. All items shall be handled with appropriate care to avoid damage during transport and installation.

1.8 SEQUENCING & SCHEDULING

A. Coordination

The Systems Integrator shall coordinate with other electrical and mechanical work including wires/cables, raceways, electrical boxes and fittings, controls supplied by others, and existing controls, to properly interface installation and commissioning of the control system.

B. Sequence

Sequence installation and start-up work with other trades to minimize downtime and to minimize the possibility of damage and soiling during the remainder of the construction period.

1.9 DISTRIBUTED CONTROL OPERATION

A. General

The control system shall use "Programmable Logic Controllers" (PLCs) at all locations in the system as detailed later in these specifications. Each site in the system shall have a unique digital address. The Central Processing Units (CPUs) and Input/Output (I/O) cards used in each of the PLCs shall all be identical, fully interchangeable without reprogramming by the operator. The PLCs shall be "self-initializing" and "self restoring" so that operator intervention is not required after power interruptions, transients from lightning storms, or component changes.

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The system shall be composed of a Central Terminal Unit (CTU) that monitors and or controls the operation of multiple Remote Terminal Units (RTUs). The CTU shall be composed of a PLC (as described above) and one or more Operator Display Consoles (ODCs) with Human-Machine-Interface (HMI) software to display, alarm, record, all data received and for operator input for changes to the system.

The control system shall be capable of implementing multiple modes of communications in a single system to include: radio, leased phone-line, dial-up phone-line, high-speed data highway, fiber optic, and Ethernet communications as details in these specifications. The individual sites in the system shall simultaneously support both Master-Slave and Peer-to-Peer communications as needed implement the distributed control features listed in these specifications.

B. Standard Control Software Features

The supplied software shall not be a one-of-a-kind system, but rather a comprehensively designed software platform that provides a number of built in features that monitor local & remote inputs combined with standard software algorithms to provide an integrated system as follows:

1. Monitor local Hand/Off/Automatic (HOA) selector switch positions (ie on existing pump control panels) and integrate the switch position in to the control logic such that a HOA in HAND or OFF shall be considered by the control system as 'un-available'.
2. Provide for High Discharge Cut-off and Low Suction Cut-off control of pumps from locally entered setpoints at RTUs equipped with suction and discharge pressure transmitters and/or from existing pressure switches.
3. Provide automatic Pressure/Flow pump staging operation of pumps of different sizes (including variable speed pumps) from local discharge pressure and discharge flow inputs in a closed-loop system. The pumps shall be up-staged on decreasing discharge pressure and down-staged on decreasing flow rate. The control shall include PID (Proportional Integral Derivative) loop control of variable speed pumps mixed with constant speed pumps for the various stages required.
4. Provide "Compound Loop" PID control of final devices (ie chemical feeders) from multiple inputs (ie flow rate and a chemical process analyzer, such as chlorine residual).

1.10 RADIO CHANNEL DATA OPERATION

A. General

The control system shall be specifically designed for radio channel data communications. The core of the system shall be over FCC licensed radio frequency spectrum intended for SCADA and remote control purposes. The systems integrator shall be responsible of obtaining the necessary FCC licenses for one or more frequencies as needed to establish both supervisory and distributed control.

All of the equipment required for operation of the system shall be directly owned by the Owner and included as part of this contract. Systems using third party repeaters, trunking masters, or leased equipment will not be allowed. The Systems Integrator shall select radio equipment as detailed below to insure reliable operation and be able to implement all software features listed in this specification whether currently required or described as a "shall be capable" feature.

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The overall system design and operation shall provide a 20db pad over the minimum required for operation on all primary data paths (primary paths may include data relays) to insure a 98% reliability of communications. Remote site communications for distributed peer-to-peer communications shall provide 30db of pad to insure operation under all weather conditions and provide a 99.9% communications reliability. The 20db and 30db pad requirements and FCC rule compliance shall be demonstrated (at no additional cost) to the Engineer at his request. The testing shall be accomplished using an IFR AM/FM 1000S communications analyzer or equal equipment.

B. Communications

The CTU-RTU supervisory communications and RTU-RTU distributed control communications system shall operate in a half-duplex mode over a single "licensed" radio frequency using "point-to-point" communication techniques. The RTUs shall monitor for the channel to avoid data collisions with other RTUs during peer-to-peer communications. The system shall be capable of sharing the radio channel with other radio telemetry system.

To facilitate system layout and future expansion all RTUs shall under the direction of the CTU be able to implement store-and-forward communications to relay data and commands to and from other RTUs as required to establish the desired path. Should the assigned relay site for a distant remote be inoperative, the Central Unit shall automatically choose another remote site to access the distant remote. Any RTU shall be able to provide automatic antenna switching as part of their relaying operations.

All data transmitted shall be in digital word form using FSK (frequency shift keying) transmission. All transmissions shall include the address of the sender and the receiver, and be subject to check sum, parity, and framing error checks, to insure a minimum data reliability of 1 error in 1,000,000,000 bits. Any transmissions that fail the data checking will be retried until correct. No data correction methods will be allowed. A plug-in RS232C data port shall be provided at all locations in the system to allow the use of a standard data terminal to view data exchanges between the sites and to provide a means of extensive de-bugging.

The system shall provide a complete data update at least once every (2) minutes with some functions updating faster as required by local system conditions.

C. Radio Channel Operation

The system shall be capable of operation on the narrow band splinter frequencies of the Private Land Mobile Radio Services within the Federal Communications Commissions (FCC) rules and regulations regarding these telemetry channels. The manufacture shall guarantee operation under co-channel conditions with other radio systems without interference to this system. FSK tones, data baud rates, transmitter output power, transmitter deviation, antenna gain, and antenna height shall be chosen to comply with the FCC requirements Part 90 - Subpart 90.35 and 90.238 for the Industrial/Business frequency pools. The radio system shall specifically meet the operating requirement that the sum of the highest FSK frequency and the amount of deviation shall not exceed 1.7 kHz for 3F2 emission (or 2.8 kHz for 6F2 emission) as detailed by the FCC for the specific frequency assigned.

CTUs and RTUs shall be capable of automatically switching antennas and/or radios (including radios on different frequencies) during CTU-RTU, RTU-RTU, and store & forward communications. The antenna/radio switching at remote units shall automatically default back to RTU-CTU paths if communications are lost with the CTU.

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D. FCC Licensing

The system manufacturer/supplier shall be responsible for collecting all information, generating all paper work, and paying all fees required obtaining a license on behalf of the Owner.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLERS & LOCAL I/O EQUIPMENT

A. General

Industrial Programmable Logic Controllers (PLCs) shall be used at all locations. The PLCs shall have an operational range of 0-60degC and 5-95% relative humidity. The PLCs shall all be from the same family of controllers, scalable from very small to very large applications, and programmed from identical programming software used for all processors. The PLCs shall be readily available on and directly purchasable online from the manufacture's WEB page. The PLCs shall be Allen-Bradley CompactLogix or Micro-Comm M1650 Series controllers. Alternative PLCs must be submitted with the "Prebid Approval" documents for approval prior to bid.

The software at all locations shall be stored in a user removable non-volatile CompactFlash or similar type ROM memory that can be exchanged under power, used to upgrade sites in the field, and store historical data (local trends, accumulators, etc) for retrieval locally or by the central unit. The memory modules shall store all site-specific logic and configurations including communication parameters, control algorithms, analog input/output scaling, PID control parameters. The module shall be programmed via the CPU and without the use of external adapters. The PLCs shall include "watch-dog" circuitry and be "self-initializing" without operator intervention. In the event that the program or configuration data is corrupted, the CPU shall reload the program and configuration data from the EEPROM memory module.

The PLCs shall be fully online programmable while the PLC continues to communicate with the rest of the system and performs its assigned control tasks. The PLCs shall support "fill-in-the-blank" type configuration for basic operation and to set-up common features such as COM port set-up, peer-to-peer data collections, local back-up control set points, input and output setup, output on/off time delay settings, front panel display setup, etc. The PLC shall also support a process script language or ladder logic type programming for site-specific customizations including special input and output manipulations, local sequential control, math functions, and PID control as follows:

- | | |
|----------------------|--|
| 1. Relay (Bit) Type | - Examine if ON, Examine if OFF |
| 2. Timer & Counter | - Timer ON, Timer OFF, Timer DONE |
| 3. Compare Functions | - Equal, Not Equal, Greater Than, Less Than, etc |
| 4. Math Functions | - Add, Subtract, Multiply, Divide, Square Root |
| 5. Scaling Functions | - Scale & Scale with Parameters |
| 6. Logical Functions | - AND, OR, & NOT |
| 7. Program Control | - Jump & Skip Next functions |
| 8. PID | - PID with compound loop input |

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The PLC programming software shall be written for the 32 bit interface of Windows XP. The supplier shall provide a licensed copy of the PLC configuration and programming software along with the necessary communications cables to the owner. Training on the use of the software shall be provided as part of the system training.

B. Construction

The PLC shall use modular construction. The base unit shall be composed of the power supply, CPU, communications modules, and basic inputs and outputs (I/O). The unit shall have expandable inputs and outputs using a "rack-less" DIN rail mount design and capable of supporting local I/O (via an integrated high-performance serial I/O bus) and remote I/O via a industrial serial bus. All terminations shall use removable, NEMA-style "finger-safe" terminal blocks so that individual modules may be removed with out disturbing adjacent modules.

The PLC shall be capable of being powered from AC, DC, or solar sources. DC and solar powered PLCs shall have an integral battery charging circuit that protects the external battery from over and under voltage conditions and provides automatic charging of the battery after power failures. The back-up power supply shall be either 12VDC with 24VDC DC/DC converter or 24VDC with a 12VDC DC/DC converter to run the 12VDC radio and 24VDC to power external sensors from a single battery source. Series tapped 24VDC batteries for 12VDC will not be allowed. Back-up batteries shall be rechargeable sealed lead-acid type batteries as manufactured by PowerSonic or equal. The back-up battery shall provide for 24 hours of back-up operation at water tower remote units and 3 hours at all other sites.

The PLC shall have a minimum of two (2) communications ports. The first shall be used primarily for CTU-RTU and RTU-RTU communications. It shall support baud rates of 110-19,200 baud and have a plug-in standard 25pin or 9pin sub-D connector that provides a full RS232 interface and radio modem interface. The second communications port shall provide programming, operator front panel interface, multiple PLC interconnect and other local communications. It shall support baud rates of 110-19,200 baud and have a 9-pin sub-D interface. The communications ports shall include LED's to show the status of all control lines. The PLC shall also optionally support Ethernet communications as detailed in the specifications.

The PLC shall utilize a rack-less design and provide for sufficient installed and configured spare inputs and outputs (I/O) to meet the site requirements as detailed and provide for 25% spares of each type. The unit shall have a minimum of (4) discrete (relay) outputs, (8) discrete inputs (DI), (4) analog inputs (AI), and (2) analog outputs (AO). The analog inputs shall provide for sensor excitation with separate fuses for each input. The fuses may be the self-resetting type. All input and output connections to the PLC shall be via Nema "finger-safe" plug-in terminal blocks.

The PLC shall support both local and remote I/O. Input/Output cards shall be mounted on a DIN rail channel. The PLC inputs, outputs, and operator interface shall be as follows: .

1. DISCRETE OUTPUTS - The discrete outputs shall be isolated relay outputs rated at 5.0A continuous @ 240VAC. LEDs on the front of the PLC base unit or expansion module shall indicate the status of each output point. Interposing relays shall be provided if the voltage or current of the external load on a contact exceed the 5.0A 240VAC ratings. Each output shall be provided with operator settable software ON and OFF time delays.

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2. DISCRETE INPUTS - The discrete inputs shall be optically isolated and provide for 24VDC excitation to remote sensors and switches. Each input shall be separately fused or current limited such that accidental grounding shall not render the other inputs non-functional. LEDs on the front of the input module shall indicate the status of each input point.
3. ANALOG INPUTS - The analog inputs shall provide filtered and scalable analog to digital conversion of input signals. The analog inputs shall be switch selectable from 0-5VDC to 0-20mADC and provide a minimum of 0.3% resolution and 0.5% accuracy over the temperature range of 0-70degrees C. The PLC shall provide separately fused 24VDC excitations to the remote sensors.
4. ANALOG OUTPUTS - The analog outputs shall provide a 4-20mA isolated signal to other panels and devices as specified.
5. PULSE INPUTS - The high-speed counter/pulse inputs shall provide for pulse rates up to 1KHz direct from flow meter transmitter heads without interposing equipment. The pulse input shall include fused 12VDC excitation to the meter transmitter.
6. POWER SUPPLY - Each PLC assembly shall include an integral power supply. Power supplies shall be designed for 12VDC or 24VDC input power and suitable for use in battery back-up operations. DC/DC converters shall be required to insure that both the 12VDC and 24VDC are regulated separately from the common source.
7. KEYPAD & DISPLAY UNIT - The optional keypad & display unit shall have a 4x20-backlighted LCD display to display the status of all local inputs and the tank level of the associated control water tower level. The 5x5 keypad shall provide for operator input of set points and timer settings. The operator interface shall be menu driven and provide for dedicated keys for cursor position and input functions. The operator interface shall provide for up to 50 screens of data display. The keypad & display unit shall be supplied and mounted on the front of the PLC enclosure if detailed in the specific PLC I/O requirement list. The keypad & display unit shall maintain the Nema 4 rating of the PLC enclosure.
8. INDUSTRIAL HMI FRONT PANEL TOUCH-SCREEN DISPLAY UNIT - The optional HMI Front Panel Touch Screen Display Unit shall have either a 15" (1024x768 native resolution) or 17" (1280x1024 native resolution) diagonal backlit Color Active Matrix Display with Graphical Touch-Screen interface. The display shall have either a capacitive or 5-wire resistive touch-screen with a touch accuracy of 2mm. The unit shall have a "runtime" version of the SCADA HMI software installed in the Main HMI Computer. The unit shall be automatically monitor all the PLCs in the network and receive expansion/revision updates from the Main HMI computer. The unit shall have a minimum of 4GB of RAM memory, 100GB HDD, serial communications port, parallel printer port, and a Gigabit Ethernet port. The operator interface shall be graphical and provide for display of all data monitored and operator input of setpoints and operating commands in the SCADA system. The Graphical Touch-screen unit shall be supplied and mounted on the front of the PLC enclosure if detailed in the specific PLC I/O requirement list. The unit shall maintain the Nema 4 rating of the PLC enclosure.

Refer to Appendix for specific front panel display requirements.

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C. Enclosures

The remote unit enclosures for indoor mounting shall meet all the requirements for NEMA Type 12 enclosures. The enclosure body shall be made of a minimum 14 gauge steel with continuously welded seams and be furnished with external mounting feet. The enclosure door shall be made of a minimum 16 gauge steel with have a 14 gauge steel hinge. Enclosures larger than 16x14 shall have a rolled lip on 3 sides of the door for added strength. The door opening shall have a rolled edge on 4 sides to protect the door gasket. The door gasket shall be heavy neoprene and attached to the door with oil resistant adhesive. Sub-panels shall be 14-gauge steel for 16x14 enclosures and 12 gauge for larger enclosures. The enclosure finish shall be gray polyester powder coating inside and out over phosphatized surfaces. The subpanels shall be finished in white. Nema 12 enclosures shall be Hoffman "CH" or "CONCEPT" wall mount enclosures.

Remote site installations requiring equipment to be mounted outside shall have a double box enclosure with the remote unit enclosure mounted inside a lockable NEMA 3R enclosure. The double enclosure shall be required to control vandalism, provide complete weather protection, reduce the heating effects of the sun, and prolong the life of the equipment. The NEMA 3R enclosure shall be constructed of 14 gauge galvanized steel, with a drip shield top and seems free sides front and back, and a stainless steel hinge pin. The enclosure finish shall be gray polyester powder coating inside and out over phosphatized surfaces. The NEMA 3R enclosure shall be Hoffman Bulletin A-3.

The remote unit enclosures mounted in damp corrosive areas (such as concrete meter vaults) shall be NEMA Type 4X rated enclosures. The enclosures shall be made of molded fiberglass polyester and be furnished with external mounting feet. The door shall have a seamless foam-in-place gasket and corrosion-resistant hinge pin and bails. Sub-panels shall be 14-gauge steel for 16x14 enclosures and 12 gauge for larger enclosures. The enclosure finish shall be a light gray inside and out. The subpanels shall be finished in white. Nema type 4X enclosures shall be Hoffman "Fiberglass Hinged Cover".

Refer to Appendix for specific enclosure requirements.

D. Front Panel Hardware Displays

As detailed in the appendix, the PLC units may include front panel displays of the specified inputs and outputs. The indicator lamps, pushbuttons, and selector switches used in the system shall be IP65 oiltight/waterproof/corrosion resistant rated. The indicators use slide or bayonet based colored LED light sources. The lenses shall be acrylic and color matched to the LED color. The lamps shall have translucent marking plates for legends and be constructed such that the acrylic lens covers the legends for dust and water protection. The pushbutton and selector switch operators shall be Nema 600V rated with contacts rated for 6A @ 120VAC inductive. The contact blocks shall be stackable and snap-fit with screw terminals for termination.

Refer to Appendix for specific front panel display requirements.

E. Local Control Functions

In general the PLC shall be programmed to provide generic control functions as detailed earlier and to work in concert with the CTU. The integrator shall be responsible to meet with the owner and the engineer to develop the automatic control strategy required for the system.

Refer to Appendix for special input and output control requirements.

2.2 RADIO TRANSCEIVERS & ACCESSORIES

A. General

The radio transceivers shall be standard "un-modified" radios that can be tuned, aligned, and repaired at any two-way radio shop. Interface to external data modems shall be through the front panel microphone jack. The radios shall be synthesized and fully field programmable and include a built-in time-out timer to disable the transmitter after 0-60seconds. The units shall be tuned to FCC specifications for the specific frequency assigned. The radio equipment shall be FCC type approved and the system capable of operation on the 3KHz or 6KHz narrow band splinter frequencies (154 or 173MHz) in the Industrial/Business radio service.

B. VHF Radio Transceiver (154Mhz or 173Mhz)

The system manufacturer shall supply a 25-watt VHF radio transceiver allowing the WTP SCADA to interface with the existing 173.39625Mhz distribution SCADA system. The radios shall be adjustable to 10 watts output power as may be required by the FCC for ERP (Effective Radiated Power) restrictions. All connections to the radio shall be plug-in. The VHF radio transceiver shall have the following specifications:

Transmitter:

RF output power	25 watts minimum (adjustable to 4)
Spurs & Harmonics	16 dBm (25uW) (or -50dBc)
Frequency stability	±0.00025% (-30 to +60 degrees C)
Emission	6F2 (2.5kHz DEV max) or 3F2 (1.2kHz DEV max)
FM hum and noise	-40 dB

Receiver:

Sensitivity	0.35uV @ 12 dB SINAD (.5uV @ 20db quieting)
Selectivity	-65 dB
Spurious image rejection	-50 dB
Inter-modulation	-65 dB
Frequency stability	±0.00025% (-30 to +60 degrees C)
Receive bandwidth	*6kHz (or 3kHz) as required to match the transmitter

* The receiver bandwidth shall be reduced to match the transmit bandwidth of the transmitter and provide a minimum adjacent channel rejection of -50db.

The radio transceivers shall be a Motorola Radius CM200 or a Microwave Data Systems 1710.

C. UHF Radio Transceiver (450Mhz)

A new (high-speed) UHF radio network will include the WTP SCADA and the Raw Water Pump Station. The system will operate with point-to-point operation within the FCC rules and regulations and provide the same RF path margins as detailed in these specifications.

The UHF radios must meet or exceed the requirements set forth in these specifications for VHF radios, except that the radio output power must be 5 watts as needed to meet FCC requirements. The radios shall be tuned to operate in 6KHz of bandwidth to meet the proposed FCC standards for 2005. Antennas shall provide a minimum 10db of gain.

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The radio transceivers shall be a **Microwave Data Systems SD4MD-Bxx-NNSNN**.

D. Antenna & Coaxial Cable

The radio antennas at all locations shall be a five element Yagi, constructed with 3/8" diameter solid aluminum rod elements and 1-1/16" diameter aluminum pipe element support with a type N coaxial connector. The antenna shall have a minimum 8.0db forward gain with a 20.0db front-to-back ratio. The antenna shall be wind rated for a 100-MPH wind speed. The VHF antennas shall be MC-Yagi, Decibel Products DB292, or Celwave PD390S. The UHF antennas shall be MC-Yagi or Celwave PD688S.

Antennas shall be cabled to the transmitter enclosure connection by a RG/8U type low loss (less than 1.8db per 100ft @ 100MHz) coaxial cable with cellular polyethylene (foam) dielectric. The coaxial cable shall have a braided copper shield coverage of 97% and a long life weather resistant polyvinyl chloride jacket. The antenna coaxial cable connection shall be a constant impedance weatherproof Type N connector, taped with a weather resistant electrical tape to insure a lifetime watertight assembly. The coaxial cable shall be Belden 8214 or 9913 cable.

E. Antenna Lightning Protection

Coaxial connection to remote and central unit enclosures shall be by means of a coaxial type bulkhead lightning arrestor. The units shall be rated at 1 kilowatt with a minimum 500V and maximum 2000V-breakdown voltage. Coaxial lightning arrestors shall be a PD-593 or PolyPhaser IS-B50LN-C1.

F. Antenna Mounting Systems

Antennas shall be mounted at a height above ground that is consistent with FCC rules and regulations and provides adequate signal fade margin as described earlier. Antennas must be a minimum of 15 feet above ground and mounted as follows:

1. The WTP and Raw Water Pump Station Structures: A bracketed antenna tower shall be supplied where specifically noted on the plans. The tower shall be assembled from 10' sections built on an 18" equilateral triangle design. Tower sections shall be constructed of 1-1/4" steel tubing with continuous solid steel rod "zigzag" cross bracing electrically welded to the tubing. The entire 10' sections shall be Hot-Dip Galvanized after fabrication for long life. The antenna towers shall be ROHN Model 45G.

2.3 INSTRUMENTATION & ACCESSORIES

A. General

All items in the control system (electronic cards, power supplies, radios, time delays, relays, etc.) shall be of plug-in construction, make use of a plug-in wiring harness, use plug-in terminal blocks, and be interchangeable without recalibration. To insure field repair-ability by non-technical personnel, equipment that must be un-wired for replacement will not be accepted.

The following instrumentation devices and techniques shall be used as specifically called for in the RTU and CTU input/output sections of this specification.

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B. Power Supplies

The DC power supplies shall provide $\pm 0.1\%$ line and load regulation with $\pm 10\%$ input variations. They shall have a temperature coefficient of $\pm 0.02\%$ per degree C. The input/output isolation shall be 100 Mohms DC (900Volts AC) with output transient response of 50 microseconds maximum. The power supplies shall be sized to operate the remote unit equipment with or without the back-up battery in place. Power Supplies shall be a Power One Series MAP130, Sola SLS, or approved equal.

C. Battery Back-up Operation

The remote units indicated shall be supplied with battery back-up operation. The rechargeable batteries shall be the sealed solid gelled electrolyte types, designed for float or standby service. Unless noted otherwise in the RTU descriptions, batteries shall be sized to maintain 24-hour service at water tower remotes and 8 hour service at pump stations and other remotes. The remote shall include a charging module to recharge the battery when power is resumed, maintain the charge between outages, and provide a low voltage cut-off to protect the battery from excessive discharge during prolonged outages. All discrete, analog, and pulse inputs (i.e. switch closures, pressure, level, flows, etc.) shall continue to function on battery back up. Batteries shall be Globe Gel/Cell or approved equal.

D. Single Phase 120VAC Power Line Lightning Protection

Every site in the system shall be equipped with AC line filtering and lightning protection. The equipment shall provide 2-stage lightning/transient protection including inductive and capacitive filtering and MOV over-voltage protection.

E. Level & Pressure Transducers

Level & pressure transducers shall be of the all solid-state two-wire transmitter type with a 4-20mA output from a 10.5-24VDC excitation. The units shall be powered from the RTU power supply. The transducers shall have a combined error (linearity and hysteresis) of $\pm 0.25\%$ full scale and be temperature compensated to $\pm 2.5\%$ per 100 degrees Fahrenheit. Zero and span adjustments shall be standardized so that transducers are interchangeable without recalibration. All exposed or wetted parts shall be series 316 stainless steel, PVC, or Buna-N. The units shall be capable of a three times full scale over pressure with out damage or change of calibration.

The transducers shall be mounted at the sensing point and wired to the enclosure. The transducers shall have a 1/4" or 1/2" NPT process pressure connection. Transducers for above ground mounting shall have a 1/2" conduit connection for cable entry. Transducers at water towers (and other outside locations) shall be mounted below grade and below frost line to prevent freezing. Below grade mounted units shall have factory signal cabling and be suitable for a minimum of 100' submerged duty.

Level transducers for clear-wells and wetwells shall be suspended in the clearwell or wetwell and supplied with sufficient factory installed cable to access a "clean/dry area" junction box. The suspension cable shall have a polyethylene jacket and internal venting to provide for atmospheric sensing of the non-process side of the diaphragm. The sensors shall have a multi-ported pressure-sensing end that protects the diaphragm while sensing the level of viscous liquids or slurries. The cable connection in wet-well applications shall have a non-fouling guard to prevent build up of foreign materials.

Pressure/Level transducers shall be Micro-Comm L5N series or Ametek Model 57S.

2.4 CENTRAL UNIT EQUIPMENT

A. General

The "Central Unit" shall be composed of two or more separate CPUs communicating over a high-speed serial data links. The first computer (called the Central Terminal Unit or CTU) shall be a PLC as specified earlier and provide all communications with remote units, local inputs and outputs, and local hardware display devices. The second computer (called the Operator Display Console or ODC) shall be responsible for the operator interface to the system and provide display, alarm, and logging of all data.

B. Construction

The CTU shall be as specified for the PLCs used on the project. The CTU control panel shall be equipped with a battery back up. The CTU shall operate for a minimum of 8 hours controlling all radio/RTU operations. The rechargeable 12 amp hour batteries shall be sealed solid gelled electrolyte type batteries. The CTU shall recharge, maintain, and contain a low voltage cut-off protecting the battery from excessive discharge.

C. Enclosures

All of the CTU and PLC equipment (including CPU card cage, radio, power supplies, automatic antenna switching, and local inputs & outputs) at the master shall be housed in a free standing or wall mount NEMA 12 enclosure.

Refer to Appendix for specific enclosure requirements.

D. Local Control Functions

In general the CTU shall be programmed to provide generic control functions as detailed earlier. The integrator shall be responsible to meet with the owner and the engineer to develop the automatic control strategy required for the system.

Refer to Appendix for special input and output control requirements.

2.5 OPERATOR DISPLAY CONSOLE (ODC)

A. General

As described previously the Central Unit shall have two microprocessors tied together with separate operating responsibilities. The first processor (Central Terminal Unit or CTU-PLC) shall handle all the telemetry, set-point comparison and command duties. The second processor (Operator Display Console or ODC) shall handle the LCD displays, operator keyboard, alarm/log printer, and data storage duties. The system shall be capable of supporting multiple ODCs connected to a single CTU-PLC.

B. System Unit

The Operator Display Console (ODC) computer shall be an Intel/Windows base processor with the following features:

1. Intel Core i7-2600 Processor operating at 3GHz (minimum)
2. Windows 7 Professional operating system
3. 4GB RAM (minimum)
4. 500GB SATA Hard Drive (minimum)

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5. 16x DVD+/-RW optical storage drive
6. USB 104-Key QWERTY Keyboard with integral numeric keypad & 6ft cable
7. USB 2-button Mouse with Scroll Wheel
8. Integral Gigabit wired Network Adapter
9. Internal 56K V.92 Data/Fax modem
10. (6) USB 2.0 ports

The system unit shall be housed in a desktop or mini-tower case as required by the owner. The CTU shall store all command inputs and set points as downloaded from the ODC. The hard drive in the ODC shall be used for program and data storage. The R/W CD-ROM shall be used for archive data storage and back-up protection of the operating program.

The separately mounted keyboard shall have a standard typewriter format with tactile feedback, twelve special function keys, and a separate numeric keypad for entering set point data and cursor control. The 256-character symbol set shall include 96 ASCII characters and the IBM (International Business Machine) graphic symbols. The system shall include a 2-button Windows compatible mouse with mouse pad. The ODC shall be a minimum Dell Optiplex Model 990 or latest current model.

C. LCD Video Displays

The system unit shall be equipped with an LCD Flat Panel display. The LCD display shall be a 21.5" high-resolution (1920 x 1080) color display terminal with minimum .247mm dot pitch, 1,000:1 contrast ratio, and IBM SXGA compatibility. The LCDs shall be utilized for display of station and system graphics and real-time data display. The LCD shall provide for operator input and output data, multiple graphic overviews, report generation, and access to system utilities. The LCD display shall be a minimum Dell 21.5inch U2212HM Flat Panel Monitor or latest available model.

D. Large Wall Mount Displays

Two large screen displays are to be mounted to the Control Room wall. The displays will be dedicated for display distribution system graphics and display of the WTP graphics. The displays shall be 55", 1080P minimum and the current model as manufactured by Visio, Samsung, Sharp, or approved equal.

E. Printer

The system shall include a color "graphic" Laserjet printer with a 600dpi X 600dpi resolution, color resolution, 21ppm color output speed, and 1000 page/month duty cycle. The printer shall provide for printing of alarms summaries, data logs, trend graphs, and reports. The printer shall be a HP DeskJet CP2020 printer or equal.

F. Internal Modem

The internal modem shall be reserved for phone-line debug & remote access.

The ODC shall include remote access software for remote access by the Owner's or Systems Integrator's remote computers. The software shall provide for remote access security and be the latest version of Symantec's PCAnywhere, Citrix GoToMyPC, or approved equal.

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G. Enclosures

The Operator Display Console unit (including CRT display, Keyboard, and System Unit) and the graphic printer shall be located on top of a desk supplied by the Owner. All interconnecting cabling shall be plug-in and supplied by the contractor.

H. Battery Back-up Operation

The ODC shall include 20 minutes of back up. The ODC back-up unit shall be a Stand-by Uninterruptible Power Supply (UPS) system that provides power line filtering and transient protection. The unit shall automatically take over (within 4mS) when the power line fails without interrupting or restarting the system and automatically recharge the battery within 10hours after the power returns to normal. The UPS shall be located at the desk location of the ODC and shall power the System Unit and display. The UPS shall be a APC Back-UPS 650, 1000, or 1400 as required.

2.6 OPERATOR DISPLAY CONSOLE SOFTWARE

A. General

The software shall be 64bit compatible and capable of operating in the ODC hardware described above as well as in customer supplied Windows Professional compatible hardware similar to the unit specified above. The contractor shall supply a fully functional "developmental" version of the SCADA software (including any required software protection keys) for the first ODC as well as a separate configured "runtime" version for installation and use in a customer supplied back-up computer. The software may be modular, however the operator interface shall provide an integrated interface to all areas of the program. Demo program copies will not be allowed.

The software shall operate in the 64-bit Windows 8 Professional Business environment. The software shall be the latest "full developmental" version of **SCADAview CSX (Client/Server)**, The software shall be licensed to the owner.

B. System Back-up & Installation

The contractor shall provide a back-up copy of the installed software on a USB-Thumb drive. Back-up copies of any setup or graphic files shall be on a USB-Thumb drive. In the event of a catastrophic failure, the Owner shall utilize the USB-Thumb drive for emergency reloading the software. The contractor shall provide an easy to use installation (or re-installation) program that will automatically setup the hard drive operating system and automatically load (or reload) the software.

C. System Capacity

At a minimum, the operating software shall be capable of accommodating 32,000 tag points as follows:

1. Discrete status & alarm points
2. Measured variables
3. Accumulated variables
4. Calculated status & alarm points
5. Calculated control points

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D. Communications

The HMI shall have several methods for exchanging data from programmable controllers and other software programs.

1. Direct
2. DDE Client/Server
3. OPC Client
4. ODBC
5. SQL Database (MySQL, MS-SQL, PostgreSQL)

E. HMI Operational Characteristics:

In general, the HMI software shall display all received data in engineering units with appropriate generated labels, generate and print alarms, print logs, store manually entered data, update displays, and perform operator commands as required by the database. The system shall automatically generate the following system displays:

1. Main Menu page (with direct access to all screens and other program modules)
2. System Summary page listing key data points for all RTUs in the system
3. RTU specific display pages showing all data for each RTU in the system

Beyond the basic operating software required for SCADA operations, the software package shall accommodate the following:

1. Status Point Operations:
 - a. Display ODC, CTU, and RTU status functions
 - b. Input/Display control database
2. Analog Data:
 - a. Display value directly in engineering units
 - b. Accept operator High & Low alarm limits and generate alarms
 - c. Accept operator rate of change alarm limit and generate alarm
 - d. Store data for trending displays
3. Flow Rate Data:
 - a. Display value directly in engineering units
 - b. Accept operator High & Low rate alarm limits and generate alarms
 - c. Totalize flow total and display in engineering units
 - d. Accept operator High/Low 24 hour total limits and alarms
 - e. Store data for trending displays
4. Pump Control Operations:
 - a. Display ODC, CTU, and RTU HAND/OFF/AUTO functions
 - b. Display Pump CALL/RUN/FAIL status for each pump
 - c. Input/Display control database
5. Alarm Point Operations:
 - a. Display ODC, CTU, and RTU alarm functions
 - b. Enter new alarm in data log archive and send alarm to printer
 - c. Sound alarm horn until alarm is acknowledge by the operator
 - d. Log alarm acknowledgment to data log and printer
 - e. Log alarm clearing and send alarm clear to printer
 - f. Input/Display control database

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6. Event Point Operations:
 - a. Display ODC, CTU, and RTU alarm functions
 - b. Display ODC, CTU, and RTU event functions
 - c. Enter new event in data log archive and send alarm to printer
 - d. Log event clearing and send alarm clear to printer
 - e. Input/Display control database
7. Historical Trending Operations:
 - a. Real-time and historical trending functions
 - b. Create a multi-pen trend.
 - c. Ability to be shaded to compare two or more different trends
 - d. Create a trend that is part of a graphic display
 - e. The trends shall have a marker displaying the pen's date, time, and value

F. Graphical Screen Display Editor

The HMI shall provide a graphics display editor for creating displays using graphic objects. The graphics display editor shall have the ability to drag and drop objects from a pre-configured graphics library, paste objects that are copied to the clipboard from another Windows application, and insert objects created by another Windows application using OLE. True OLE support is required in that it shall be possible to call up the native application that created the object being inserted and use the naïve object editing tools from within the HMI. The graphics display editor shall have tear-away toolbars and color palettes. It shall be possible to customize the color pallet. Graphics drawn with a customized color pallet shall not require the customized color pallet to be present on all runtime computers. Colors must be stored internal to the graphic files as Red, Green, Blue numbers, not pallet indexes. The graphics display editor shall have:

1. Context sensitive “right-mouse” support on all objects.
2. As a minimum the following drawing tools:
Rectangle, line, ellipse, wedge, and text
3. As a minimum the following editing tools:
Tag substitute, flip, rotate, resize, reshape, align, cut, paste, copy, duplicate, bring to front, send to back, space, fill, undo, redo, line, and color.
4. As a minimum the following viewing tools:
Zoom in, zoom out, pan, and view entire graphic.
5. The ability to use tag placeholders to provide a way to use one graphic display to represent a number of similar operations.
6. Provide tools for each of the following as a minimum:
Numeric input, numeric display, string input, string display, label, arrow, recipe, alarm summary, tag monitor, input command line, trend, button, OLE object, and ActiveX object.
7. The ability to create a screen background by converting objects to wallpaper. These wallpaper objects cannot be selected or edited.
8. Allow the user to create libraries of graphic objects.
9. Allow the user to assign control to any object or grouping of objects. It shall also allow the user to drill down in a group to modify any object or object attribute without losing any object control property.
10. Allow control to be copied from any object to another object.
11. Permit the user to specify screen placement anywhere on the display.

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2.7 HMI CLIENT SERVER – TO BE ADDED IN THE FUTURE

A. General

The HMI option shall permit Client/Server operation whereby graphics functionality (full operations) shall be provided at a client station. The HMI sever shall permit up to 10 remote clients at any one time. HMI Client server communications shall be based upon STANDARD TCP/IP communications and permit remote operation across a WAN or a high speed radio based network.

B. The HMI Server shall:

1. Support data server redundancy.
2. Support seamless fail over from a primary server to a secondary server.
3. Support seamless fail back from a secondary server to a primary server.
4. Support notification of a service disruption including computer name of failed server.
5. Support notification service recovery including the computer name of active server.
6. Support redundancy without the need to write application logic.
7. Automatically synchronize the alarm state information on the primary and secondary so there is no disruption or loss of alarm state information on a failover.
8. Permit client/server operation whereby graphics functionality (full operations) shall be provided at a client station.

2.8 WEB SERVER

A. General

The ODC shall include an integral WEB Server allowing the operator to remotely access the system using standard WEB browser software (MS Internet Explorer). The operator shall have the ability to monitor the main display screen, view current alarms, view RTU sub-screens, view trend graphs, and make changes to the HOA and operator setpoints.

The integral WEB Server will use the same ODC HMI software security to control unauthorized access.

2.9 VOICE ALARM PHONE-DIALER

A. General

The ODC shall be equipped with software based automatic alarm dialer software. The software shall be tied to the MMI software database to provide automatic dialing of operator selected alarms. The software shall be 32bit compatible and capable of operating in the ODC hardware described above. The contractor shall supply a fully functional "developmental" version of the Alarm Dialer Software (including any required software protection keys) for the first ODC as well as a separate configured "runtime" version for installation and use in a customer supplied back-up computer. The software may be modular, however the operator interface shall provide an integrated interface to all areas of the program.

The software shall dial a pre-programmed list of phone numbers to provide a natural voice describing generated the specific alarm and time of occurrence. The dialer software shall have provisions to accept an operator acknowledgement of the alarm that will cancel further calls. If a proper acknowledgement is not received, the software will continue to dial phone numbers from the list until an acknowledgement is received.

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The alarm dialer software shall allow operators to dial into the system to retrieve current alarm status and via a voice driven menu system access current operational data for each remote station.

B. Phone Dialer Modem

The phone dialer software shall include a voice modem that will allow the ODC computer to interface with standard dial-up phone-lines. The modem shall be FCC type approved. The Alarm Dialer Software shall be SCADAdial, Win911, or SCADAlarm.

PART 3 - EXECUTION

3.1 EQUIPMENT EXAMINATION

The control system shall be completely tested prior to shipment. The entire control system shall be "Burned In" at the factory for a period of at least 20 days. The component equipment shall be computer tested and temperature cycled at zero degrees and at fifty degrees centigrade.

3.2 SYSTEM START-UP

The manufacturer shall supply "Factory" personnel for start-up service as needed to insure satisfactory operation. Subsequent trips to the job site to correct defects shall be made at no charge to the Owner during the warranty period.

3.3 TRAINING

The system manufacturer shall supply "factory" personnel to conduct two separate on-site training sessions, totaling a minimum of three days of training.

The initial training session shall be conducted during start-up as needed until the Owner and Engineer are satisfied that the operators are comfortable with the operation and maintenance of the system. Training shall be done on site with the owner's personnel.

Three to six months after the Owner commencing system operation, the system manufacturer shall supply "factory" personnel to conduct follow-up training of the Owner's personnel. The follow-up training shall be conducted on-site and consist of reviewing the operation and maintenance of the system. The Owner shall be contacted a minimum of two weeks in advance, prior to scheduling the training session to allow proper coordination.

3.4 SUBSTANTIAL COMPLETION

The Engineer will grant substantial completion only after completion of the start-up and initial training phase of the project. The Engineer shall make an inspection of the system to determine the status of completion. Substantial completion will be awarded only when the system is providing usable service to the Owner. If the system is commissioned in phases, the Contractor may request substantial completion for the completed phases.

3.5 ACCEPTANCE TEST

After start-up and debugging of the entire system has been completed, the system manufacturer shall notify the Engineer that he is ready to begin the 60-day acceptance test. The system must run continuously for 60 consecutive calendar days. During this period, all system functions shall be exercised in automatic control, including all levels of back-up control. During the initial phase of the acceptance test, the multiple levels of control and radio path pad shall be demonstrated to the Owner as follows:

1. Primary level control shall be demonstrated by allowing the operators to manually initiate remote device operation and observing the automatic operation by comparing trend charts to operator entered stop/start values.
2. Secondary level control shall be demonstrated by turning off the ODC and verifying that each automatic control loop continues to function by monitoring operation with a passive monitor.
3. Third level control shall be demonstrated by turning off the CTU radio and verifying that the RTUs continue automatic operation and communications between RTUs by monitoring one full cycle of automatic operation using a passive monitor.
4. The fourth level of control shall be demonstrated by placing selected RTUs in back-up pressure mode and monitoring tower levels to observe one full pumping cycle.

Any level test or system interruption and accompanying component, subsystem, or program failure shall be logged for cause of failure, as well as the time of occurrence and the duration of each failure.

The Owner's representative shall classify failures as either major or minor. A minor failure would be a small, non-critical component failure that is corrected by the operators. This occurrence shall be logged but shall not be grounds for non-acceptance unless the same or similar failure occurs repeatedly (more than two such failures of similar components). A major failure shall be considered to have occurred when a component, subsystem, or program fault causes a halt in the operation of the any portion of the system and/or when a "factory" technician's work is required to make a repair or to reinitiate operation of the system.

A major failure shall cause termination of the 60-day acceptance test. When the causes of a major failure have been corrected, a new 60-day acceptance test shall be started. Final Acceptance of the control system shall not occur until satisfactory completion of this 60-day test.

The manufacturer shall provide "factory" personnel who shall be on site and conduct the initial system exercise portion of the testing. The manufacturer shall be responsible for maintaining a checklist type test report wherein each function is checked-off and initialed by the Owner's representative as it is demonstrated. During the remainder of the 60-day acceptance test, the manufacturer shall provide 24-hour response to calls from the owner in order to correct any failure.

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3.6 WARRANTY/SUPPORT PROGRAM

The control system manufacturer shall supply a **TWO (2)** year parts and labor warranty and comprehensive support program for all items and software supplied under this section (including PLC/RTU front panel displays, except as noted below). Power surges and lightning damage shall be included as part of the warranty.

The warranty shall begin from the time of "substantial completion" as issued by the engineer. The manufacturer shall provide a 24-hour response to calls from the Owner. The manufacturer, at his discretion, may dispatch replacement parts to the Owner by next-day delivery service for field replacement by the Owner. Any damage to the control system caused by the actions of the Owner in attempting these field replacements shall be the sole responsibility of the manufacturer. If, during the warranty period, satisfactory field repair can not be attained by field replacement of parts by the Owner, the manufacturer shall dispatch "factory" personnel to the job site to complete repairs at no cost to the Owner.

The support program shall begin from the time of "substantial completion" as issued by the engineer. The support program shall include free updating of all software as needed and providing free phone support from the integrator throughout the warranty period.

The ODC Industrial Computer Unit shall be covered by a one (1) year warranty beginning with "substantial completion". Lightning damage shall be included as part of the warranty on these components.

PART 4 - APPENDIX: DETAILED EQUIPMENT DESCRIPTION

4.1 WATER TREATMENT PLANT STATION REQUIREMENTS:

A. Installation Requirements:

All of the Central Terminal Unit (CTU) equipment (including CTU, radio, power supplies, and local inputs & outputs) at the central shall be housed in a single wall mount NEMA 12 enclosure.

The CTU shall communicate with the distribution PLC/RTUs via existing VHF radio based data network. The CTU shall communicate with the Raw Water Station via a new UHF highspeed radio based data network. Additionally, the WTP PLCs and computer will be networked via CAT6/Ethernet network.

The General/Electrical Contractor will be responsible for all electrical installation including the (2) antennas and coax that will be mounted on the 40' Rohn Antenna tower specified previously. The General/Electrical Contractor will be responsible for installation of the Rohn tower assembly and required concrete.

B. Front Panel Display Requirements:

1. Keypad & Display assembly to display all inputs and output status

C. Discrete Outputs:

1. HS Pump VFD #1 Call
2. HS Pump VFD #2 Call
3. HS Pump VFD #3 Call (Future)
4. Chemical Feed Call (Bleach Feeder #1)
5. Chemical Feed Call (Bleach Feeder #2)
6. Chemical Feed Call (Fluoride Feeder)
7. Chemical Feed Call (Post-Injection Feeder)
8. Chemical Feed Call (Pre-Injection Feeder)
9. -16 spares

D. Discrete Inputs:

1. Power Failure/Generator Running
2. HS Pump VFD #1 Running
3. HS Pump VFD #2 Running
4. HS Pump VFD #3 Running (Future)
5. HS Pump VFD #1 Fault
6. HS Pump VFD #2 Fault
7. HS Pump VFD #3 Fault (Future)
8. -24 spares

E. Analog Inputs:

1. Clearwell Water Level (New Transducer as specified earlier)
2. Finished Water Flow Rate (Signal from flow meter provided by others)
3. Discharge Pressure (New Transducer as specified earlier)
4. Finished Water Turbidity

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5. Finished Water PH
6. Finished Water CL2 Residual
7. Bleach Scale #1 Weight (Signal from others)
8. Bleach Scale #2 Weight (Signal from others)
9. Fluoride Weight (Signal from others)
10. Post-Injection Scale Weight (Signal from others)
11. Pre-Injection Scale Weight (Signal from others)
12. – 20. spares

F. Analog Outputs:

1. HS Pump VFD #1 Speed Command
2. HS Pump VFD #2 Speed Command
3. HS Pump VFD #3 Speed Command (Future)
4. (Reserved) Bleach Feed Pump Speed Command
5. (Reserved) Fluoride Feed Pump Speed Command
6. (Reserved) Pre-Injection Feed Pump Speed Command
7. (Reserved) Post-Injection Feed Pump Speed Command
8. -10 spares

G. Ethernet IP Data Network – Allen Bradley (Actiflo PLC Interface)

The CTU Panel shall include an Industrial Ethernet Switch/Router for interfacing with the Package Water Treatment control system. The Ethernet Switch shall be a N-Tron 708TX or approved equal. The following data will be exchanged between the Actiflo Control System and WTP SCADA System: The exact list will be determined and identified during the submittal process.

1. Approximately (50) Status signals
2. Approximately (50) Alarm signals
3. Approximately (50) Analog signals
4. Approximately (30) Control and Setpoint Signals

H. The following WTP data will be exchanged with the water office CTU (existing VHF radio):

1. Power Failure/Generator Running
2. HS Pump VFD #1 Running
3. HS Pump VFD #2 Running
4. HS Pump VFD #1 Fault
5. HS Pump VFD #2 Fault
6. Clearwell Water Level
7. Finished Water Flow Rate
8. Raw Water Flow Rate
9. Discharge Pressure
10. Finished Water Turbidity
11. Finished Water PH
12. Finished Water CL2 Residual

I. High Service Pump Operational Requirements (additional operation design will be evaluated during the submittal review process):

1. The High Service (HS) pumps will be capable of starting/stopping based on operator-entered setpoints compared to the remote tank water levels. A low-level clearwell operational setpoint will not allow the HS pumps to operate in the event of a low water level in the clearwell.

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2. During plant operation the HS pumps will operate to maintain a consistent operator entered water level in the clearwell.

4.2 RAW WATER PUMP STATION REQUIREMENTS:

A. Installation Requirements:

Telemetry Control and Pump Command outputs to other panels shall be dry isolated contacts on relays. Local water level inputs shall be by two-wire transducers as specified.

The Pump Station equipment shall be housed in a NEMA 12 wall mount enclosure. The pump station equipment shall include an internal power switch, bulkhead coaxial cable lightning arrestor, and a power line lightning arrestor as specified earlier.

The General/Electrical Contractor will be responsible for all electrical installation including the antenna and coax that will be mounted on the 40' Rohn Antenna tower specified previously. The General/Electrical Contractor will be responsible for installation of the 40' Rohn tower assembly and required concrete.

B. Front Panel Display Requirements:

1. Keypad & Display assembly to display all inputs and output status

C. Discrete Outputs:

1. Raw Water Pump #1 CALL
2. Raw Water Pump #2 CALL
3. spare
4. spare

D. Discrete Inputs:

1. Power Failure
2. Raw Water Pump #1 RUNNING
3. Raw Water Pump #2 RUNNING
4. High Discharge Pressure Alarm Pump 1 (Pressure Switch supplied by SCADA supplier)
5. High Discharge Pressure Alarm Pump 2 (Pressure Switch supplied by SCADA supplier)
6. spare
7. spare
8. spare

E. Analog Inputs:

1. Water Level/Intake Transducer (New Transducer as specified earlier)
2. FUTURE Flow Rate/Total
3. spare

F. Analog Outputs:

1. Raw Water Pump #1 Speed Control
2. Raw Water Pump #2 Speed Control
3. spare
4. spare

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G. Raw Water Pump Operational Requirements:

1. The Actiflo Control Panel (PLC) will share a “Plant Start Command” with the SCADA PLC. Based on operator entered parameters a Raw Water (RW) pump will start and maintain a desired Actiflo flow rate. The pumps will be alternated after each pumping cycle.
2. During a Actiflo backwash procedure, the Actiflo PLC will share a new desired flow rate (approximately 50%) with the SCADA. The RW pump VFD will be slowed down matching the new desired flow rate.

SECTION 22 01 00 - PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Pipe and pipe fittings.
- B. Valves.
- C. Sanitary sewer piping system.
- D. Domestic water piping system.

1.02 RELATED SECTIONS:

- A. Section 22 05 29 - Supports and Anchors.
- B. Section 22 05 53 - Mechanical Identification.
- C. Section 22 07 00 - Piping Insulation.

1.03 REFERENCES:

- A. ANSI B31.1 - Power Piping.
- B. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings.
- C. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
- D. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- E. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- F. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
- G. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- H. ASTM B42 - Seamless Copper Pipe.
- I. ASTM B75 - Seamless Copper Tube.
- J. ASTM B88 - Seamless Copper Water Tube.
- K. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe.

- L. AWWA C110 - Ductile-Iron and Gray-Iron Fittings 3 in. Through 48 in., for Water and Other Liquids.
- M. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
- N. AWWA C651 - Disinfecting Water Mains.
- O. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

1.04 QUALITY ASSURANCE:

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code.
- C. Welders Certification: In accordance with ASME Section VIII.

1.05 REGULATORY REQUIREMENTS:

- A. Perform Work in accordance with applicable plumbing code.
- B. Conform to applicable code for installation of backflow prevention devices.
- C. Provide certificate of compliance from authority having jurisdiction.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Deliver, store, protect and handle products to site under provisions of Section 22 01 00.
- B. Accept valves on site in shipping containers with labeling in place.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 ENVIRONMENTAL REQUIREMENTS:

- A. Do not install underground piping when bedding is wet or frozen.

1.08 EXTRA MATERIALS:

- A. Furnish under provisions of Section 22 01 00.
- B. Provide two re packing kits for each size valve.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING:

- A. Cast Iron Pipe: ASTM A 74, service weight.
 - 1. Fittings: Cast Iron.
 - 2. Joints: ASTM C564, neoprene gasket system or lead and oakum.
- B. Schedule 40, PVC Pipe. ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: D2855, solvent weld with ASTM D2564 solvent cement.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING:

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast Iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. Schedule 40, PVC Pipe. ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: D2855, solvent weld with ASTM D2564 solvent cement.

2.03 SANITARY SEWER PIPING, ABOVE GROUND:

- A. Schedule 40, PVC Pipe. ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: D2855, solvent weld with ASTM D2564 solvent cement.

2.04 WATER PIPING, ABOVE GROUND:

- A. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, solder, Grade 96TA.

2.06 FLANGES, UNIONS, AND COUPLINGS:

- A. Pipe Size 2 inches and Under:
 - 1. Ferrous Pipe: 150 psig malleable iron threaded unions.
 - 2. Copper Tube and Pipe: 150 psig bronze unions with soldered joints.
- B. Pipe Size over 2 inches:
 - 1. Ferrous Pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.
 - 2. Copper Tube and Pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.
- C. Grooved and Shouldered Pipe End Couplings:
 - 1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - 2. Sealing Gasket: "C" shape composition sealing gasket.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.10 GATE VALVES:

- A. Manufacturers: Milwaukee 105 or Equal.
- B. Up to and including 2 inches: Bronze body, bronze trim, non-rising stem, handwheel, inside screw, single wedge or disc, threaded ends.
- C. Over 2 inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends.

2.11 BALL VALVES:

- A. Manufacturers: Milwaukee BA-200 or Equal.
- B. Up to and including 2 inches: Bronze two piece body, stainless steel ball, Teflon seats and stuffing box ring, lever handle, threaded ends with union.

PART 3 EXECUTION

3.01 EXAMINATION:

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION:

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

- B. Remove scale and dirt, on the inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION:

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Establish elevations of buried piping outside the building to ensure not less than three feet of cover.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Provide support for utility meters in accordance with the requirements of utility companies.
- L. Prepare support for fittings, supports and accessories not prefinished , ready for finish painting.
- M. Install bell and spigot pipe with bell end upstream.
- N. Install valves with stem upright or horizontal, not inverted.
- O. Slope piping and arrange to drain at low points. Use eccentric reducers to maintain top of pipe level.

3.04 APPLICATION:

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.

- C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.
- D. Install gate valve for shut-off and to isolate equipment , part of system, or vertical risers.

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM:

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution an test for disinfectant residual at minimum of 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual test less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner that 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION 22 01 00 Plumbing Piping

SECTION 22 02 00 - PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 CONDITIONS OF THE CONTRACT

- A. The conditions of the Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.
- B. This Section is a Division 22 Basic Materials and Methods Section and is a part of each Division 22 Section.
- C. The contractor shall be responsible for construction coordination of all work described in this section with the work specified in other sections of the specifications and shown on the Drawings. In advance of construction, coordinate and work out any minor problems with other trades to avoid conflicts therewith. However, if other minor problems are encountered, bring these problems to the attention of the Architect, who will make the final decisions as to correction.
- D. If substituted equipment (approved-equal) is to be used, the Contractor shall revise the floor plans shown on the Drawings, indicating to scale, the equipment to be used. The purpose of these revised scale plans is to identify any problems with substituted equipment, and access and clearance requirements are maintained. These revised scale plans are to be submitted with the substituted equipment submittals.

1.02 WORK INCLUDED

- A. This Section consists of General Requirements and Standard Specifications covering certain parts of work under Division 22 and is supplemented by other Division 22 sections covering additional work, requirements, and materials specifically applicable to the work of each section.

1.03 CODE AND REGULATORY AGENCY COMPLIANCE

- A. Provide work and materials in full accordance with the latest rules and regulations of the following:
 - 1. Occupational Safety and Health Administration
 - 2. 2012 International Plumbing Code
 - 3. National Fire Protection Association, 101, Life Safety Code

1.04 QUALITY ASSURANCE

- A. Manufacturers: Only firms regularly engaged in manufacturing of the Plumbing services, equipment and specialties of types and sizes required, whose products have been in satisfactory use in similar service shall be used on this project.

- B. Installers Qualifications: Only firms with successful installation experience on projects with work similar to that required for this project shall perform work on this project.

1.05 SUBMITTALS

- A. Provide six copies of each type of equipment material or information for installation.

1.06 SITE EXAMINATION

- A. Examine site, verify dimensions and locations against Drawings, and inform self of conditions under which work is to be done before submitting proposal. No allowance will be made for extra expense on account of error.
- B. Information shown relative to existing services is based upon available records and data but is approximate only. Make minor deviations found necessary to conform with actual locations and conditions without extra cost. Verify location and elevation of utilities prior to commencement of excavation for new piping or its installation.

1.07 PLACEMENT OF EQUIPMENT AND WORK

- A. The placement of substituted (approved equal) equipment and specified equipment in the locations shown on the drawings shall be the Contractors responsibility. The Contractor shall verify that all substituted and specified equipment will fit, operate and have clearances and accessibility for maintenance, inspections, and operation within the space shown on the Drawings and/or clearances and accessibility cannot be achieved, he shall bring these problems to the attention of the Architect who will make the final decision as to the method of correction. Corrections to work already completed and in-place shall not constitute an increase in the contract amount.
- B. Move equipment and/or work into spaces through openings provided or located in the spaces during construction, as required.
- C. Do disassembling and reassembling of equipment or other work necessary to accomplish this requirement without extra cost to the Owner. Do not disassemble or reassemble any equipment in order to locate it in the space.

1.08 MATERIAL LIST AND SUBSTITUTIONS

- A. Comply with Supplementary General Conditions.

1.09 MAINTENANCE AND OPERATING INSTRUCTIONS

- A. Incorporate complete operating instructions including starting, stopping, and description of emergency manual operation methods for the following:
 - 1. Plumbing Pumps
 - 2. Plumbing systems
 - 3. Water Heating Systems

4. Provide charts and diagrams as required
 5. Provide operating manual for any equipment listed in individual sections of the specifications
- B. Provide maintenance instructions for each item of individual equipment covering pertinent maintenance data, such as lubricants to be used, frequency of lubrications, inspections required, adjustments, belt and pulley sizes, etc.
 - C. Provide parts, bulletins containing manufacturer's bulletins with parts numbers, instructions, etc., for each item of equipment. Strip bulletins so that useless bulk is avoided.
 - D. Post service telephone numbers and/or addresses in an appropriate place as designated by the Architect.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Mention herein or on Drawings requires that this Contractor provide each item listed of quality noted or acceptable equal. All material shall be new, full weight, standard in all respects, and in first-class condition. Provide materials of the same brand of manufacture throughout for each class of material or equipment where possible. Materials shall be tested within the Continental United States by independent, nationally recognized testing agency and shall be listed in accordance with testing agency requirements.
- B. The grade or quality of materials desired is indicated by the trade names or catalog numbers stated herein. The catalog numbers and specification are for bidding purposes only. Actual equipment submitted and ordered shall be verified to be appropriate for indicated use.
- C. Dimension, sizes, and capacities shown are a minimum and shall not be changed without permissions of the Architect/Engineer.

2.02 MATERIALS FURNISHED

- A. Identify all materials and equipment by manufacturer's name and model number. Remove unidentified materials and equipment from site.
- B. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified.
- C. Equipment or material damaged during transportation, installation, or operation is considered as totally damaged. Replace with new equipment. Variance for this permitted only with written consent.

PART 3 - EXECUTION

3.01 DRAWINGS AND COORDINATION

- A. General arrangement and location of piping, equipment, etc., are shown on Drawings or herein specified. Careful examine other work that may conflict with this work. Install this work in harmony with other crafts and at proper time to avoid delay of work.
- B. In advance of construction, work out minor changes and relocations to suit actual conditions and work of other trades to avoid conflict therewith. Any change in rerouting ductwork, piping and equipment shall not be cause for additional cost.
- C. The Sub-Contractor shall verify that the measurement of constructed rooms, spaces and areas are as shown on Drawings. Any measurement deviation and/or discrepancies shall be brought to the attention of the Architect who will make the final decision as to the method of correction. Corrections to work already completed and in place shall be done at the Contractor's expense.
- D. In addition, obtain all necessary information from the other trades regarding centers of partitions, walls, location of plumbing mains, fire sprinkler mains, and electrical conduits, ducts, pipes, etc., in order that pipes equipment, and ductwork may be placed in their correct position.
- E. Execute any work or apparatus shown on the Drawings and not mentioned in the specifications, or vice versa, the same as if specifically mentioned by both Omission from Drawings or specifications of any minor details of construction, installation, materials or essential specialties does not relieve this Contractor from furnishing same in place complete.
- F. Furnish and install any incidental work not shown or specified which can reasonably be inferred as part of the work and necessary to provide a complete and workable system.
- G. Furnish materials and work at proper time to avoid delay of the work.

3.02 CLOSING IN ON UNINSPECTED WORK

- A. Do not allow or cause work installed to be covered up or enclosed before it has been inspected and tested. Should work be enclosed or covered up before it has been inspected and tested, Contractor shall uncover work at own expense. After it has been inspected and tested, make repairs necessary to restore work of other Contractors to condition in which it was found at time of cutting.
- B. Two (2) sets of Drawings showing all revisions shall be immediately presented to Architect for his records. Maintain additional copies on the project as necessary to comply with "RECORD DRAWINGS" requirement of the General Requirements.
- C. Incorporate all revisions into record Drawings. These drawings shall be up to date at the end of every week and shall be available to Architect or Engineer at any time for inspection.

3.03 GUARANTEE

- A. Be responsible for work done and material installed under these plans and specifications. Repair or replace, as may be necessary, any defective work, material, or part which may show itself within one (1) year of filing of Notice of Completion and be responsible for damage to other materials, furnishing, equipment, or premises caused by such defects during this period, if in the opinion of the Architect said defect is due to imperfection of material or workmanship. Provide all such work and materials at no cost to Owner.
- B. Be responsible for damage to any part of premises during guarantee period caused by leaks or breaks in work furnished and/or installed under this Section.
- C. Replace refrigerant, lubricants, or gases lost as a result of defects, breaks, or leaks in work.

3.04 RECORD DRAWINGS

- A. In addition, furnish one (1) tracing showing all outside utility connections, piping, etc., installed under this contract. Locate and dimension all work with reference to permanent landmarks.
- B. Match all symbols and designations used in contract Drawings when preparing "Record" Drawings.
- C. Indicate clearly and correctly all work installed differently from that shown, and maintain records up to date as work progresses. Include invert elevations of pipes below grade of floor, the floor lines, plugged wyes, tees, caps, exact locations and sizing or piping, location of valves, and the like. Dimension locations from structural points.
- D. Properly identify all stubs for future connections as to locations and use by setting of concrete marker at finished grade in manner suitable to Architect.

3.05 MAINTENANCE DATA

- A. Submit maintenance data and parts lists for all plumbing systems materials and products. Include product data, shop drawings, and Record Drawings in the maintenance manual all in allowance with the requirements of Division 1.

3.06 CLEANING UP

- A. Comply with Supplementary General Conditions.

END OF SECTION 22 02 00 Plumbing General Requirements

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Pipe and equipment hangers and supports.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.02 RELATED SECTIONS:

Not used.

1.03 REFERENCES:

- A. ASME B31.1 - Power Piping.
- B. ASME B31.9 - Building Services Piping.
- C. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- D. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- E. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS:

A. Manufacturers:

- 1. a) Grinnell
- b) B-Line
- c) Unistrut

B. Plumbing Piping - DWV

- 1. Conform to ASME B31.9.
- 2. Hangers for Pipe Sizes ½ to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
- 3. Hangers for Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
- 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- 5. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- 6. Wall Support for Pipe Sizes to 4 inches and Over: Welded steel bracket and wrought steel clamp.
- 7. Vertical Support: Steel riser clamp.
- 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water

1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes ½ to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
16. Roof Support: Polycarbonate pipe stand, Micro Industries Model 24R or Equal.

2.02 ACCESSORIES:

- A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.03 INSERTS:

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING:

- A. Metal Flashing: 26 gage galvanized steel.
- B. Metal Counter flashing: 22 gage galvanized steel.
- C. Lead Flashing:
 1. Waterproofing: 5 lb/ft² sheet lead.
 2. Soundproofing: 1 lb/ft² sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 EQUIPMENT CURBS:

- A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, pitched to match roof slope, 1-1/2 inch thick insulation, factory installed wood nailer.

2.06 SLEEVES:

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe of 18 gage galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Round Duct work: Galvanized steel.
- E. Sleeves for Rectangular Duct work: Galvanized steel.
- F. Fire stopping Insulation: Glass fiber type, non-combustible.
- G. Sealant: Acrylic.

PART 3 EXECUTION

3.01 INSTALLATION:

- A. Install in accordance with manufacturer's instructions.

3.02 INSERTS:

- A. Provide inserts for placement in concrete form work.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.03 PIPE HANGERS AND SUPPORTS:

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Use hangers within 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Design hangers for pipe movement without disengagement of supported pipe.
- J. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.04 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 4 inches thick and extended 6 inches beyond supported equipment.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.05 FLASHING:

- A. Provide flexible flashing and metal Counter flashing where piping and duct work penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on both sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash, and seal.
- C. Seal drains watertight to adjacent materials.
- D. Provide curbs for mechanical roof installations 14 inches minimum height above roofing surface. Flash and counter flash with sheet metal; seal weather tight. Attach Counter flashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.06 SLEEVES:

- A. Set sleeves in position in form work. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors one inch above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.07 SCHEDULES:

HANGER ROD (inches)	PIPE SIZE (inches)	HANGER SPACING (feet)
3/8	1/2 to 1-1/4	6.5
3/8	1-1/2 to 2	10
1/2	2-1/2 to 3	10
5/8	4 to 6	10
7/8	8 to 12	14
5/8	PVC (all sizes)	6
1/2	C.I. Bell and Spigot (or No-Hub) and at Joints	5

END OF SECTION 22 05 29 Hangers and Supports for Plumbing Piping and Equipment

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.

1.02 REFERENCES:

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.01 NAMEPLATES:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.02 TAGS:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Chart: Typewritten letter size list in anodized aluminum frame.

2.03 STENCILS:

Not used.

2.04 PIPE MARKERS:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Color: Conform to ASME A13.1.
- D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

- F. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS:

A. Manufacturers:

- 1. Brady, Seton or Carlton.

B. Description: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:

- 1. Green - Plumbing valves.

2.06 PAINTING:

A. Manufacturers: Products recognized for pipe application. Paint applied directly to elastomeric insulation shall be made specifically for that purpose.

B. Description: Paint all exposed gas piping. Employ qualified craftsman with a minimum of three years experience in pipe painting.

PART 3 EXECUTION

3.01 PREPARATION:

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for painting.

3.02 INSTALLATION:

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic pipe marker complete around pipe in accordance with manufacturer's instructions.

E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

F. Identify air handling units with tags.

G. Identify valves in main and branch piping with tags.

H. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and

drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- I. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closet to equipment.

END OF SECTION 22 05 53 Identification for Plumbing and Equipment

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED SECTIONS:

Not used.

1.03 REFERENCES:

- A. ASTM C195 - Mineral Fiber Thermal Insulation Cement
- B. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation
- C. ASTM C449 - Mineral Fiber and Hydraulic-setting Thermal Insulating and Finishing Cement.
- D. ASTM 534 - Performed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- E. ASTM C547 - Mineral Fiber and Performed Pipe Insulation.

1.04 QUALITY ASSURANCE:

- A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84.

1.05 QUALIFICATIONS:

- A. Applicator: Company specializing in performing the work of this section with a minimum of three years experience.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver, store protect and handle products to site under provisions of Section 23 02 00.
- B. Deliver materials to site in original factory packaging, labeled with manufacture's identification, including product density and thickness
- C. Store insulation in original wrapping and protect form weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufactures of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.01 GLASS FIBER:

- A. Manufacturers:
 - 1. Owen's-Corning,
 - 2. Manville
 - 3. Knauf Corporation

- B. Installation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' ('ksi') value: ASTM C335, 0.24 at 75 degrees F.
 - 2. Minimum Service Temperature: -20 degrees F.
 - 3. Maximum Service Temperature: 300 degrees F.
 - 4. Maximum moisture absorption: 0.2 percent by volume.

- C. Vapor Barrier Jacket
 - 1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
 - 3. Secure with self sealing longitudinal laps and butt strips.
 - 4. Secure outward with outward clinch expanding staples and vapor barrier mastic.

- D. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

- E. Vapor Barrier Lap Adhesive
 - 1. Compatible with insulation.

- F. Insulating Cement/Mastic
 - 1. ASTM C185; hydraulic setting on mineral wool.

PART 3 EXECUTION

3.01 Examination:

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION:

- C. Install materials in accordance with manufacture's instructions.
- D. On exposed piping, locate insulation and cover seams in least visible locations.

- E. Insulated cold pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory applied or field applied.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness of adjacent pipe.
 - 3. Finish with glass cloth and vapor barrier adhesive.
 - 4. PVC fitting covers may be used.
 - 5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 - 6. Insulate entire system including fittings, valves, unions, flanges, strainer, flexible connections, and expansion joints.

- F. For insulated pipes covering fluids above ambient temperature:

1. Provide standard jackets, with vapor barrier, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
3. Finish with glass cloth and adhesive.
4. PVC fitting covers may be used.
5. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but level and seal ends of insulation.
6. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

E. Inserts and Shields

1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields galvanized steel between pipe hangers or pip hanger rolls and inserts.
3. Insert location: Between support shields and piping under the finish jacket.
4. Insert Configuration: Minimum of 6 inches long, of same thickness and contour as adjoining insulation; maybe factory fabricated.
5. Insert Materials: Hydrous calcium silicate insulation as manufactured by Pipe Shield Incorporated.

G. Finish insulation at supports, protrusions, and interruptions.

3.03 GLASS FIBER INSULATION SCHEDULE:

PIPING SYSTEMS	PIPE SIZE	THICKNESS (Inch)
Domestic Hot Water & Recirc	All	1
Domestic Cold Water	All	1/2

END OF SECTION 22 07 00 - Plumbing Insulation

SECTION 23 02 00 - HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 CONDITIONS OF THE CONTRACT

- A. The conditions of the Contract (General, Supplementary, and other Conditions) and the General Requirements are hereby made a part of this Section.
- B. This Section is a Division 23 Basic Materials and Methods Section and is a part of each Division 23 Section.
- C. The contractor shall be responsible for construction coordination of all work described in this section with the work specified in other sections of the specifications and shown on the Drawings. In advance of construction, coordinate and work out any minor problems with other trades to avoid conflicts therewith. However, if other minor problems are encountered, bring these problems to the attention of the Architect, who will make the final decisions as to correction.
- D. If substituted equipment (approved-equal) is to be used, the Contractor shall revise the floor plans shown on the Drawings, indicating to scale, the equipment to be used. The purpose of these revised scale plans is to identify any problems with substituted equipment, and access and clearance requirements are maintained. These revised scale plans are to be submitted with the substituted equipment submittals.

1.02 WORK INCLUDED

- A. This Section consists of General Requirements and Standard Specifications covering certain parts of work under Division 23 and is supplemented by other Division 23 sections covering additional work, requirements, and materials specifically applicable to the work of each section.

1.03 CODE AND REGULATORY AGENCY COMPLIANCE

- A. Provide work and materials in full accordance with the latest rules and regulations of the following:
 - 1. Occupational Safety and Health Administration
 - 2. 2012 International Mechanical Code
 - 3. National Fire Protection Association, 101, Life Safety Code

1.04 QUALITY ASSURANCE

- A. Manufacturers: Only firms regularly engaged in manufacturing of the HVAC services, equipment and specialties of types and sizes required, whose products have been in satisfactory use in similar service shall be used on this project.
- B. Installers Qualifications: Only firms with successful installation experience on projects with work similar to that required for this project shall perform work on this project.

1.05 SUBMITTALS

- A. Provide six copies of each type of equipment material or information for installation.

1.06 SITE EXAMINATION

- A. Examine site, verify dimensions and locations against Drawings, and inform self of conditions under which work is to be done before submitting proposal. No allowance will be made for extra expense on account of error.
- B. Information shown relative to existing services is based upon available records and data but is approximate only. Make minor deviations found necessary to conform with actual locations and conditions without extra cost. Verify location and elevation of utilities prior to commencement of excavation for new piping or its installation.

1.07 PLACEMENT OF EQUIPMENT AND WORK

- A. The placement of substituted (approved equal) equipment and specified equipment in the locations shown on the drawings shall be the Contractor's responsibility. The Contractor shall verify that all substituted and specified equipment will fit, operate and have clearances and accessibility for maintenance, inspections, and operation within the space shown on the Drawings and/or clearances and accessibility cannot be achieved, he shall bring these problems to the attention of the Architect who will make the final decision as to the method of correction. Corrections to work already completed and in-place shall not constitute an increase in the contract amount.
- B. Move equipment and/or work into spaces through openings provided or located in the spaces during construction, as required.
- C. Do disassembling and reassembling of equipment or other work necessary to accomplish this requirement without extra cost to the Owner. Do not disassemble or reassemble any equipment in order to locate it in the space.

1.08 MATERIAL LIST AND SUBSTITUTIONS

- A. Comply with Supplementary General Conditions.

1.09 MAINTENANCE AND OPERATING INSTRUCTIONS

- A. Incorporate complete operating instructions including starting, stopping, and description of emergency manual operation methods for the systems provided.
- B. Provide maintenance instructions for each item of individual equipment covering pertinent maintenance data, such as lubricants to be used, frequency of lubrications, inspections required, adjustments, belt and pulley sizes, etc.
- C. Provide parts, bulletins containing manufacturer's bulletins with parts numbers, instructions, etc., for each item of equipment. Strip bulletins so that useless bulk is avoided.
- D. Post service telephone numbers and/or addresses in an appropriate place as designated by the Architect.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Mention herein or on Drawings requires that this Contractor provide each item listed of quality noted or acceptable equal. All material shall be new, full weight, standard in all respects, and in first-class condition. Provide materials of the same brand of manufacture throughout for each class of material or equipment where possible. Materials shall be tested within the Continental United States by independent, nationally recognized testing agency and shall be listed in accordance with testing agency requirements.
- B. The grade or quality of materials desired is indicated by the trade names or catalog numbers stated herein. The catalog numbers and specification are for bidding purposes only. Actual equipment submitted and ordered shall be verified to be appropriate for indicated use.
- C. Dimension, sizes, and capacities shown are a minimum and shall not be changed without permissions of the Architect/Engineer.

2.02 MATERIALS FURNISHED

- A. Identify all materials and equipment by manufacturer's name and model number. Remove unidentified materials and equipment from site.
- B. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified.
- C. Equipment or material damaged during transportation, installation, or operation is considered as totally damaged. Replace with new equipment. Variance for this permitted only with written consent.

PART 3 - EXECUTION

3.01 DRAWINGS AND COORDINATION

- A. General arrangement and location of piping, ductwork, equipment, etc., are shown on Drawings or herein specified. Careful examine other work that may conflict with this work. Install this work in harmony with other crafts and at proper time to avoid delay of work.
- B. In advance of construction, work out minor changes and relocations to suit actual conditions and work of other trades to avoid conflict therewith. Any change in rerouting ductwork, piping and equipment shall not be cause for additional cost.
- C. The Sub-Contractor shall verify that the measurement of constructed rooms, spaces and areas are as shown on Drawings. Any measurement deviation and/or discrepancies shall be brought to the attention of the Architect who will make the final decision as to the method of correction. Corrections to work already completed and in place shall be done at the Contractor's expense.
- D. In addition, obtain all necessary information from the other trades regarding centers of partitions, walls, location of plumbing mains, fire sprinkler mains, and electrical conduits, ducts, pipes, etc., in order that pipes equipment, and ductwork may be placed in their correct position.

- E. Execute any work or apparatus shown on the Drawings and not mentioned in the specifications, or vice versa, the same as if specifically mentioned by both Omission from Drawings or specifications of any minor details of construction, installation, materials or essential specialties does not relieve this Contractor from furnishing same in place complete.
- F. Furnish and install any incidental work not shown or specified which can reasonably be inferred as part of the work and necessary to provide a complete and workable system.
- G. Furnish materials and work at proper time to avoid delay of the work.

3.02 CLOSING IN ON UNINSPECTED WORK

- A. Do not allow or cause work installed to be covered up or enclosed before it has been inspected and tested. Should work be enclosed or covered up before it has been inspected and tested, Contractor shall uncover work at own expense. After it has been inspected and tested, make repairs necessary to restore work of other Contractors to condition in which it was found at time of cutting.
- B. Two (2) sets of Drawings showing all revisions shall be immediately presented to Architect for his records. Maintain additional copies on the project as necessary to comply with "RECORD DRAWINGS" requirement of the General Requirements.
- C. Incorporate all revisions into record Drawings. These drawings shall be up to date at the end of every week and shall be available to Architect or Engineer at any time for inspection.

3.03 GUARANTEE

- A. Be responsible for work done and material installed under these plans and specifications. Repair or replace, as may be necessary, any defective work, material, or part which may show itself within one (1) year of filing of Notice of Completion and be responsible for damage to other materials, furnishing, equipment, or premises caused by such defects during this period, if in the opinion of the Architect said defect is due to imperfection of material or workmanship. Provide all such work and materials at no cost to Owner.
- B. Be responsible for damage to any part of premises during guarantee period caused by leaks or breaks in work furnished and/or installed under this Section.
- C. Replace refrigerant, lubricants, or gases lost as a result of defects, breaks, or leaks in work.

3.04 RECORD DRAWINGS

- A. In addition, furnish one (1) tracing showing all outside utility connections, piping, etc., installed under this contract. Locate and dimension all work with reference to permanent landmarks.
- B. Match all symbols and designations used in contract Drawings when preparing "Record" Drawings.
- C. Indicate clearly and correctly all work installed differently from that shown, and maintain records up to date as work progresses. Include invert elevations of pipes below grade of floor, the floor lines, plugged wyes, tees, caps, exact locations and sizing or piping, location of valves, and the like. Dimension locations from structural points.

- D. Properly identify all stubs for future connections as to locations and use by setting of concrete marker at finished grade in manner suitable to Architect.

3.05 MAINTENANCE DATA

- A. Submit maintenance data and parts lists for all HVAC systems materials and products. Include product data, shop drawings, and Record Drawings in the maintenance manual all in allowance with the requirements of Division 1.

3.06 CLEANING UP

- A. Comply with Supplementary General Conditions.

END OF SECTION 23 02 00 - HVAC General Requirements

SECTION 23 05 29 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Pipe and equipment hangers and supports.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.02 RELATED SECTIONS:

- A. Section 15260 - Piping Insulation.
- B. Section 15410 - Plumbing Piping.

1.03 REFERENCES:

- A. ASME B31.1 - Power Piping.
- B. ASME B31.2 - Fuel Gas Piping.
- C. ASME B31.5 - Refrigeration Piping.
- D. ASME B31.9 - Building Services Piping.
- E. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- F. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- G. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- H. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS:

- A. Manufacturers:
 - 1. a) Grinnel.
 - b) Or Equal.
- B. Plumbing Piping - DWV, roof drainage:
 - 1. Conform to ASME B31.9.
 - 2. Hangers for Pipe Sizes ½ to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

6. Wall Support for Pipe Sizes to 4 inches and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water, Gas

1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes ½ to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
16. Roof Support: Polycarbonate pipe stand, Micro Industries Model 24R or Equal.

2.02 ACCESSORIES:

- A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.03 INSERTS:

- A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING:

- A. Metal Flashing: 26 gage galvanized steel.
- B. Metal Counter flashing: 22 gage galvanized steel.
- C. Lead Flashing:
 1. Waterproofing: 5 lb/ft² sheet lead.
 2. Soundproofing: 1 lb/ft² sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 EQUIPMENT CURBS:

A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, pitched to match roof slope, 1-1/2 inch thick insulation, factory installed wood nailer.

2.06 SLEEVES:

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe of 18 gage galvanized steel.

C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.

D. Sleeves for Round Duct work: Galvanized steel.

E. Sleeves for Rectangular Duct work: Galvanized steel.

F. Fire stopping Insulation: Glass fiber type, non-combustible.

G. Sealant: Acrylic.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Install in accordance with manufacturer's instructions.

3.02 INSERTS:

A. Provide inserts for placement in concrete form work.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.03 PIPE HANGERS AND SUPPORTS:

A. Support horizontal piping as scheduled.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers within 1-1/2 inch minimum vertical adjustment.

- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Design hangers for pipe movement without disengagement of supported pipe.
- J. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- K. All duct work and piping shall be provided with seismic restraints in accordance with The Seismic Restraint Manual: Guidelines for Mechanical Systems dated 1991, as published by SMACNA and in accordance with local codes.

3.04 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 4 inches thick and extended 6 inches beyond supported equipment.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.05 FLASHING:

- A. Provide flexible flashing and metal Counter flashing where piping and duct work penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on both sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter flash, and seal.
- C. Seal drains watertight to adjacent materials.
- D. Provide curbs for mechanical roof installations 14 inches minimum height above roofing surface. Flash and counter flash with sheet metal; seal weather tight. Attach Counter flashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.06 SLEEVES:

- A. Set sleeves in position in form work. Provide reinforcing around sleeves.

- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors one inch above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.07 SCHEDULES:

HANGER ROD (inches)	PIPE SIZE (inches)	HANGER SPACING (feet)
3/8	1/2 to 1-1/4	6.5
3/8	1-1/2 to 2	10
1/2	2-1/2 to 3	10
5/8	4 to 6	10
7/8	8 to 12	14
5/8	PVC (all sizes)	6
1/2	C.I. Bell and Spigot (or No-Hub) and at Joints	5

END OF SECTION 23 05 29 HVAC Supports and Anchors

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES:

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.

1.02 REFERENCES:

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.01 NAMEPLATES:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.02 TAGS:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Chart: Typewritten letter size list in anodized aluminum frame.

2.03 STENCILS:

Not used.

2.04 PIPE MARKERS:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Color: Conform to ASME A13.1.
- D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

- F. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.05 CEILING TACKS:

- A. Manufacturers:
 - 1. Brady, Seton or Carlton.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. Yellow - HVAC equipment.
 - 2. Red - Fire dampers/smoke dampers.
 - 3. Green - Plumbing valves.

2.06 PAINTING:

- A. Manufacturers: Products recognized for pipe application. Paint applied directly to elastomeric insulation shall be made specifically for that purpose.
- B. Description: Paint all exposed gas piping. Employ qualified craftsman with a minimum of three years experience in pipe painting.

PART 3 EXECUTION

3.01 PREPARATION:

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces for painting.

3.02 INSTALLATION:

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic pipe marker complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Identify air handling units with tags.
- G. Identify valves in main and branch piping with tags.
- H. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of

pipng. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- I. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- J. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closet to equipment.

END OF SECTION 23 05 53 Identification for HVAC Piping and Equipment

SECTION 23 05 93 - TESTING, ADJUSTING, BALANCING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of work:
 - 1. Extent of testing, adjusting and balancing work is indicated by requirements of this Section, and also by drawings and schedules, and is defined to include, but is not necessarily limited to, air distribution system, and associated equipment and apparatus of HVAC work.
 - 2. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents.
- B. Component types of testing, adjusting and balancing specified in this Section includes fans, air-conditioning units, ductwork systems.

1.02 QUALITY ASSURANCE

- A. Industry standards: Comply with American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), National Environmental Balancing Bureau (NEBB) or Associated Air Balance Councils (AABC) recommendations pertaining to measure, instruments, and testing, adjusting, and balancing. Provide an independent Test and Balance by a certified technician or hire HVAC design engineering firm with Professional Engineer and five years experience.

1.03 SUBMITTALS

- A. Comply with Section 01300, Submittals.
- B. Submit certified test report signed by Test and Balance Supervisor who performed TAB work. Include identification and types of instruments used and their most recent calibration data with submission of final test report.
- C. Maintenance data: Include in maintenance manuals, copies of certified test reports.

1.04 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed. If Test and Balanced is performed during construction it will be deemed null and void and performed over in presence of Architect/Engineer at no cost to the Owner and the Contractor shall incur all Architect's or Engineer's cost for supervision.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean free from debris, dirt, and discarded building materials.

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

- B. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, ductwork and housing which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposed. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings. Do not leave test holes uncovered.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in a manner acceptable to Tester.
- B. Air balance: The air balance shall include the following air tests in accordance with the following requirements:
 - 1. Test and adjust blower RPM or vane setting to design requirements (within +/- 5% of design requirements).
 - 2. Test and record motor full load amperes.
 - 3. Make pilot tube traverse of main supply ducts and obtain design cfm at fans.
 - 4. Test and record system static pressures, suction and discharge.
 - 5. Test and adjust system for design recirculated air cfm.
 - 6. Test and adjust outside system for design cfm outside air.
 - 7. Test and adjust exhaust air system for design cfm.
 - 8. Test and record entering air temperatures of heating and cooling coils (both db and wb of cooling coils).
 - 9. Test and record leaving air temperatures of heating and cooling coils (both db and wb of cooling coils).
 - 10. Adjust all main supply and return air ducts to proper design cf.
 - 11. Adjust all zones to proper design cfm, supply and return.
 - 12. Test and adjust each outlet and inlet (diffuser, grille and register) to within +/- 10% of design requirements. Use proportional method of balancing. Do not test each outlet and inlet with hood or similar device by adjusting air flow for since

reading. (Testing and adjusting single outlet without proportional balancing will result in unbalance when other outlets and inlets are adjusted.

13. Size, type and manufacturer of diffusers, grilles, registers, and tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
14. Readings and tests of diffusers, grilles, and registers shall include required fpm velocity and test resultant velocity, required cfm and test resultant cfm after adjustments.
15. In cooperation with the control manufacturer's representative, setting adjustments of automatically operated dampers to operate as specified, indicated and/or noted.
16. Adjust diffusers, grilles, and registers to minimum drafts in all areas.
17. Prepare reports of test results, including instrumentation calibration reports, in format recommended by applicable standards.
18. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.
19. Mark equipment setting, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of TAB work. Provide markings with paint or other suitable permanent identification materials.

END OF SECTION 23 05 93 Testing Adjusting, Balancing

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.01 SCOPE

- A. Refrigerant piping.
- B. Ductwork system insulation.

1.02 QUALITY ASSURANCE

- A. Flame/smoke ratings. Provide composite HVAC insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with Flame-Spread rating of 25 or less, and smoke-developed rating of 50 or less, as tested by ASTM E 84 (NFPA 225) method for ductwork and equipment. Flame-Spread of 25 or less and smoke-developed rating of 150 or less for Pipe Insulation and Fittings.

1.03 SUBMITTALS

- A. Product data: Submit manufacturer's specifications and installation instructions for each type of HVAC insulation. Submit schedule showing manufacturer's product number, thickness, and furnished accessories for each HVAC system requiring insulation.
- B. Certifications: Submit manufacturer's certifications to show compliance with these specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed, showing fire hazard ratings or products.
- B. Protect insulation against dirt, water, chemical or HVAC damage. Do not install damaged insulation.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. KNAUF Fiberglass, Armstrong World Industries, Inc., Johns-Mansville Corporation, Owens-Corning Fiberglass Corporation, or Pittsburg Corning Corporation.

2.02 REFRIGERANT INSULATION MATERIALS

- A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

- a. Aeroflex USA Inc.; Aerocel.
- b. Armacell LLC; AP Armaflex.
- c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2.03 DUCTWORK INSULATION MATERIALS

- A. Rigid fiberglass ductwork insulation: ASTM C612, Class 1 (non-load bearing) where insulation is not subjected to compressive loading, Class 2 (load bearing) where insulation is subjected to compressive loading; except provide higher Class where indicated.
- B. Flexible fiberglass ductwork insulation: ASTM C553, Type I, Class B-4.
- C. Cellular glass ductwork insulation: ASTM C552, Type I.
- D. Jackets for ductwork insulation: ASTM C921, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.
- E. Ductwork insulation accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

2.04 EQUIPMENT INSULATION MATERIALS

- A. Rigid fiberglass equipment insulation: ASTM C612.
- B. Flexible fiberglass equipment insulation: ASTM C553, Type 1, Class B-4.
- C. Cellular glass equipment insulation: ASTM C533, Type 1, Block.
- D. Jacketing material for equipment insulation: Provide pre-sized glass cloth jacketing materials, not less than 7.8 ounces per square yard, except as otherwise indicated.
- E. Equipment insulation compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for

applications indicated. All equipment insulation compounds shall comply with local, state, and county smoke and flame-spread requirements.

- F. Equipment insulation accessories: Provide staples, bands, wire, wire netting, tape corner angles, anchors, stud pins and metal covers as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 HVAC PIPING SYSTEM INSULATION

- A. Insulate all refrigerant piping with 1" thick insulation.

3.02 DUCTWORK SYSTEM INSULATION

- A. Rectangular low pressure ductwork shall be externally insulated downstream and upstream of air handler unit unless otherwise indicated on drawings.
- B. Insulation of ductwork exposed to weather: Protect outdoor insulation from weather by installing outdoor protective sheet metal jacket with finish. Jacket shall be made weather tight and sealed.
- C. Rectangular and round externally insulated ductwork. Insulate the following with 2" thick 3/4 lb. density fiberglass with vapor barrier.
 - 1. Outdoor air ductwork.
 - 2. Supply air duct.
 - 3. Return air ductwork.
 - 4. Exhaust air ductwork within 10' of roof.
 - 5. Bells of supply diffusers.
 - 6. HVAC plenums and unit housings not pre-insulated at factory.
- D. Hot ductwork (above ambient temperature): Insulate range and hood exhaust ductwork, with 2" thick flexible fiberglass.

3.03 EQUIPMENT INSULATION

- A. Cold equipment (below ambient temperature): Insulate HVAC equipment to have 1/2" thick fiberglass with vapor barrier.

3.04 INSTALLATION OF PIPING INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation on pipe systems subsequent to testing acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
- F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, pre-cut or job fabricated units (at Installer's option) except where specific form or type is indicated.
- G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- H. Install protective metal shields and insulated inserts wherever needed to prevent compression of insulation.
- I. Pipe hanger insulation inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.05 INSTALLATION OF DUCTWORK INSULATION

- A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Install insulation materials with smooth and even surfaces.
- C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent

puncture and other damage.

- E. Butt external ductwork insulation up to wall, fasten insulation to ductwork at wall as to provide airtight fitting. Do not fasten insulation to wall.
- F. Ductwork exposed to weather: Protect outdoor insulation from weather by installing outdoor protective finish aluminum jacketing as recommended by manufacturer, or as indicated on drawings.
- G. Corner ductwork: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

3.06 INSTALLATION OF EQUIPMENT INSULATION

- A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

3.07 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 07 00 HVAC Insulation

SECTION 23 31 13 - METAL DUCTWORK

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of metal ductwork is indicated on drawings and in schedules and by requirements of this section.
- B. Refer to Section 23 07 00 for exterior insulation of metal ductwork; not work of this section.
- C. Refer to Section 23 05 93 for testing, adjusting, balance of metal ductwork systems, not work of this section.

1.02 QUALITY ASSURANCE

- A. Codes and standards:
 - 1. SMACNA standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork or comply with ASHRAE Handbook, Equipment Volume, Chapter 1, "Duct Construction", for fabrication and installation of metal ductwork.
 - 2. NFPA compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems".
- B. Field reference manual: Have available for reference at project field office, copy of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

1.03 SUBMITTALS

- A. Comply with Section 01300. Product data: Submit manufacturer's technical product data and installation instructions for metal ductwork materials and products.
- B. Record drawings: At project closeout, submit record drawings of installed metal ductwork products, in accordance with requirements of Division 1.
- C. Shop drawings: Submit 1/8" = 1'0" dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure. Show modifications of indicated requirements, made to conform to local shop practice, and show those modifications ensure that free area, materials, rigidity are not reduced.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 DUCTWORK MATERIALS

- A. Exposed ductwork material: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections, including pitting, seam marks, roller marks, stain and discolorations, and other imperfections, including those which would impair painting.
- B. Sheet metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lock forming quality; with G90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.

2.02 MISCELLANEOUS DUCTWORK MATERIALS

- A. Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- B. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15 deg change of direction per section. Unless specifically detailed otherwise, use 45 deg laterals and 45 deg elbows for branch takeoff connections. Where 90 deg branches are indicated, provide conical type tees.
- C. Duct sealant: Non-hardening, non migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. United McGill duct sealer or equal.
- D. Duct cement: Non-hardening, non-migrating mastic or liquid neoprene based cement, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for cementing fitting components, or

longitudinal seams in ductwork. United McGill duct sealer or equal.

- E. Ductwork support material: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, 3" wide straps, trim and angles for support or ductwork. Rods shall be minimum 1/4" diameter and straps shall be minimum 1/8" thick x 3" wide for ducts 24" and 36" x 14" and smaller. For ducts larger provide 3/8" diameter rod and 3/16" x 3" wide straps.
 - 1. Except where space is indicated as "High Humidity" area, interior support materials of not less than 1/4" diameter or 3/16" thickness may be plain (not galvanized).
 - 2. For exposed stainless steel ductwork, provide matching stainless steel support materials.
- F. Flexible ducts: Either spiral-wound spring steel with flameproof vinyl sheeting, or corrugated aluminum; complying with UL 181.
 - 1. Where installed in unconditional spaces other than return air plenums, provide 1" thick continuous flexible fiberglass sheath with vinyl vapor barrier jacket.
- G. Flexible ducts: Exterior reinforced laminated vapor barrier, 1-1/2" thick fiber glass insulation (K = .25 @ 75 degrees F), encapsulated spring steel wire helix and impervious, smooth non-perforated interior vinyl liner. Individual lengths of flexible ducts shall contain factory fabricated steel connection collars.

2.03 FABRICATION

- A. Shop fabricate ductwork in 4, 8, 10 or 12 foot lengths, unless otherwise indicated required to complete runs. Preassemble work in shop to greatest extent possible, as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
- B. Shop fabricate ductwork of gages and reinforcement complying with SMACNA ("HVAC Duct Construction Standards" or shop fabricate ductwork of gauges and reinforcement complying with ASHRAE Handbook, Equipment Volume, Chapter 1, "Duct Construction".
- C. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 deg for contracting tapers and 20 deg for expanding tapers.

- D. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible.
- E. Fabricate ductwork with duct liner in each section of duct (where indicated). Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with HVAC fasteners.

2.04 FACTORY-FABRICATED LOW PRESSURE DUCTWORK

- A. At Installer's option, provide factory-fabricated duct and fittings, in lieu of shop-fabricated duct and fittings.
- B. Material: Galvanized sheet steel complying with ASTM A 527, lock forming quality, with ASTM A %25, G90 zinc coating, mill phosphatized.
- C. Gage: 28-gauge minimum for round and oval ducts and fittings, 4" through 24" diameter.
- D. Elbows: One piece construction for 90 deg and 45 deg elbows 14" and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint.
- E. Divided flow fittings: 90 deg tees, constructed with saddle tap spot welded and bonded to uct fitting body.
- F. Available manufacturers: Subject to compliance with requirements, manufacturers offering factory-fabricated ductwork which may be incorporated in the work include, but are not limited to, the following:
 - 1. Semco Manufacturing, Inc.
 - 2. United Sheet Metal Division, United McGill Corp.

2.05 KITCHEN EXHAUST DUCTS

- A. Fabricate kitchen exhaust ducts and supports, used for smoke and vapor removal for cooking equipment, of 16-ga minimum galvanized steel where concealed, and of 18-ga minimum stainless steel where exposed. For duct construction, comply with SMACNA "HVAC Duct Construction Standards", and NFPA 96 "Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment".

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine areas and conditions under which metal ductwork is to be installed. Do

not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF METAL DUCTWORK

- A. Assemble and install ductwork in accordance with SMACNA Standards including duct sealer for joints and seams which will achieve air-tight (95% leakage for systems rated 3" and under) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors to type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
- B. Field fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.
- C. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in HVAC shafts, hollow wall construction or above suspended ceilings. Do not erase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- D. Electrical equipment spaces: Do not route ductwork through transformer vaults, electrical panel rooms and their electrical equipment spaces and enclosures.
- E. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on four sides by at least 1-1/2". Fasten to duct and substrate.
 - 1. Where ducts pass through fire-rated or smoke-rated floors, walls, or partitions, provide fire-stopping between duct and substrate, in accordance with requirements of Division-7 Section "Fire-Stopping". Provide fire dampers as required by all local, state or federal codes.
- F. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork

system.

- G. Installation: Install metal ductwork in accordance with SMACNA "HVAC Duct Construction Standards" and as described on the drawings.

3.03 INSTALLATION OF FLEXIBLE DUCT

- A. Maximum length: For any duct run using flexible ductwork, do not exceed (3'0") extended length.
- B. Installation: Install in accordance with Section III of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible".
- C. Flexible ducts: Supported at or near mid-length with 2" wide 28 ga steel hanger collar attached to the structure with an approved duct hanger. The maximum length will be seven feet and can be used at the terminal ends only, except that flexible ducts properly installed may be used to cross seismic joints without offsets.

3.04 INSTALLATION OF KITCHEN EXHAUST DUCTS

- A. Fabricate joints and seams with continuous welds for watertight construction. Provide for thermal expansion of ductwork through 2,000 deg F (1,093 deg C) temperature range. Install without dips or traps which may collect residues, except where traps have continuous or automatic residue removal. Provide access openings at each change in direction, located on sides of duct 1-1/2" minimum from bottom, and fitted with grease-tight covers of same material as duct.

3.05 EQUIPMENT CONNECTIONS

- A. Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated or required.

3.06 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of duct and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
- B. Strip protection paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.
- C. Temporary closure: At ends of ducts which are not connected to equipment of air distribution devices at time of ductwork installation, provide temporary closure of

polyethylene film or other covering which will prevent entrance of duct and debris until time connections are to be completed.

- D. Balancing: Refer to Section 15990 "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leak in ductwork that became apparent in balancing process.

END OF SECTION 23 31 13 Metal Ductwork

SECTION 330001

WATER LINES

2.01 SCOPE

The work to be accomplished under this Section of the Specifications consists of the providing of all labor, materials, equipment, and services necessary for the construction of water mains and appurtenances shown on the drawings and more fully described hereinafter.

2.02 POLYVINYL CHLORIDE PIPE (PVC)

Plastic pipe shall meet the following minimum standards:

ASTM Specification D2241, D1784, D2122, D3139 Product Standard PS 22-70
NBS
Standard Dimension Ratio (SDR-21 200 psi) for pressure up to 133 psi; (SDR 17
250 psi) for pressure up to 167 psi.

Health Properties - The Seal of the National Sanitation

Testing Laboratory must appear on each pipe

Jointing materials shall be non-toxic.

Joints shall be made with the use of rubber O-ring gasket couplings, or integral bell joints.

2.03 BASIS OF ACCEPTANCE/PVC PIPE CERTIFICATIONS

The basis of acceptance of PVC plastic water main pipe will be a written certification, accompanied by a copy of test results that the pipe and pipe material has been sampled, tested, and inspected in accordance with the designated standard specifications. Contractor shall obtain these certifications from the manufacturer and deliver them to the Engineer's representative on the project site. A sufficient number of tests and certifications shall be made so as to be representative of the complete project. Copies of the test results shall be kept on file by the manufacturer, and shall be available for review by the Engineer upon request.

Pipe and fittings shall be visually inspected on the project site for proper markings which shall include manufacturer's name, or trademark, nominal pipe size, pressure rating for water at 73.4° F., plastic pipe material designation code (e.g. PVC 1120), standard dimension ratio, this

ASTM Designation D2241 with which pipe complies, and the National Sanitation Foundation (NSF) Seal of Approval for drinking water.

2.04 TRACER WIRE AND MARKING TAPE

Install 12 gauge underground tracer wire directly above pipe in trench with all main water lines.

Install underground marking tape in trench with all main water lines. Marking tape shall be installed at a depth of 12 inches minimum above the top of the pipe.

The underground marking tape shall be TERRA-TAPE (detectable) or an approved equal and shall be two inches in width. All underground marking tape shall be blue in color and shall be imprinted to read "CAUTION BURIED WATER LINE BELOW."

No separate pay item will be made for the installation of marking tape. The cost is to be included in the unit price for water line installation.

2.05 DUCTILE IRON PIPE, FITTINGS & JOINTS

- A. Ductile iron pipe shall be designed and manufactured in accordance with ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, latest revisions. All pipe must be new and shall be manufactured in the United States of America (USA); all ductile iron pipe shall be cast, cleaned, lined, coated, tested, and certified at a single manufacturing facility located in the USA – with all manufacturing units contiguous to one another. Approved USA manufacturers are American, US Pipe, McWane, and approved equals.

All pressure pipe for water service shall be SMaRT certified by the Institute for Market Transformation to Sustainability.

All pipe shall be designed for the following minimum conditions:

1. Internal working pressure of 300 psi plus 100 psi surge allowance plus safety factor of 2.
2. Earth load of 5 feet of cover or as shown on plans.
3. Laying condition Type 3 per ANSI/AWWA C150/A21.50 - pipe bedded in 4" minimum loose soil. Backfill lightly consolidated to top of pipe.

4. Truckload Loading per AASHTO H-20.

- B. **FITTINGS:** Fittings shall be ductile iron in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, latest revisions.
- C. **JOINTS:** Ductile iron pipe and fittings to have rubber gasket joints in accordance with the latest revision of ANSI/AWWA C111/A21.11. Buried piping and fittings shall be push-on restrained joint, or mechanical joint (fittings).

Piping and fittings above ground shall be flanged.

Where buried restrained **pipe** joints are required to resist thrust due to internal pressure, restrained gasket [AMERICAN Amarillo Fast-Grip or equal, colored (yellow, orange, etc.) restrained joint gasket] - or fabricated, push-on restrained joints (AMERICAN Flex-Ring or AMERICAN Lok-Ring joints - or equal) shall be utilized at the specified locations.

Where buried restrained **fitting** joints are required to resist thrust due to internal pressure, restrained mechanical joints (MJ) utilizing torque-activated MJ restraints (MegaLugs, One-Loks, or equal), restrained gasket [AMERICAN Amarillo Fast-Grip or equal, colored (yellow, orange, etc.) restrained joint gasket] - or fabricated, push-on restrained joints (AMERICAN Flex-Ring or AMERICAN Lok-Ring joints - or equal) shall be utilized at the specified locations.

Restrained joints shall be rated for a working pressure of 350 psi minimum (4"-18") and 250 psi minimum (20"-64").

Restrained joints (for items other than MJ sleeves and MJ valves) using set screws such as retainer glands, Mega-Lugs, or other torque-activated means of restraint shall be permitted only following specific approval by the owner / engineer.

- D. **COATING AND LINING:** Pipe and fittings for **buried applications** shall be asphaltic coated outside per ANSI/AWWA C151/A21.51, latest revision, and cement lined inside, with or without an asphaltic seal coating, in accordance with ANSI/AWWA C104/A21.4, latest revision.
- E. **FLANGE PIPING:** All flanged pipe shall comply with ANSI/AWWA C115/A21.15, latest revision. Pipe barrel shall be manufactured in accordance with ANSI/AWWA C151/A21.51, latest revision. All flanges shall be ductile iron and rated for a working pressure of 250 psi.
- F. **WELDED-ON OUTLETS:** Reference the attached specification for welded-on outlets.

G. TEST AND INSPECTION:

1. Each pipe greater than or equal to 30" nominal size shall be subject to a hydrostatic test of at least 500 psi. for a period of not less than 10 seconds after which time the pressure is to be elevated to a peak pressure that induces a stress in the pipe wall equivalent to 75% of the minimum specified yield strength of ductile iron (42,000 psi.) as calculated by the following formula:

$$p = \frac{2f_s t}{D}$$

Where: **p** = peak hydrostatic pressure, psi.

f_s = stress in pipe wall during hydrostatic test, which shall be 0.75 times the minimum yield strength of the ductile iron in tension, i.e. 42,000 psi.

t = nominal wall thickness, in.

D = outside diameter, in.

2. All ductile iron pipe material suppliers shall be ISO 9001 or 9002 registered or provide the services of an independent inspection agency. If ISO registration is not provided, all pipe and fittings shall be factory-inspected by the approved inspection agency. The inspection agency shall have access to the pipe manufacturer's plant such that, with adequate assistance and notice, each item may be examined. The cost of the services of the inspection agency will be borne by the pipe supplier; the manufacturer will furnish certificates that all material has been manufactured, tested, and inspected in accordance with applicable specifications and standards.
3. The pipe manufacturer is to provide a notarized certificate stating that pipe furnished has been manufactured and tested in accordance with the applicable standards.

2.06 CASING PIPE

Casing pipe shall be steel, plain end, uncoated and unwrapped, have a minimum yield point strength of 35,000 psi and conform to ASTM A252 Grade 2, or ASTM A139 Grade B, without hydrostatic tests. The steel pipe shall have welded joints and be in at least 18-foot lengths.

The wall thickness of the pipe shall be a minimum of 0.250 inches. The diameter of the pipe shall be as noted in the Bid Proposal.

2.07 STATE HIGHWAY CROSSINGS

Steel casing pipe for highway and railroad crossings shall be bored and/or jacked in place to the elevations shown on the drawings. All joints between lengths shall be solidly welded with a smooth non-obstructing joint inside. The casing pipe shall be installed without bends. The water line pipe shall be installed after the casing pipe is in place.

At each end of the casing pipe, the water main pipe shall be wrapped with two layers of roofing felt. The wrapping shall extend a minimum of 12 inches in each direction from the end of the casing pipe. After the water main has been installed, inspected, tested and wrapped as specified, both ends of the casing pipe shall be closed with brick or concrete block masonry in a manner acceptable to the Engineer.

2.08 GATE VALVES

All gate valves shall be of the resilient seat type, iron body, non-rising stem, fully bronze mounted and suitable for water working pressures of 200 psi. Valves shall be of standard manufacture and of the highest quality both as to materials and workmanship.

Gate valves for buried water main service may be furnished with mechanical joint or push-on end connections. Gate valves for other duty shall be as shown on the Drawings or specified hereinafter.

All gate valves shall have the name or monogram of the manufacturer, the year the valve casting was made, the size of the valve, and the working water pressure cast on the body of the valve.

Each gate valve shall be installed in a vertical position with a valve box. Gate valves set with valve boxes shall be provided with a 2-inch square operating nut and shall be opened by turning counter-clockwise.

All valves shall conform with the latest edition of AWWA C509.

2.09 CONNECTION OF NEW WATER MAINS TO EXISTING MAINS

The contractor shall connect new water mains to existing water mains where shown on the drawings or directed by the Engineer, and shall furnish all necessary equipment and material required to complete the connection. Tapping sleeves and valves for "wet" connections shall be as

specified hereinbefore and WILL BE SEPARATE PAY ITEMS. Connections made without tapping sleeve and valves will NOT be a separate pay item, but shall be merged into the unit price for the water mains.

The contractor shall locate existing mains and check outside diameters of pipe prior to ordering sleeves and accessories. NO additional payment will be allowed for machining pipe and/or accessories if the proper size is not ordered.

2.10 VALVE BOXES

Valve boxes shall be of 5-1/4 inch standard cast iron, two or three pieces, screw type valve box with drop cover marked "WATER." Valve box for gate valves shall be three-piece type. Valve boxes shall be accurately centered over valve operating nut, and backfill thoroughly tamped about them. Valve box bases shall not be set on the valves, but shall be supported on crushed stone fill. They shall be set vertically and properly cut and/or adjusted so that the tops of boxes will be at grade in any paving, walk, or road surface, and two and three inches above ground in grass plots, fields, woods, or other open terrain. Valve boxes and covers shall be as manufactured by Tyler Corporation, Opelika Foundry, Bingham & Taylor, or equal.

2.11 FIRE HYDRANTS

Install fire hydrants where shown on the drawings or directed by the Engineer. Fire hydrants shall conform in all respects to the requirements of AWWA C502. Hydrants barrel shall have safety breakage feature above the ground line. All hydrants shall have six inch mechanical joint shoe connection, two 2-1/2 inch discharge nozzles and one pumper nozzle with caps fitted with cap chains. Connection threads shall conform to local standards. Main valve shall have 5-1/4 inch full opening and be of the compression type opening against water pressure so that valve remains closed should barrel be broken off.

Fire hydrants shall be fully bronze mounted. Main valves shall have a threaded bronze seat ring assembly of such design that it is easily removable by unscrewing from a threaded bronze drain ring. Bronze drain ring shall have multiple ports providing positive automatic drainage as the main valve is opened or closed. Drainage waterways shall be completely bronze to prevent rust and corrosion.

Operating stem shall be equipped with anti-friction thrust bearing to reduce operating torque and assure easy opening. Stop shall be provided to limit stem travel. Stem threads shall be enclosed in a permanently sealed lubricant reservoir protected from weather and the waterway with O-ring seals.

Fire hydrants shall be designed for 150 psi working pressure and shop tested to 300 psi pressure with main valve both opened and closed. Under test, the valve shall not leak, the automatic drain shall function, and there shall be no leakage into the bonnet.

Hydrants shall be set plumb with not less than two cubic feet of crushed stone and backed with at least one cubic foot of Class "C" concrete or equivalent. Set hydrants so that centerline of pumper nozzle is minimum 18 inches above finished grade. An operating wrench and traffic damage repair kit shall be provided with every 15 hydrants. Provide one set where quantity of hydrants is less than 15.

Fire hydrants shall be M&H, Mueller, Darling, Kennedy or approved equal.

2.12 CLEARING AND GRUBBING

Pipelines are to be installed on private properties as well as upon the rights-of-way of highways, railways, and other utilities. The contractor shall familiarize himself with all special requirements of the respective right-of-way holders before commencing work. No clearing shall be done until the Owner has secured proper authorization or permission from the holders of rights-of-way.

In addition, the contractor shall acquaint himself with all federal, state, and/or local regulations for preventing forest fires, and these regulations shall govern in all cases. Brush and undergrowth shall be piled and burned only at locations reviewed by the Engineer. Fire spreading beyond clearance limits causing property damage shall be the contractor's responsibility. Burning, to the extent that it will not conflict with such regulations, shall directly follow clearing work and shall be completed to the Engineer's satisfaction before line materials are distributed along the pipe route.

Stumps in the way of the pipe trench shall be grubbed or otherwise removed and the course of the line shall generally be grubbed and graded to allow passage of equipment and to allow the ditch to be excavated to the line and grade established by the Engineer.

2.13 GRADING

Slopes within highway rights-of-way that are cut down or notched to facilitate operation of construction equipment shall be rebuilt to original height and slope to the satisfaction of the Engineer and the State Highway Division Maintenance Engineer. Spoil banks from grading operations shall not be placed where surface drainage will be affected.

2.14 EXCAVATION FOR PIPELINE TRENCHES

No extra or separate payment will be made for rock excavation. All excavation costs shall be merged into the cost of pay items for the pipe.

A minimum cover of 36 inches shall be provided for all water mains.

2.15 PIPE BEDDING

All water main pipe shall be supported on a bed of well compacted earth, dirt, sand, fine gravel, or Size #9 crushed stone as shown in the details on of the plans. Bedding material shall be free from rock and be acceptable to the Engineer. In no case shall pipe be supported directly on the rock bottom of trenches, boulders, or loose rock in the trench. When rock is encountered in the trench bottom, bedding shall consist of fine gravel or Size #9 crushed stone only. Pipe bedding will NOT be a separate pay item.

2.16 PIPE INSTALLATION

Pipe shall be laid true to line and grade when given, or as directed by the Engineer. Supporting of pipe shall be as specified under "Pipe Bedding" hereinbefore and in no case will the supporting of pipes on blocking be permitted.

Fittings for the water mains shall be provided and placed as and where directed by the Engineer or as shown on the Drawings. Dead ends of pipes and of branches shall be permanently sealed and plugged using manufactured units compatible with the pipe system.

Before each piece of pipe is lowered into the trench, it shall be thoroughly inspected to insure its being clean. Any piece of pipe or fitting which is known to be defective shall not be laid or placed in the lines. Any defective pipe or fitting discovered after the pipe is laid shall be removed and replaced until satisfactory without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe.

Granular pipe bedding material shall be used to correct irregularities in the earth trench subgrade and shall be furnished at the contractor's expense as specified hereinbefore.

The interior of the pipe, as the work progresses, shall be clean. When laying of any pipe is stopped for any reason, the exposed end of such pipe shall be temporarily closed with a plywood plug fitted into the pipe bell so as to exclude earth or other material.

No backfilling (except for securing pipe in place) over pipe will be allowed until the Engineer has had an opportunity to make an inspection of the joints, alignment, and grade in the

section laid, but such inspection shall not relieve the contractor of further liability in case of defective joints, misalignment caused by backfilling, and other such deficiencies that are noted later.

2.17 JOINTING

Jointing of pipe and fittings shall be according to manufacturer's published recommendations or manufacturer's field representative directions unless modified in these Specifications or in the field by the Engineer.

2.18 BACKFILLING PIPELINE TRENCHES

Trenches outside existing sidewalks, driveways, streets, and highways shall be backfilled in accordance with Method "A." Trenches within the limits of sidewalks and unpaved driveways shall be backfilled in accordance with Method "B."

Trenches within the paving limits of existing streets, highways and driveways shall be backfilled in accordance with Method "C." When directed by the Engineer, the contractor shall wet backfill material to assure maximum compaction.

Before final acceptance, the contractor will be required to level off all trenches or to bring the trench up to grade and restore surface. The contractor shall also remove from roadways, rights-of-way, and/or private property all excess earth or other materials resulting from construction.

In the event that pavement is not placed immediately following trench backfilling in streets and highways, the contractor shall be responsible for maintaining the trench surface in a level condition at proper pavement grade at all times.

2.19 SETTLEMENT OF TRENCHES

Wherever water lines are in, or cross, driveways and streets the contractor shall be responsible for any trench settlement which occurs within these rights-of-way within one year from the time of final acceptance of the work. If paving shall require replacement because of trench settlement within this time, it shall be replaced by the contractor at NO EXTRA COST to the Owner. Repair of settlement damage shall meet the approval of the Engineer and, as applicable, of Monroe County or the City of Tompkinsville, or the Kentucky Department of Highways.

2.20 CONCRETE CRADLE, ANCHORS, AND ENCASEMENT

Concrete cradle, anchors, encasement or caps over water mains and fittings shall be placed where shown on the drawings, required by the specifications or as directed by the Engineer.

Concrete shall be 2500 psi and shall be mixed sufficiently wet to permit it to flow under the pipe to form a continuous bed. In tamping concrete, care shall be taken not to disturb the grade or line of the pipe or injure the joints. Concrete placed outside the specified limits or without authorization from the Engineer will NOT be subject to payment.

Water mains and fittings shall have concrete thrust or "kicker" blocks at all pipe intersections and changes of direction to resist forces acting upon the pipeline. Thrust blocking and anchors shall NOT be a pay item.

All valves shall be anchored in accordance with the details. Valve anchoring will NOT be a separate pay item but will be included in payment for the valve.

Encasement or capping of water mains under creeks and drainage waterways shall be constructed as shown on the drawings and SHALL BE a separate pay item listed as "Concrete Cradle and Encasement." Crushed stone for the encasement or enveloping shall be as specified under "Special Pipe Bedding."

2.21 STREAM CROSSINGS

Stream crossings (Numbers 4 – 16) will be made using open cut (CWPD) per the detail sheet or via directional bore. If open cut, the pipe shall be installed in steel casing pipe and if installed via horizontal, directional boring, Class 200 polyethylene pipe of the next largest nominal diameter is to be utilized.

2.22 RIP RAP

Rip rap material shall meet Kentucky Department of Highways Standard Specifications for Road and Bridge Construction. No less than 80 percent by volume, of individual stones shall range in size from 0.25 to 1.5 cubic feet. Stones of small size are permissible for filling of voids or dressing after placement of larger stones.

2.23 BITUMINOUS CONCRETE HIGHWAY, STREET, AND DRIVEWAY REPLACEMENT

The contractor shall replace those sections of existing roads, streets, and driveways required to be removed to install the pipelines under this contract. He shall construct same to the

original lines and grades and in such manner as to leave all such surfaces in fully as good or better condition than that which existed prior to his operations.

Prior to trenching, the pavement shall be scored or cut to straight edges at least 12 inches outside each edge of the proposed trench to avoid unnecessary damage to the remainder of the paving. Edges of the existing pavement shall be recut and trimmed to square, straight edges after the pipeline has been installed and prior to placing the new base and pavement.

Backfilling of the trench shall be in accordance with Method "C" as described hereinbefore. Base course for the paving shall be dense graded crushed limestone furnished and placed in accordance with the current requirements of the Standard Specifications for Road and Bridge Construction of the Kentucky Department of Highways to a depth of six inches in roads and streets and four inches in driveways.

A subslab of reinforced concrete shall be placed for state maintained highways as indicated in the drawings. The subslab shall have a minimum thickness of 6 inches. Concrete for the subslab shall be 2500 psi.

The wearing surface of roads, streets, and driveways shall be plant mix bituminous concrete furnished and placed in accordance with the current requirements of the aforementioned Standard Specifications to a depth of two inches in roads and streets and 1-1/2 inches in driveways.

2.24 PORTLAND CEMENT CONCRETE HIGHWAY, STREET, AND DRIVEWAY REPLACEMENT

Wherever Portland cement concrete streets and driveways are removed, they shall be reconstructed to the original lines and grades and in such manner as to leave all such surfaces in fully as good (or better) condition that which existed prior to the contractor's operations.

The existing concrete paving shall be sawed or cut to straight edges 12 inches outside the edges of the trench or broken out to an existing joint as directed by the Engineer. The maximum width of the trench at pavement level shall be as shown in maximum pay width schedule on the Standard Details unless otherwise specified by the Engineer. The concrete pavement shall be equal to the existing pavement thickness but not less than six inches and four inches in thickness for street and driveways respectively.

Pavement replacement shall be accomplished with 2500 psi concrete in accordance with the details shown on the Drawings.

2.25 UNPAVED DRIVEWAYS

Where unpaved driveways and parking areas are disturbed during the construction work, they shall be replaced in fully as good or better condition than that which existed prior to the contractor's operations.

Backfilling of the pipeline trench shall be with dense graded aggregate in accordance with Method "B" Paragraph 18, Part II, of the General Specifications; then trench shall be topped to grade with six inches compacted thickness TDOT #57 crushed stone surface course.

2.26 REMOVING AND REPLACING CONCRETE SIDEWALKS

Where concrete sidewalks are cut or disturbed during the construction work, they shall be replaced in fully as good or better condition than that which existed prior to the contractor's operations.

In general, concrete sidewalks shall not be tunneled under when encountered in trenching. Except in cases where tunneling is approved, the contractor shall cut sidewalk with a saw or other approved method to provide a smooth even edge. When concrete sidewalk is tunneled under (with the approval of the Engineer only) it shall be back-filled with granular material or mechanically tamped earth under the portion undermined so as to prevent settlement.

When replacing concrete sidewalks, the existing concrete edges shall be trimmed to straight edges six inches back of the trench sides. The existing edges shall be cleaned and kept moist during pouring to insure a good bond.

After the trench has been backfilled and tamped, a base course of crushed stone shall be placed to a compacted thickness of three inches. Immediately prior to pouring of the concrete, the crushed stone base shall be thoroughly wetted or the concrete shall be poured on a layer of heavy building paper.

The paving shall consist of four inches of Class "BB" concrete, struck off to accurately placed screens and worked with a wooden float until the mortar appears on the top. After the surface has been thoroughly floated, it shall be brushed to leave markings of a uniform type similar to the existing walk. All joints and edges shall be finished with an edging tool. The allowable variation shall be 1/8 inch to 10 feet transversely and longitudinally.

2.27 TESTING WATER PIPELINES

Testing of the water mains shall be accomplished as noted hereinafter.

- (a) All water mains and components shall be given a hydrostatic test to rated working water pressure of the pipe under which leakage shall not exceed 10 gallons per 24 hours per inch of diameter per mile of pipe. Loss of water pressure during test shall not exceed 10 psi in a 24-hour period, 5 psi in a 10-hour period or 2 psi in a 4-hour period.
- (b) Contractor shall furnish a recording gauge and water meter for measuring water used during leakage test and recording pressure charts for duration of test. Recording pressure charts shall be turned over to the Engineer at conclusion of the tests. The pressure recording device shall be suitable for outside service with a range from 0-200 psig, 24-hour spring wound clock, designed for 9-inch charts, and shall be approved by the Engineer. For contractor's information only, such pressure recording devices may be available from the Foxboro Company, Foxboro, Massachusetts, Bristol Division of ACCO, Waterbury, Connecticut, or Weksler Instruments Corporation, Freeport, New York.
- (c) The Owner will provide initial water for testing and disinfecting the water mains. Should the first test fail to pass all additional water required for subsequent tests shall be furnished at the contractor's expense.

2.28 DISINFECTION OF WATER LINES

New potable water lines shall not be placed in service (either temporarily or permanently) until they have been thoroughly disinfected in accordance with the following requirements and to the satisfaction of the Engineer.

After pressure testing, a solution of hypochlorite using HTH or equal shall be introduced into the section of the line being disinfected sufficient to insure a chlorine dosage of at least 25 ppm in the main. While the solution is being applied, the water should be allowed to escape at the ends of the line until tests indicate that a dosage of at least 50 ppm has been obtained throughout the pipe. Open and close all valves and cocks while chlorinating agent is in the piping system. The chlorinated water shall be allowed to remain in the pipe for 24 hours after which a residual of at least 25 ppm shall be obtained. The disinfection shall be repeated until 25 ppm is obtained after which time the main shall be thoroughly flushed until the residual chlorine content is not greater than 1.0 ppm, and then may be connected to the system. Before the new line is placed in service, negative bacteriological samples must be obtained from the line as analyzed by a State approved laboratory. The number of samples shall be per the latest edition of AWWA Standard C651 depending upon the length of line tested.

2.29 TAPPING SLEEVES AND VALVES

Tapping sleeves for connections to existing water lines shall be of the mechanical joint type suitable for working pressures of 200 psi and shall be Mueller No. H-615, American Darling No. 1004, M&H No. 1174, Kennedy Fig. 920, or approved equal.

Tapping valves shall be of the mechanical joint type suitable for working pressures of 200 psi and shall be Mueller No. H-667, American-Darling No. 565, M&H No. 751, Kennedy Fig. 950, or approved equal.

2.30 CLEAN UP

Upon completion of the water mains and appurtenances, the contractor shall remove all debris and surplus construction materials resulting from the work. The contractor shall grade the ground along each side of pipe trenches in a uniform and neat manner, leaving construction areas as near as possible to the original ground line.

END OF SECTION



American
Geotechnical and
Environmental, Inc.

March 12, 2009

Mr. Robert Stigall, P.E.
Stigall Engineering Associates, Inc.
4117 Hillsboro Road, Suite 206
Nashville, Tennessee 37215

RE: Geotechnical Engineering Study
Monroe County Water District
Water Intake Structure
Monroe County, Kentucky
AG & E File Number: 2009-003

Dear Mr. Stigall:

In compliance with your recent request, we have completed a geotechnical engineering study for the above referenced project. It is our pleasure to transmit four (4) copies of our written report of the results of this study for the Monroe County Water District.

The scope of geotechnical services provided for this project includes the following:

- Performing a field study of the subsurface soil and rock by the drilling of one (1) exploratory test boring and,
- The review of available geologic and soil survey maps of the general region, and
- Performing appropriate laboratory tests of selected samples obtained from this site.

The purpose of this study was to determine the types of subsoils and bedrock present at the proposed site and to evaluate their suitability for support of the proposed Intake Structure. Included with these services are comments and recommendations relative to the design and construction of the foundations.

The proposed project is planned for construction on the western shore line of the Cumberland River near McMillans Landing. The proposed Intake Structure will be located approximately 350 feet north of the ferry landing and approximately mid-slope between the shore line and a bluff line as shown in Figure 1.

P.O. Box 681237 • Franklin, TN 37068-1237
(615) 791-9768 • FAX (615) 791-8963

The attached photographs show the area of the proposed Intake Structure to include small diameter trees, grass, and underbrush. The slope of the ground surface is about 27 percent slope with a small bench in the slope near the edge of the river. Please note dozer assistance was needed to excavate a road to the proposed Intake Structure.

Preliminary design plans indicate the proposed project will include the construction of a new Raw Water Intake Structure that will be placed at the location shown on Figure 1. The Intake Structure will have a plan dimension of 18 feet by 22 feet with the bottom slab at Elevation 488.0. The existing ground surface ranges from Elevation 530 to 535, resulting in a total height of 50 feet.

Using standard rotary drill equipment, AG & E drilled one (1) exploratory test boring at the location shown on Figure 1. Please note the elevation noted on the Log of Test Boring is an estimate based upon the topographic survey.

The surface of the proposed construction site is covered with a layer of topsoil that is 0.8 feet thick. Topsoil is soft in consistency and contains highly compressible organic matter. It is therefore considered unsuitable for engineering purposes and should be stripped from the construction site and wasted, or stockpiled for later landscaping use.

Beneath the topsoil, we encountered cohesive alluvial soil deposits that extend to the top of bedrock at a depth of 29.7 feet, about Elevation 502.3. We found dark brown sandy clayey silt to silty clay soils to a depth of 8.0 feet where a brown silty clay with trace sand was found. At a depth of 18.0 feet is a very moist to wet brown and brownish gray colored clayey silt. Below 22.0 feet is a gray to dark gray clayey silt that also contains some organic matter. Auger refusal was then encountered at a depth of 29.7 feet, about Elevation 502.3.

These soils exhibit a soft to medium stiff consistency with Standard Penetration Test Values (N-Values) ranging from 5 to 11 blows per foot. The moisture content of these soils ranges from 23 to 31 percent with an average of 27 percent.

Based upon our observations of the soil samples, we believe the water table can be found at a depth of 8 to 15 feet. The test boring was dry upon completion of the soil boring operation, but the addition of the water for the rock core sampling did not allow for an accurate water table reading before leaving the site.

The auger refusal material was then cored to a total depth of 60 feet below the existing ground surface better explore the continuity of the underlying bedrock. The bedrock samples were obtained using standard NX - sized diamond bit rock coring equipment in general accordance with ASTM procedure D-2113.

Sound bedrock was encountered at the auger refusal depth of 29.7 feet. The rock core samples obtained are a medium gray to gray limestone that is cryptocrystalline to fine grained with thin shale parings and some chert. This limestone is also massively bedded.

The sample recovery and Rock Quality Designation (RQD) in part, evaluate the characteristics of the bedrock. The sample recovery is an indicator of voids within the sandstone bedrock and other beds of uneven weathering. The sample recovery ranges from 86 to 100 percent. The values less than 100 percent are an indication of highly weathered shale partings that were washed away by the drill water used to keep the drill bit cool. Please note that 100 percent of the drill water was returned to the ground surface, indicating there were no open air voids encountered at this location.

The Rock Quality Designation (RQD) also describes the quality of the bedrock encountered. The RQD is based on a modified core recovery procedure which is obtained by summing the total length of core recovered, but only counting those pieces of core which are hard and sound, and that are twice as long as or longer than the diameter of the core. The quality of the core samples obtained is fair to poor with RQD values of 86 to 100 percent.

A review of published geologic information the site is underlain by the Leipers Limestone of the Ordovician Period. This formation is described as a medium to dark gray limestone that is thin to thick bedded and very silty.

Limestone rock was found at a depth of 30 feet. The bottom of the Intake Structure will have a bottom slab elevation of 488.0. Therefore, the total depth of excavation will be 48 to 50 feet deep. The supporting bedrock is a sound limestone rock with a uniaxial compressive strength of 7,820 pounds per square inch (psi).

The footings for the Intake Structure will bear directly on the bedrock and they can be designed for a net allowable bearing pressure of up to 80,000 pounds per square foot (psf). Should any overblasting occur, we recommend the overshot materials be undercut and then backfilled with concrete to the design subgrade elevation. A well graded Dense Graded Aggregate that is properly placed and compacted can also be used, but its use will need to be limited to 6 inches or less. Should more than one foot of gravel be used, the allowable bearing pressure should be reduced to 10,000 psf.

The above stated bearing values should be considered an upper limit. Any value less than that listed above will be acceptable for the foundation system, but we recommend the various foundation sections all be designed using the same value to minimize differential settlements within the new structure. Using the value given, predicted total settlement within the building is estimated to be less than 1.0 inch with differential settlements being less than 75 percent of the total.

We recommend all concrete walls be formed on both sides and be a minimum distance of 2 feet away from any bedrock or soil face. The magnitude of lateral earth pressure against subsurface walls below the top of the bedrock will be limited to the weight of the backfill and hydrostatic pressures. The lateral forces on the structure from the overburden soil will be dependent upon which forces the owner selects to base the design upon.

Our primary concern is the long term stability of the Intake Structure should the river channel meander into this area during its operational life. Should a high volume flow event remove the mature trees that are currently growing along the shore line, significant erosion and/or landsliding of this hillside can be expected. The magnitude of lateral forces the structure will need to resist will vary widely depending upon which hillside failure scenario the structure will be designed to resist. This is a decision the owner will need to formulate on their own based upon the risk he is willing to assume and/or how quickly a temporary intake structure can be prepared should this structure fail.

Following is a summary of the minimum design parameters to use for the Intake Structure to resist the lateral forces;

Limestone Rock

Uniaxial Compressive Strength	7,820 psi
RQD	95%
Angle of Internal Friction	26 ^o
Young's Modulus	5.5 X 10 ⁶ psi
Poisson's Ratio	0.25
Unit Weight	150 pcf

In-Place Overburden Soil

Active Coefficient	0.49
Passive Coefficient	2.04
At-Rest Coefficient	0.37
Unit Weight	120 pcf
Water Table	10 feet below the ground surface

In designing unyielding subsurface walls for lateral pressure, consideration must be given to the degree of compaction required for the backfill behind the walls. It is our understanding that no pavement will be placed against this structure and that any future settlement of the backfill materials can be treated as a maintenance concern. Therefore, we recommend a light to moderate degree of compaction be specified for the backfill. We therefore recommend the backfill be placed and compacted within an approximate density range of 85 to 90 percent of standard Proctor maximum dry density. Densities in excess of 90 percent are undesirable as this will increase the lateral load on the wall, in particular, during construction. We recommend the granular fill include a No. 67 stone gradation. End dumping of this gradation material usually will result in degrees of compaction of 80 to 85 percent.

The wall should be adequately braced during placement and compaction of the backfill. The contractor should also be very careful with the backfill placement so that he does not create an unbalanced situation by placing too much backfill on any one side of the structure. This imbalance of lateral forces can cause the Intake Structure to tilt if these differential forces are not anticipated in the design. Consideration for the installation of rock anchors in the

foundation can be used to resist the buoyant forces that will occur when the structure is empty of water, if needed.

Additional lateral forces that can be applied to the Intake Structure include a massive landslide and the flood stage hydraulic forces from the moving water should a landslide occur during a 100 year flow in the river. Please note that these are extreme forces and they do not need to be applied to the structural design of the Intake Structure if the owner is willing to accept the risk of future loss of use. It is our opinion the potential for loss of use will be initiated when the mature trees along the stream bank are lost and the course of the river begins to meander toward the structure. The erosion from the meandering stream bed will increase the likelihood of a massive landslide that could be as deep as the 30 feet depth of soil.

The landslide forces on the structure can be evaluated by assuming a wedge of soil breaking around the sides of the structure. Including the backslope of the hillside and the bulk density of the soil, the temporary load of the soils against the structure during a massive landslide can be calculated using an equivalent fluid pressure of 135 pcf. This load will be perpendicular to the flow of the river. Hydraulic forces in addition to the debris that will be flowing down the river during a major flood event should also be considered because a massive landslide is likely to occur during a major flood. The hydraulic forces on the structure will be similar to the hydraulic forces a bridge foundation experiences.

All excavations should be properly braced or laid back to meet applicable Occupational Safety and Health Administration (OSHA) requirements. Specifically, OSHA classifies the overburden soil as Type C soils. OSHA regulations require the sideslopes of any excavation to be properly braced or laid back on a sideslope of 1.5 horizontal to 1 vertical (1.5:1).

The steep slope of the existing ground surface does not indicate laying back the excavated slope is a feasible option. Assuming the excavations will remain stable at a 1.5:1 backslope, the laid back excavation will extend about 50 feet from the proposed work area. We anticipate, however, that areas of localized sloughing will be encountered as the excavation encounters pockets of perched groundwater. A static groundwater level can also be anticipated below a depth of 8 to 15 feet.

Therefore, some form of excavation bracing will be needed for the proposed excavation. There is a wide variety of technologies that can be used to brace the excavation. We can assist the contractor with his design, if needed.

Our recommendations for this report were developed utilizing subsurface information obtained from the test boring performed. At this time, we would like to point out that exploratory test borings only depict the subsurface conditions at the specific location and time at which they were made. The subsurface conditions at other locations on the site may differ from those occurring at the test boring locations; however, only minor variations that can readily be evaluated and adjusted for during construction are expected.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practice. This company is not responsible for the conclusions, opinions, or recommendations made by others based upon the data included herein.

Thank you for the opportunity to be of service to you in this matter. If you should have any questions concerning this or any other matter, please feel free to contact us at your convenience.

Respectfully Submitted,

AMERICAN GEOTECHNICAL & ENVIRONMENTAL, INC.



Robert T. Stickney, P.E.
President

Enclosure





View of the Project Site from the southeast



View of the Project Site from the north

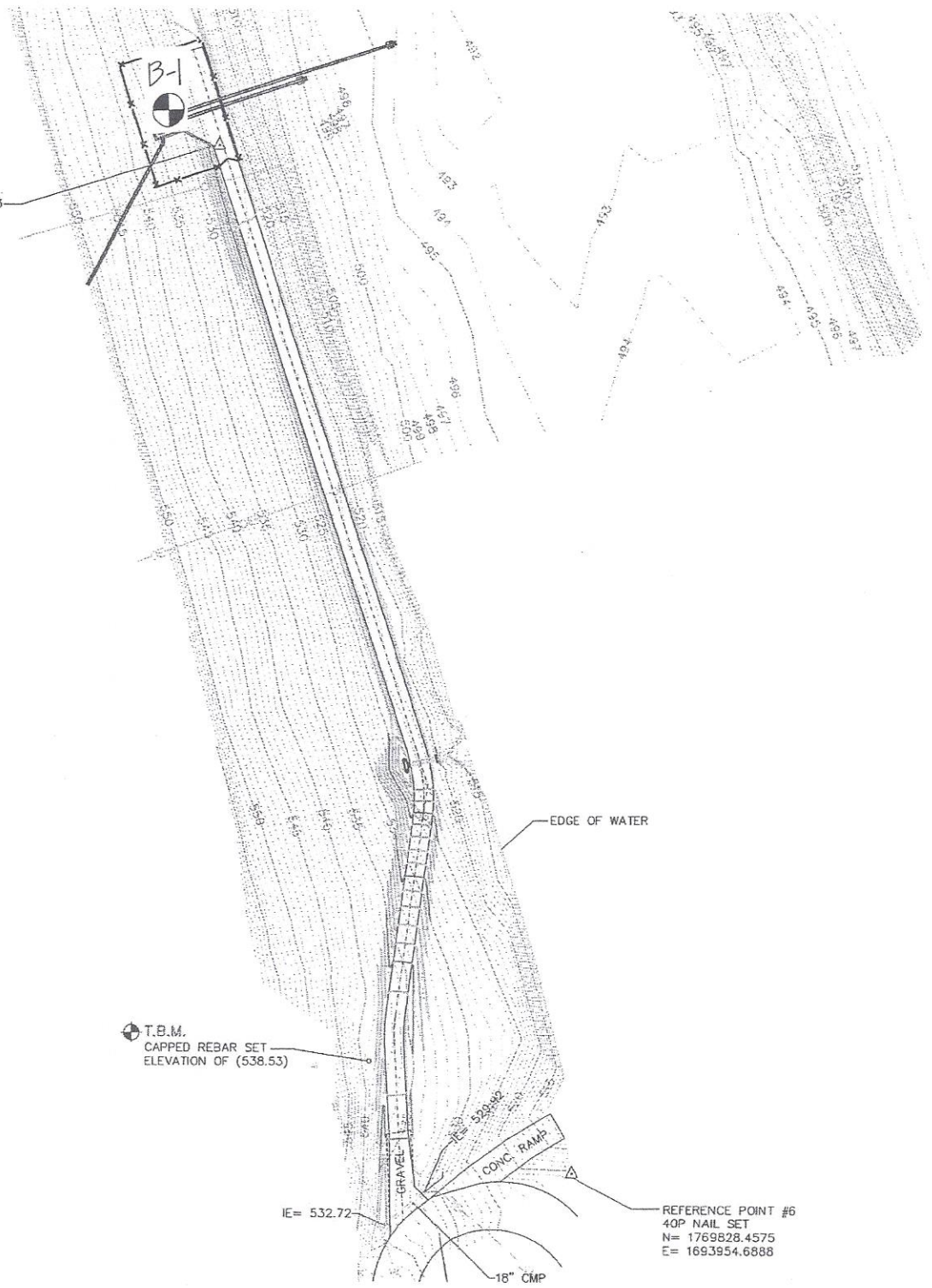
PHOTOGRAPHS

**Proposed Intake Structure
Monroe County, Kentucky**

PROJECT NO.: 2009-003

**AG
& E**

REFERENCE POINT #3
 40P NAIL SET
 N= 1770481.7951
 E= 1693724.4898



T.B.M.
 CAPPED REBAR SET
 ELEVATION OF (538.53)

REFERENCE POINT #6
 40P NAIL SET
 N= 1769828.4575
 E= 1693954.6888

Test Boring Location

BORING LOCATION PLAN

**Water Intake Structure
 Monroe County, Kentucky**

PROJECT NO.
2009-003

SCALE
1" = 100'

FIGURE NO.
1





Client Stigall Engineering Associates, Inc. Boring # 1
 Architect/Engineer _____ Job # 2009-003
 Project Name Water Intake Structure Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 2/6/09 Hammer Wt. 140 lbs.
 Date Completed 2/6/09 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. 2 in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	0.8										
Dark brown clayey silty to silty clay, moist, medium stiff.	531.2			1	SS	6				26.1	
Dark brown sandy clayey silty to silty clay, moist, soft to medium stiff.	529.0	3.0		2	SS	5				29.5	
		5		3	SS	10				22.7	
Brown silty clay, with trace fine gained sand, wet, medium stiff to soft.	524.0	8.0		4	SS	11				26.1	
		10		5	SS	5				26.1	
Brown and brownish gray clayey silt, very moist, medium stiff.	514.0	18.0		6	SS	7				24.5	
Dark gray clayey silt, with some organic matter, very moist, soft.	510.0	22.0		7	SS	5				30.6	
		25									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 1
 Architect/Engineer _____ Job # 2009-003
 Project Name Water Intake Structure Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 2/6/09 Hammer Wt. 140 lbs.
 Date Completed 2/6/09 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
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SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
	29.7			8	SS	50/0.7'				26.6	
Medium gray to gray limestone, cryptocrystalline to fine grained, with some chert and thin shale partings, thick to massively bedded.	502.3	30		9	RC		Rec=86%				RQD=86%
				10	RC		Rec=88%				RQD=88%
100% Drill Water Return		35		11	RC		Rec=100%				RQD=100%
		40		12	RC		Rec=93%				RQD=93%
		45		13	RC		Rec=100%				RQD=100%
		50		14	RC		Rec=96%				RQD=96%
Test boring discontinued at 55.0 feet.	55.0	55									
	477.0										

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH

NON COHESIVE SOILS

(Silt, Sand, Gravel and Combinations)

DENSITY

Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

PARTICLE SIZE IDENTIFICATION

Boulders	-8 inch diameter or more
Cobbles	-3 to 8 inch diameter
Gravel	-Coarse - 1 to 3 inch Medium - 1/2 to 1 inch Fine - 1/4 to 1/2 inch
Sand	-Coarse - 0.6 mm to 1/4 inch (dia. of pencil lead) Medium - 0.2 mm to 0.6 mm (dia. of broom straw) Fine - 0.05mm to 0.2 mm (dia. of human hair)
Silt	-0.06 mm to 0.002 mm (cannot see particles)

RELATIVE PROPORTIONS

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS

(Clay, Silt and Combinations)

CONSISTENCY

Very Soft	- 3 blows/ft. or less
Soft	- 4 to 5 blows/ft.
Medium Stiff	- 6 to 10 blows/ft.
Stiff	-11 to 15 blows/ft.
Very Stiff	-16 to 30 blows/ft.
Hard	-31 blows/ft. or more

PLASTICITY

Degree of Plasticity	Plasticity Index
Low	0 - 7
Medium	8 - 22
High	over 22

Classification on logs are made by visual inspection in general accordance with the Unified Classification System.

Standard Penetration Test - Driving a 2.0 " O. D., 1 3/8" I. D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary to drive the spoon 6.0 inches to seat the sampler into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the field drill log (Example 6/4/6). On the report log, the Standard Penetration Test result (N value) is normally presented and consists of the sum of the last penetration counts (i.e. N = 4 + 6 = 10 blows/ft.).

Strata Changes - in the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (-----) represents an actually observed strata change, a dashed line (- - - -) represents an estimated strata change.

Groundwater observations were made at the time indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water level readings indicated on the logs.

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geo-

technical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage*, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or ground-water fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed un-

der the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

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**SUPPLEMENTAL GEOTECHNICAL
ENGINEERING STUDY**

**WATER TREATMENT PLANT
Monroe County, Kentucky**

AG & E FILE NUMBER: 2009-002

Prepared By
American Geotechnical & Environmental, Inc.
P. O. Box 681237
Franklin, Tennessee 37068
(615) 791-9768

Prepared for
Stigall Engineering Associates, Inc.
4117 Hillsboro Avenue, Suite 206
Nashville, Tennessee 37215

April 21, 2015



American
Geotechnical and
Environmental, Inc.

April 21, 2015

Mr. Robert Stigall, P.E.
Stigall Engineering Associates, Inc.
4117 Hillsboro Avenue, Suite 206
Nashville, Tennessee 37215

RE: Supplemental Geotechnical Engineering Study
Water Treatment Plant
Monroe County, Kentucky
AG & E File Number: 2009-002

Dear Mr. Stigall:

In compliance with your recent request, we have completed a supplemental geotechnical engineering study for the above referenced project. It is our pleasure to transmit two (2) copies of our written report of the results of this study.

This report represents the results of our findings, an engineering interpretation of these findings with respect to the available project characteristics, and recommendations to aid design and construction of foundations, floor slabs, and other earth related phases of the project.

If you should have any questions concerning this or any other matter, please feel free to contact us at your convenience. It has been a pleasure working with you on this project.

Respectfully Submitted,

AMERICAN GEOTECHNICAL & ENVIRONMENTAL, INC.

Robert T. Stickney, P.E.
President

Enclosure

cc: Mr. Dan Sheridan; TLM Associates



P. O. Box 681237 • Franklin, TN 37068-1237

(615) 791-9768 • Email: agande@comcast.net

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**SUPPLEMENTAL GEOTECHNICAL
ENGINEERING STUDY**

**WATER TREATMENT PLANT
Monroe County, Kentucky**

AG & E FILE NUMBER: 2009-002

1.0 INTRODUCTION

This report presents the results of a supplemental geotechnical engineering study for the proposed Water Treatment Plant on the south side of Cloyd Williams Road in Monroe County, Kentucky. Our previous study was performed in 1999 for a different water treatment plant layout, AG & E File Number 2009-002 dated February 18, 2009. The purpose of this study is to supplement those areas of the currently proposed water treatment plant that were not covered by our previous study. This study was verbally authorized by Mr. Robert Stigall of Stigall Engineering Associates, Inc.

The scope of geotechnical services provided for this project includes the following:

- Performing a field study of the subsurface soil by the drilling of six (6) supplemental test borings numbered B-10 to B-15 and,
- The review of available geologic and soil survey maps of the general region, and
- Performing appropriate laboratory tests of selected samples obtained from this site.

The purpose of this study was to determine the types of subsoils present at the proposed site and to evaluate their suitability for support of the proposed building foundations. Included with these services are comments and recommendations relative to the design and construction of the building foundations, floor slabs and pavements for this project.

2.0 SITE AND PROJECT CHARACTERISTICS

The proposed project is planned for construction on the south side of Cloyd Williams Road (Big Sulphur Road) at the location shown in Figure 1. The attached photographs show the project site to be a corn field with Sulphur Creek forming the south side of the property and a small feeder stream on the west side. The ground surface has a moderate to gentle slope with the highest elevation and steepest slope at the road. The total relief across the proposed construction area is 30 feet and 10 feet of relief within the area of the proposed water treatment plant.

Preliminary design plans for this project include the construction of a new Plant Building and Clearwell and a new Backwash Basin structure that will be located as shown on Figure 1. The new Plant Building and offices will have a plan dimension of 70 feet by 148 feet with a Finish Floor Elevation of 542.0. The Clearwell will be constructed within the southern 43 feet of the structure with a slab elevation at Elevation 527.0. The Backwash Basin structure will have a plan dimension of 100 feet by 50 feet with a first floor at Elevation 541.25. The lowest elevation of the Hopper beneath the building will be Elevation 525.0.

3.0 GENERAL SUBSURFACE CONDITIONS

Using standard rotary drill equipment, AG & E drilled six (6) additional exploratory test borings for this study. These test borings are labeled B-10 to B-15 and they were performed within the proposed building area as shown on Figure 1. After completion of our field study, the soil samples were returned to our soil mechanics laboratory for analysis and testing.

The elevations noted on Figure 2 in the Appendix, the Subsurface Fence Diagram, are interpolated from the topographic survey provided by Stigall Engineering Associates, Inc. The subsurface soil profile and groundwater conditions are described in detail on the boring logs in the Appendix to this report, but in general terms consist of the following.

3.1 Subsurface Profile

Borings No. 3, 4, and 8 to 15 are within the currently proposed area of construction. These test borings found the topsoil layer to range from 0.8 to 1.0 feet, with an average of 1.0 feet thick. Topsoil is soft in consistency and contains highly compressible organic matter. It is therefore considered unsuitable for engineering purposes and should be stripped from the construction site and wasted, or stockpiled for later landscaping use.

Each of these test boring then encountered alluvial soils that range in depth from 4.4 to 11.0 feet where auger refusal was encountered. The alluvium is a strong brown to mottled brown and brown colored soil that has a silty clay to sandy silty clay texture at Borings No. 3, 4, 8 and 9. These soils exhibit a stiff to very stiff consistency with Standard Penetration Values (N-Values) ranging from 13 to 29 blows per foot. The soils at Borings No. 10 to 15 found brown colored silty clay soils that grade into a sandy silty clay texture below 3.0 feet. These alluvial soils exhibit a medium stiff to very stiff consistency.

Laboratory tests performed on selected samples indicate the soils have a moist natural water content with a moisture content range of 17 to 27 percent, with an average of 23 percent. Pocket penetrometer strength tests range from 2.0 to more than 4.5 tons per square foot (tsf). The clayey soils have a moderate plasticity as evidenced by an Atterberg Limits test performed on Sample No. 2 at Boring No. 13. The results of this test are 46 and 22 percent for the Liquid and Plastic Limit values respectively. The classification of these soils by the Unified Soil Classification System is CL, a low plasticity clay.

As previously mentioned, all test borings were extended to a depth of auger refusal as summarized in Table 1 below.

Table No. 1

AUGER REFUSAL DEPTH

Boring No.	Approx. Surface Elevation*	Approx. Refusal Elevation	Depth to Refusal (ft)
B- 3	545.0	537.8	7.2
B- 4	544.0	533.0	11.0
B- 8	552.0	542.0	10.0
B- 9	544.0	537.2	6.8
B-10	543.0	538.0	5.0
B-11	541.5	536.1	5.4
B-12	543.0	537.5	5.5
B-13	542.0	534.3	7.7
B-14	538.0	533.6	4.4
B-15	539.0	530.6	8.4

* - Surface elevations are interpolated from topographic survey.

Auger refusal is defined as the depth below the ground surface at which a test boring can no longer be advanced with the soil drilling technique being used. The type of limestone bedrock in this area can produce several obstructions that can cause the augers to meet with refusal above sound bedrock. These obstructions can range from slabs of unweathered limestone suspended in the residual soil matrix ("floaters"), on

rock "pinnacles" rising above the surrounding bedrock surface, in widened joints that may extend well below the surrounding bedrock surface, or on the upper surface of continuous bedrock. Several of these possible auger refusal conditions are illustrated in Figure 3 in the Appendix. Rock coring procedures are generally required to determine the character and continuity of the auger refusal material and these factors must be considered when evaluating the depth to auger refusal in those test borings that are not cored.

A review of published geologic information the site is underlain by the Leipers Limestone of the Ordovician Period. This formation is described as a medium to dark gray limestone that is thin to thick bedded and very silty. This is similar to the rock fragments obtained in some of the Standard Penetration Test samples obtained.

3.2 Groundwater Conditions

Observations concerning groundwater were made during and at completion of the test boring operations. No groundwater was noted on the drilling tools with all open boreholes being dry at completion of the drilling operations. In fine-grained soils such as those present at this site, the true static groundwater level can only be determined by observations of cased holes or monitoring wells. While the true groundwater level is subject to normal seasonal variations in precipitation and surface runoff amounts, based on the above observations and soil coloration, we believe it to exist well below the depth of any anticipated excavations.

Any water encountered during the construction of this project will be the result of water bearing pervious seams, and/or a perched water table condition. Conventional dewatering methods such as pumping from sumps should prove to be adequate for any excavation for this site.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon our analysis of the soil conditions, the preliminary design details, and the design assumptions previously outlined, the following conclusions and recommendations were developed. If the project characteristics are changed from those assumed herein, our recommendations should be reviewed to see if any modifications are needed.

4.1 Plant Building and Clearwell Foundation Recommendations

Our field and laboratory tests indicate the Clearwell will be supported by the underlying bedrock while the Plant Building and Office area will be supported by the natural cohesive soils. Borings No. 12 to 15 encountered auger refusal at Elevation 530.6 to 537.5. The Plant Building Finish Floor Elevation will be Elevation 542.0 with the slab elevation for the Clearwell slab at Elevation 527.0. Therefore, the Clearwell will be supported by the underlying bedrock and the remainder of the building by as much as 11.4 feet of natural soil.

We recommend the foundations for the Clearwell portion of the building can be designed to be supported by the limestone bedrock and dimensioned for a net allowable bearing pressure of 8,000 pounds per square feet (psf). Uplift forces for the buoyant condition during flood conditions can be resisted by a combination of the dead weight of the concrete and/or by the installation of anchors into the rock. Typical engineering characteristics of the Leipers Limestone formation include a unit weight of 150 pounds per cubic foot and a compressive strength of 6,000 to 8,000 pounds per square inch.

The magnitude of lateral earth pressure against the subsurface portions of the Clearwell during a 100 year flood event will be dependent on the method of backfill placement, the type of backfill soil, drainage provisions and whether or not the wall is permitted to yield after placement of the backfill. It has been demonstrated that, when a wall is held rigidly against horizontal movement, the lateral pressure against

the wall is greater than the "active" earth pressure. Therefore, rigid walls should be designed for higher, "at-rest" pressures (K_0), while yielding walls can be designed for active pressures (K_a). For the non-yielding walls, a coefficient of earth pressure at-rest (K_0) of 0.4 is recommended with granular backfill against the wall for drainage purposes. We recommend the walls be designed for an equivalent fluid pressure of 40 pcf, plus any hydrostatic and/or live loading.

The foundations for the remaining portions of this structure will be supported by a combination of the natural soils and up to 3 feet of structural fill. The differential settlement between these portions of the building and the Clearwell will be 0.75 to 1.0 inch. This will result in potential differential settlement damages to the building and/or piping in the structure. Therefore, we recommend this portion of the building be designed to be structurally independent of the Clearwell. If this is not possible it will be necessary to extend all of the foundation excavations downward to bear upon the limestone bedrock. If this is the case, we recommend all of the foundations be designed as recommended in the previous paragraph.

Should the Clearwell be structurally separated from the rest of the building and the building foundations be supported by the natural soils and structural fills, we recommend these foundations be designed for a net allowable soil bearing pressure of up to 2,000 pounds per square foot (psf) for standard isolated spread footings and conventional wall or strip footings. Please note the soils are capable of supporting higher bearing pressures, but we have provided this reduced allowable bearing pressure to minimize the total and differential settlements across the structure. The Site Class Definition from Table 1615.1.1 in the 2003 International Building Code is Site Class C.

All exterior footings in the building should be placed at a minimum depth of 1.5 feet or greater below finished exterior grade for frost protection. Interior footings may be placed at a nominal depth provided they rest on firm natural soil or engineered fill. If any soft, wet, organic or loose soil, or any old fill is encountered at the design foundation elevation, the excavations should be extended downward so that the footings rest on firm soils.

4.2 Backwash Basin Foundation Recommendations

Borings No. 3, 4, 9, 10, and 11 encountered auger refusal at Elevation 533.0 to 542.0. The subgrade elevation for the Backwash Basin slab will range from Elevation 530 to 524. therefore, the entire structure will be supported by limestone rock.

We recommend the foundations for the Filter Building and Hopper be designed with the same parameters as recommended for the Clearwell. We recommend the foundations be designed to be supported by the limestone bedrock and dimensioned for a net allowable bearing pressure of 8,000 pounds per square feet (psf).

Uplift forces for the buoyant condition during flood conditions can be resisted by a combination of the dead weight of the concrete and/or by the installation of anchors into the rock. Typical engineering characteristics of the Leipers Limestone formation include a unit weight of 150 pounds per cubic foot and a compressive strength of 6,000 to 8,000 pounds per square inch.

The magnitude of lateral earth pressure against the subsurface portions of the Clearwell during a 100 year flood event will be dependent on the method of backfill placement, the type of backfill soil, drainage provisions and whether or not the wall is permitted to yield after placement of the backfill. It has been demonstrated that, when a wall is held rigidly against horizontal movement, the lateral pressure against the wall is greater than the "active" earth pressure. Therefore, rigid walls should be designed for higher, "at-rest" pressures (K_0), while yielding walls can be designed for

active pressures (K_a). For the non-yielding walls, a coefficient of earth pressure at rest (K_0) of 0.4 is recommended with granular backfill against the wall for drainage purposes. We recommend the walls be designed for an equivalent fluid pressure of 40 pcf, plus any hydrostatic and/or live loading.

4.3 Asphalt Pavement

The test boring data indicates the natural subgrade and fill materials available at the site will be suitable as subgrade materials for flexible type pavements with proper preparation. After the stripping of the surface vegetation and rough grading, the exposed subgrade should be properly prepared in accordance with our recommendations prior to placement of any fill or stone base course. This proofroll testing will be critical in identifying the presence of any soft surface soils where the site grading requires less than 2 feet of cut.

Pavement thickness design is dependent upon the anticipated traffic conditions during the life of the pavement, subgrade and paving material characteristics, and climatic conditions of the region. The actual pavement performance is highly dependent upon proper preparation and compaction of the fill and subgrade soils, and the types of soils used. A California Bearing Ratio (CBR) value of 4 has been estimated for the existing subsoils using soil property relationships including Atterberg Limits. The recommended values stated herein are dependent upon the proper placement and compaction of the fill and the testing of the subgrade conditions prior to construction of the pavement section. If higher quality materials, such as a well graded aggregate, are placed as fill and properly compacted, greater subgrade strength values can be considered in the design of the pavement section.

The following pavement section is based upon the assumption that the pavement will be constructed on a non-modified subgrade or engineered fill. The traffic volume will consist of automobile traffic in the Standard Pavement Section and less than 10 trucks per day in the Heavy Duty Pavement Section areas. We recommend the minimum

pavement section be designed as noted in the following tables. If additional truck traffic is expected, then we recommend further analyses be performed to better define the pavement design life and subgrade conditions.

STANDARD PAVEMENT SECTION

<u>Material</u>	<u>Thickness (in)</u>
Granular Base	6.0
Asphalt Concrete Surface	2.0

Total Pavement Section =	8.0

HEAVY DUTY PAVEMENT SECTION

<u>Material</u>	<u>Thickness (in)</u>
Granular Base	6.0
Asphalt Concrete Base	2.0
Asphalt Concrete Surface	1.0

Total Pavement Section =	9.0

All paving materials must comply with the current Kentucky Department of Highways Specifications. The granular base must be compacted to at least 100 percent of the standard Proctor maximum density (ASTM D-698).

Frequently, the refuse corral and loading dock for a project such as this one is serviced by relatively large, heavily loaded trucks. In areas where a vehicle such as semi-trailer trucks are anticipated, it may be advisable to increase the design values given above to minimize fatigue stress and rutting of the flexible pavement system. As an alternate, a rigid (concrete) pavement can be considered for specific areas such as the refuse corral or loading dock.

5.0 RECOMMENDED EARTHWORK PROCEDURES

5.1 Site Preparation

All vegetation, topsoil and other organic material or miscellaneous fill and debris should be removed from the construction areas prior to the building or placing of fills. After the completion of the stripping operations and preparation of any proposed fill area, the exposed subgrade areas should be proofrolled. Proofrolling is best achieved during reasonably dry weather using a loaded tandem axle, rubber tire dump truck, or similar approved vehicle, traversing the site in two perpendicular directions. The unsuitable zones identified through this proofroll test should then be replaced with approved fill materials as described in this report.

5.2 Excavation

We do not anticipate any difficulty will be experienced in excavating the overburden on this site with conventional equipment and methods. All final grade excavations and fills should be limited to a 2 horizontal to 1 vertical slope. Also, all excavations should be properly braced or laid back to meet applicable Occupational Safety and Health Administration (OSHA) requirements. Specifically, OSHA classifies these soils as Type A soils. OSHA regulations require the sideslopes of any excavation to be properly braced or laid back on a sideslope of 3/4 horizontal to 1 vertical (3/4:1).

The depth of cut into the limestone rock will be as much as == feet deep. If blasting techniques are used for these excavations, we would like to caution the contractor to be as careful as possible to minimize the depths of overblasting. Because of the variable air voids that will be caused by the blasting and the possibility of not compacting the in-place overshot rock uniformly, we recommend all of the overshot rock within each building area, plus 10 feet outside of its outside perimeter, be undercut to the top of the sound bedrock. The excavation can then be backfilled with

the excavated shot rock to the desired subgrade elevations. This shot rock will need to be placed and compacted as recommended in Section 5.3.

We recommend all footing excavations be tested by the geotechnical engineer or his representative to be sure that any excessively loose, soft or otherwise unsuitable materials are removed and that the subgrade soils are satisfactory for foundation support. At the time of testing, it may be necessary to make hand auger borings or to conduct pocket penetrometer or other tests in the base of the foundation excavation. The necessary depth of testing will be established in the field.

If possible, all footing concrete should be poured the same day the excavation is made. If this is not practical, the soils exposed in the base of all excavations should be protected against any detrimental change in conditions such as from disturbance, rain, and freezing. Surface run-off water should be drained away from all excavations and not allowed to pond.

5.3 Fill and Compaction

Once the subgrade has been properly prepared, fill may be placed in order to attain the desired final grades. In general, any non-organic soils, such as the soils present at this site, can be used for structural fill. Suitable fill materials for structural fills should consist of a cohesive soil with a Plasticity Index less than 30 and a maximum particle size of 4 inches.

The clayey fill should be placed in lifts of uniform thickness. The lift thickness should not exceed that which can be properly compacted throughout its entire depth with the equipment available, usually no more than 6 inches. We recommend that structural fills supporting footings, floor slabs and pavements be compacted to 98 percent of the Standard Proctor maximum dry density (ASTM D-698). The moisture content of the fill soils should be within plus or minus 3 percent of the optimum moisture content. Density tests shall be performed with a minimum of one test per 6

inch lift per 5,000 to 10,000 square feet with a minimum of two tests regardless of the square footage. The fill placement should be observed and documented by a representative of the geotechnical engineer. Fill pads should be constructed so that the compacted surface extends horizontally beyond the outside footing edges at least 10 feet.

For proper and timely construction of the fills, the soils should be placed at or near the optimum moisture content as determined by the specified Proctor test. The moisture content of the fill soils should be within plus or minus 3 percent of the optimum moisture content. Suitable equipment for either aerating or adding water to the fill materials should be available as the soil moisture and weather conditions dictate.

Approval of any shot rock material should be made prior to placement to verify gradation and maximum particle size. Due to the thickness of the backfill layer, the maximum particle sizes should be limited to no more than one half the thickness of the lift being placed. The maximum particle size should be limited 1.5 feet in any one dimension with 20 to 30 percent passing the No. 4 sieve and no more than 5 percent passing the No. 200 sieve. Mixing of any shot rock, natural clayey soils and/or trucked in fill is not recommended.

Compaction of the clean shot rock materials should consist of a maximum lift thickness of 18 to 24 inches using at least 4 to 6 complete passes of a 10 ton vibratory roller, or 4 to 6 passes of a Cat D-8 Dozer. A pass is defined as a complete coverage of the surface with a roller drum overlapping of 2 feet, D-8 track overlapping of 50 percent.

We recommend this firm be retained to perform continuous review of any construction of the soils related phases of this project. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or our recommendations. As a part of this review, field density tests should be performed as frequently as necessary to assist in the evaluation of the fill with respect to the above recommendations.

6.0 LIMITATIONS OF STUDY

Our recommendations for this report were developed utilizing subsurface information obtained from the test borings that were made at the proposed site. At this time, we would like to point out that soil test borings only depict the soil conditions at the specific location and time at which they were made. The soil conditions at other locations on the site may differ from those occurring at the boring locations; however, only minor variations that can readily be evaluated and adjusted for during construction are expected at this particular site.

The conclusions and recommendations herein have been based upon the available subsurface information and the assumptions previously stated and the preliminary design details furnished by the engineer for the proposed project. Any revision in the plans for the proposed structure from those anticipated in this report should be brought to the attention of the soils engineer so that he may determine whether any changes in the foundation recommendations are necessary. If deviations from the noted foundation conditions are encountered during the construction, they should also be brought to the attention of the soils engineer.

The scope of our services does not include any environmental assessment or investigation for the presence of absence of hazardous or toxic materials in the soil, groundwater or surface water within or beyond the site studied. Any statements in this report or on the test boring logs regarding odors, staining of soils or other unusual conditions observed are strictly for the information of our client.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practice. This company is not responsible for the conclusions, opinions, or recommendations made by others based upon the data included herein.

APPENDIX

Photographs

Figure 1 - Boring Location Plan

Figure 2 - Subsurface Fence Diagram

Figure 3 - Auger Refusal Illustration

Logs of Test Boring

Field Classification System for Soil Exploration

Important Information About Your Geotechnical
Engineering Report



View of the Project Site from the southeast



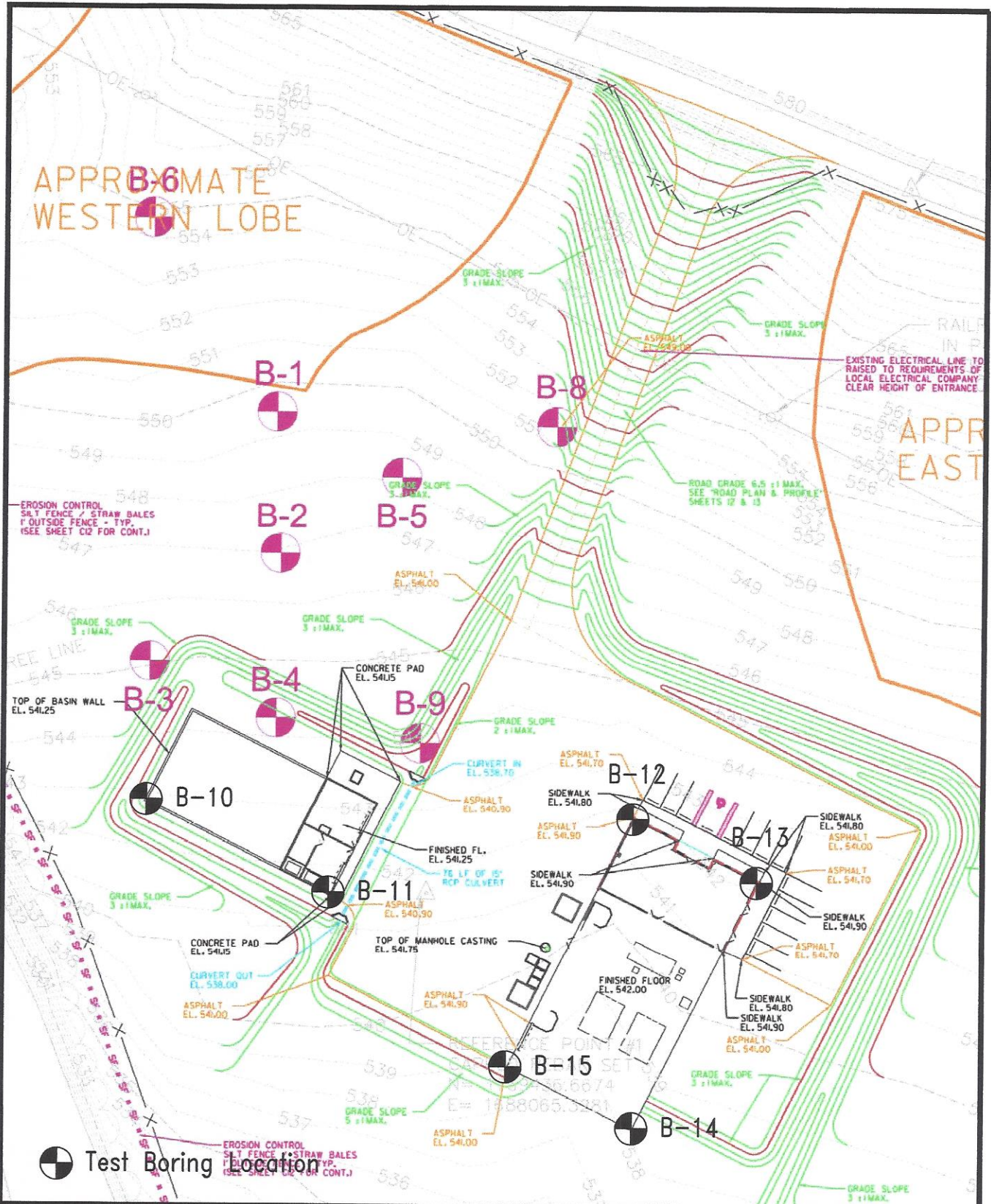
View of the Project Site from the northwest

PHOTOGRAPHS

**Water Treatment Plant
Monroe County, Kentucky**

PROJECT NO.: 2009-002

**AG
& E**



BORING LOCATION PLAN

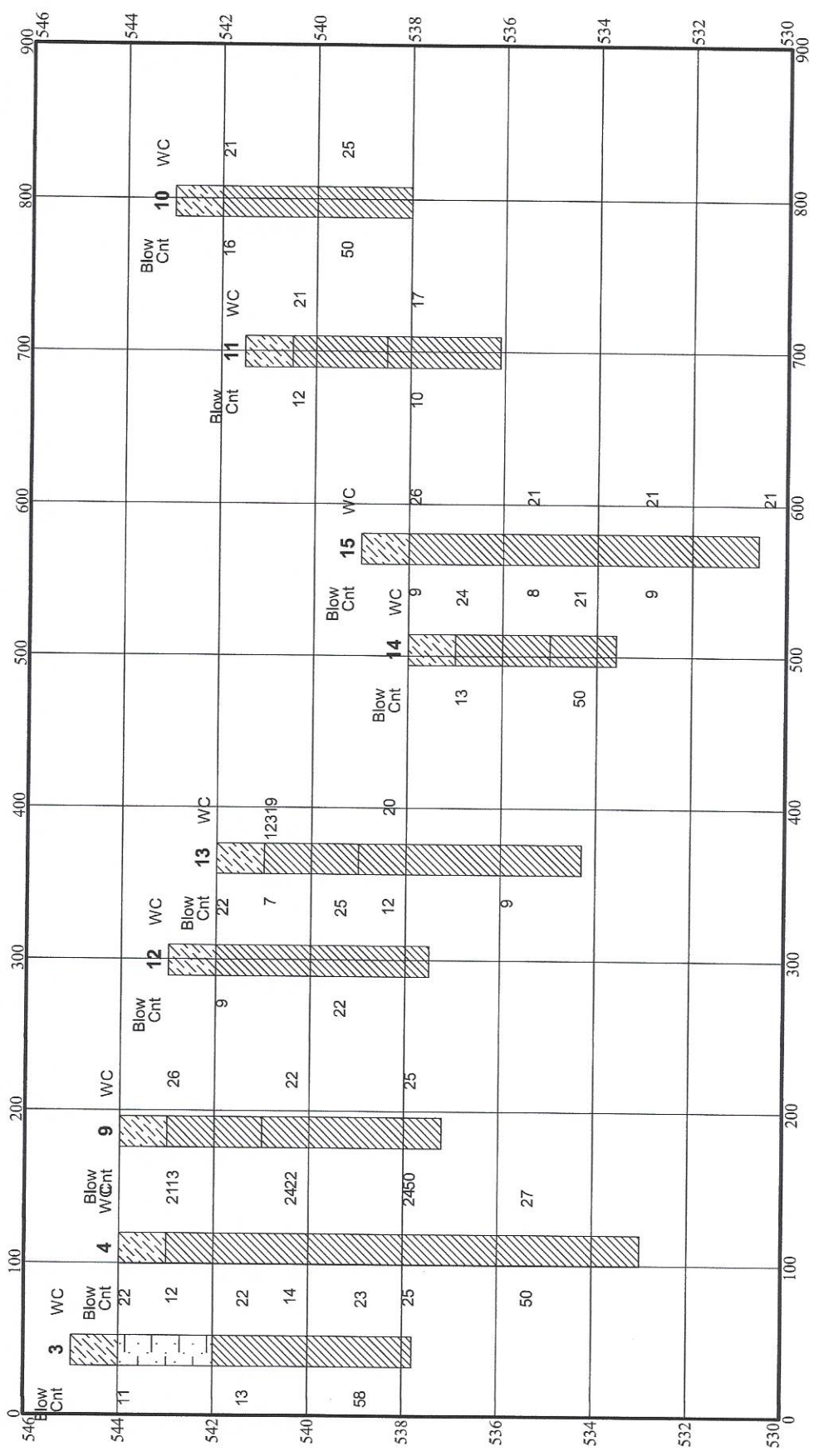
Water Treatment Plant
 Monroe County, Kentucky

PROJECT NO.
 2009-002

SCALE
 1" = 100'

FIGURE NO.
 1





NOTE - Fence diagram graphics match the graphics shown on the boring logs.

DISTANCES:
 Beginning 0.0
 Ending 900.0
 VIEWING ANGLES (degrees):
 Horizontal 0.0
 Vertical 0.0

Boring	North	East	Elev.	Depth
3	320.0	390.0	545.0	7.2
4	290.0	450.0	544.0	9.4
9	290.0	525.0	544.0	6.8
10	260.0	390.0	543.0	5.0
11	220.0	480.0	541.5	5.4
12	250.0	630.0	543.0	5.5
13	220.0	690.0	542.0	7.7
14	100.0	630.0	538.0	4.4
15	130.0	570.0	539.0	8.4

Position	North	East
Left, Front	335.80	350.49
Right, Front	300.06	296.07
Left, Back	335.80	350.49
Right, Back	300.06	296.07

SUBSURFACE FENCE DIAGRAM

Water Treatment Plant
 Monroe County, Kentucky

PROJECT #	DATE	FIGURE
2009-002	Apr 15	2



Client Stigall Engineering Associates, Inc. Boring # 3
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 2/6/09 Hammer Wt. 140 lbs.
 Date Completed 2/6/09 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Strong brown sandy silty clay, moist, stiff.	544.0			1	SS	11				22.1	
Brown to mottled brown silty clay, with trace fine grained sand, moist, stiff.	542.0	5		2	SS	13		4.5+		21.7	
	7.2			3	SS	58/0.8'		4.5+		23.3	
Test boring discontinued at 7.2 feet at auger refusal.	537.8	10									
		15									
		20									
		25									

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 4
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 2/6/09 Hammer Wt. 140 lbs.
 Date Completed 2/6/09 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Brown to mottled brown silty clay, with trace fine grained sand, moist, stiff.	543.0		LITH- OLOGY	1	SS	12		3.0		21.2	
		5		2	SS	14		3.0		23.9	
				3	SS	25		4.5+		23.7	
		10		4	SS	50/0.4'		4.5+		26.8	
Test boring discontinued at 11.0 feet at auger refusal.	533.0	11.0									
		15									
		20									
		25									

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 9
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 2/6/09 Hammer Wt. 140 lbs.
 Date Completed 2/6/09 Hammer Drop 30 in.
 Drill Foreman SOUTH BROS Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Dark brown silty clay, moist, stiff.	543.0			1	SS	13		2.0		26.2	
Brown to mottled brown silty clay, with trace fine grained sand, moist, very stiff.	541.0	5		2	SS	22		4.5+		21.7	
Test boring discontinued at 6.8 feet at auger refusal.	537.2	10		3	SS	50/0.3'				24.5	

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 10
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 4/1/15 Hammer Wt. 140 lbs.
 Date Completed 4/1/15 Hammer Drop 30 in.
 Drill Foreman EARTH SCI Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Brown silty clay, moist, stiff.	542.0			1	SS	16		4.5+		21.3	
Brown sandy silty clay, moist, very stiff.	540.0			2	SS	50/0.4'				25.2	
Test boring discontinued at 5.0 feet at auger refusal.	538.0	5									

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 11
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 4/1/15 Hammer Wt. 140 lbs.
 Date Completed 4/1/15 Hammer Drop 30 in.
 Drill Foreman EARTH SCI Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Brown silty clay, moist, stiff.	540.5			1	SS	12		4.0		20.8	
Brown sandy silty clay, moist, medium stiff.	3.0 538.5			2	SS	10				17.1	
Test boring discontinued at 5.4 feet at auger refusal.	5.4 536.1	5									

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ▼ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 12
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 4/1/15 Hammer Wt. 140 lbs.
 Date Completed 4/1/15 Hammer Drop 30 in.
 Drill Foreman EARTH SCI Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Brown silty clay, moist, medium stiff.	542.0			1	SS	9		4.5+		22.0	
Mottled brown silty clay, moist, very stiff.	3.0 540.0			2	SS	22				24.8	
Test boring discontinued at 5.5 feet at auger refusal.	5.5 537.5	5									

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 13
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 4/1/15 Hammer Wt. 140 lbs.
 Date Completed 4/1/15 Hammer Drop 30 in.
 Drill Foreman EARTH SCI Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
Topsoil	1.0										
Strong brown silty clay, moist, medium stiff.	541.0			1	SS	7		3.0		24.2	
Brown sandy silty clay, moist, medium stiff to stiff.	539.0	5		2	SS	12		4.5+		19.8	LL=46 PL=22
Test boring discontinued at 7.7 feet at auger refusal.	534.3	10		3	SS	9					

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc. Boring # 14
 Architect/Engineer _____ Job # 2009-002
 Project Name Water Treatment Plant Drawn By RTS
 Project Location Monroe County, Kentucky Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 4/1/15 Hammer Wt. 140 lbs.
 Date Completed 4/1/15 Hammer Drop 30 in.
 Drill Foreman EARTH SCI Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 538.0											
Topsoil	1.0										
Brown silty clay, moist, stiff.	537.0			1	SS	13		4.5+		24.5	
Brown sandy silty clay, moist, stiff.	3.0 535.0			2	SS	50/0.4'				21.2	
Test boring discontinued at 4.4 feet at auger refusal.											
	4.4 533.6	5									
		10									
		15									
		20									
		25									

SAMPLER TYPE

SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH

∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD

HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH



Client Stigall Engineering Associates, Inc.
 Architect/Engineer _____
 Project Name Water Treatment Plant
 Project Location Monroe County, Kentucky

Boring # 15
 Job # 2009-002
 Drawn By RTS
 Approved By RTS

TEST DATA

DRILLING AND SAMPLING INFORMATION

Date Started 4/1/15 Hammer Wt. 140 lbs.
 Date Completed 4/1/15 Hammer Drop 30 in.
 Drill Foreman EARTH SCI Spoon Sampler O.D. 2 in.
 Inspector _____ Rock Core Dia. _____ in.
 Boring Method HSA Shelby Tube O.D. _____ in.

SOIL CLASSIFICATION	STRATUM DEPTH	DEPTH SCALE	LITH- OLOGY	SAMPLE NO.	SAMPLE TYPE	Standard Penetration Test N. Blows/Ft.	Unconfined Compressive Strength Tons/Ft. ²	Pocket Penetrometer Tons/Ft. ²	Natural Dry Density lbs/cu. ft.	Water Content %	Atterberg Limits LL - Liquid Limit PL - Plastic Limit
SURFACE ELEVATION - 539.0											
Topsoil	1.0										
Brown silty clay, moist, medium stiff.	538.0			1	SS	9		4.0		26.2	
Brown sandy silty clay, moist, medium stiff.	3.0 536.0	5		2	SS	8		3.0		20.9	
	8.4			3	SS	9				20.7	
Test boring discontinued at 8.4 feet at auger refusal.											
	530.6	10									
		15									
		20									
		25									

SAMPLER TYPE
 SS - DRIVEN SPLIT SPOON
 ST - PRESSED SHELBY TUBE
 CA - CONTINUOUS FLIGHT AUGER
 RC - ROCK CORE

GROUND WATER DEPTH
 ∇ AT COMPLETION Dry FT.
 ∇ AFTER _____ FT.
 WATER ON RODS _____ FT.

BORING METHOD
 HSA - HOLLOW STEM AUGERS
 CFA - CONTINUOUS FLIGHT AUGERS
 DC - DRIVING CASING
 RW - ROTARY WASH

NON COHESIVE SOILS

(Silt, Sand, Gravel and Combinations)

DENSITY

Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

PARTICLE SIZE IDENTIFICATION

Boulders	-8 inch diameter or more
Cobbles	-3 to 8 inch diameter
Gravel	-Coarse - 1 to 3 inch Medium - 1/2 to 1 inch Fine - 1/4 to 1/2 inch
Sand	-Coarse - 0.6 mm to 1/4 inch (dia. of pencil lead) Medium - 0.2 mm to 0.6 mm (dia. of broom straw) Fine - 0.05mm to 0.2 mm (dia. of human hair)
Silt	-0.06 mm to 0.002 mm (cannot see particles)

RELATIVE PROPORTIONS

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

COHESIVE SOILS

(Clay, Silt and Combinations)

CONSISTENCY

Very Soft	- 3 blows/ft. or less
Soft	- 4 to 5 blows/ft.
Medium Stiff	- 6 to 10 blows/ft.
Stiff	-11 to 15 blows/ft.
Very Stiff	-16 to 30 blows/ft.
Hard	-31 blows/ft. or more

PLASTICITY

Degree of Plasticity	Plasticity Index
Low	0 - 7
Medium	8 - 22
High	over 22

Classification on logs are made by visual inspection in general accordance with the Unified Classification System.

Standard Penetration Test - Driving a 2.0 " O. D., 1 3/8" I. D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary to drive the spoon 6.0 inches to seat the sampler into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the field drill log (Example 6/4/6). On the report log, the Standard Penetration Test result (N value) is normally presented and consists of the sum of the last penetration counts (i.e. $N = 4 + 6 = 10$ blows/ft.).

Strata Changes - in the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (-----) represents an actually observed strata change, a dashed line (- - - -) represents an estimated strata change.

Groundwater observations were made at the time indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water level readings indicated on the logs.

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geo-

technical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact. For this reason, most experienced owners retain their geotechnical consultants through the construction stage, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.*

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report prepared or authorized for their use.* Those who do not provide such access may proceed un-

der the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

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8811 Colesville Road/Suite G106/Silver Spring, Maryland 20910/(301) 565-2733

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