

**Department of Public Works**

**WEST WING SERVICE AREA  
PUMP STATION**

**CONTRACT NO.: 2022-04  
PROJECT NO.: C309603**

SPECIFICATIONS, PROPOSAL, CONTRACT AND BOND

90% Submittal

October 2023

BIDS TO BE OPENED ON \_\_\_\_\_, 2023 AT 2:00 P.M. IN THE  
NEW CASTLE COUNTY PURCHASING DIVISION  
2<sup>ND</sup> FLOOR, NEW CASTLE COUNTY GOVERNMENT CENTER  
87 READS WAY, NEW CASTLE, DELAWARE 19720



**NEW CASTLE COUNTY  
Department of Administration**

## **Notice & Invitation to Bid**

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### **WEST WING SERVICE AREA PUMP STATION**

Sealed bids are invited for the construction of a 0.246 MGD average (700 GPM Peak) flow, sanitary sewer pump station, including pump process room, generator room, electrical room, bathroom, and storage room. Exterior facilities include influent grinder wet well, process wet well, influent gravity collection sewers and manholes, 14-inch and 18-inch diameter wastewater discharge force mains, electric service transformer, domestic water supply, site grading and paving, including appurtenances and related work in accordance with the project plans and specifications. The work is located on New Castle County property in Middletown, New Castle County, Delaware.

Bids addressed to the New Castle County Purchasing Division will be received by the Purchasing Division, New Castle County Government Center, 87 Reads Way, New Castle, DE, 19720, telephone (302) 395-5250 until **2:00 p.m. [REDACTED], 2023**, when they will be opened and read publicly.

Bid envelopes shall carry a clear notation "**West Wing Service Area Pump Station**" **Contract No.: 2022-04, Bid No.: 22-2205**. Plans and Specifications may be obtained in the William J. Conner Building, 187-A Old Churchmans Road, New Castle, DE, 19720, on and after **[REDACTED], 2023** upon payment of \$25.00 (non-refundable) for paper copies, digital copies provided without a fee. Please call (302) 395-5749 or (302) 395-5251, or e-mail [john.wolos@newcastlede.gov](mailto:john.wolos@newcastlede.gov) or [Monnica.newman@newcastlede.gov](mailto:Monnica.newman@newcastlede.gov) in advance to arrange for pick up or mailing.

Bids shall be accompanied by a bidder's bond or certified check in an amount equal to 10 percent of the bid price, payable to New Castle County and conditioned to be forfeited to said County for failure to enter into a contract, if awarded.

Awards, if any, will be made to the lowest responsible bidder. The County reserves the right to reject all bids and to waive minor irregularities. Bidders are required to submit all Proposal pages with their bid. The Proposal must be signed and sealed. A bid bond must be included with the Proposal. The CRC form, if not already submitted, and the Alcohol & Drug Testing Affidavit must be included with your submission. Any deviation from these instructions may result in the rejection of your bid. The successful Bidder will be required to give bond of a surety company, acceptable to the County, and licensed to do business in the State of Delaware, in the amount of the contract price.

### **CONTRACTOR/SUBCONTRACTOR RESPONSIBILITY CERTIFICATION**

Contractors proposing to submit a bid to New Castle County for a Public Works contract expected to exceed \$500,000 are required to complete and submit a signed original Contractor Responsibility Certification (CRC) form. The New Castle County Department of Public Works Contracts Officer must receive this executed form no later than the advertised deadline for bid submittals. Failure to submit the form by that time shall result in the County's inability to consider your bid for award. CRC forms submitted by facsimile will not be accepted. Bidders are encouraged to submit the form in advance of the bid. The form is printed in the specification and also available at: [http://nccde.org/document\\_center/view/78](http://nccde.org/document_center/view/78). Please see New Castle County Code Section 2.05.605.(D) for additional requirements and information.

### **ALCOHOL & DRUG TESTING**

New Castle County Code, Section 2.05.305 requires contractors and subcontractors to implement a mandatory alcohol & drug testing program for their employees who work pursuant to a Public Works contract. Included in the specifications for this project is an affidavit certifying compliance with the County Code. This affidavit must be executed and submitted with the bid. Failure to submit the affidavit by that time shall result in the County's inability to consider your bid for award. Forms submitted by facsimile will not be accepted.

#### **PREBID MEETING**

There will be pre-bid meeting at **10:00 a.m.** on \_\_\_\_\_, **2023** in the William J. Conner Building, 187-A Old Churchmans Road, New Castle, DE. Interested bidders will be sent a Teams meeting invitation for virtual attendance. Attendance at the meeting is not mandatory.

#### **PREQUALIFICATION**

New Castle County will only accept bids from contractors prequalified in the category, "E(a)," Major Transmission Sewer. Prequalification forms are available from the Public Works Contracts Officer in the William J. Conner Building, telephone (302) 395-5749 or (302) 395-5251. Prequalification application forms must be received by New Castle County prior to the opening of bids.

Michael Hojnicky  
Chief of Technology and Administrative Services  
Bid # 22-2204



**SPECIAL NOTICE TO BIDDERS**

**NEW CASTLE COUNTY DEPARTMENT OF PUBLIC WORKS**

**West Wing Service Area Pump Station  
Contract No. 2022-04**

**Use of Prevailing Wage is Mandatory for this Contract**

The *New Castle County Code* Section 2.05.303.D requires all contractors performing construction on this Department of Public Works contract to pay personnel employed on this contract in accordance with the State of Delaware Prevailing Wages as described in these Specifications.

**Reporting of Wages**

All contractors and subcontractors performing work on this contract will be required to submit their payroll information electronically to New Castle County's web site, <http://www.nccde.org/prevailingwage>

In accordance with the Department of Public Works Wage Requirements and Enforcement Procedures weekly payroll reports must be filed within seven (7) days of the close of the pay period.

**Debarred Contractors**

The listed contractors have been debarred from working on New Castle County-funded Public Works Department construction contracts:

<b>Date of Debarment</b>	<b>Contractor</b>	<b>Company President</b>	<b>Debarred Until</b>



187-A OLD CHURCHMANS ROAD  
NEW CASTLE, DE 19720  
(302) 395-5700

**DEPARTMENT OF PUBLIC WORKS**

Prevailing wage as Adopted by the State of Delaware, Department of Labor  
PREVAILING WAGES FOR **HEAVY CONSTRUCTION**, EFFECTIVE MARCH 15, 2023

CLASSIFICATION	NEW CASTLE COUNTY	KENT COUNTY	SUSSEX COUNTY
ASBESTOS WORKERS	26.95	23.70	51.54
BOILERMAKERS	86.57	39.16	71.83
BRICKLAYERS	84.08	72.20	30.37
CARPENTERS	59.56	59.56	47.80
CEMENT FINISHER	53.16	29.69	22.12
DIVER	95.30	Contact DOL	Contact DOL
DIVER TENDER	108.79	Contact DOL	Contact DOL
ELECTRICAL LINE WORKERS	88.36	88.36	88.36
ELECTRICIANS	79.17	79.17	79.17
GLAZIERS	24.89	21.62	14.65
INSULATORS	65.34	65.34	65.34
IRONWORKERS	73.31	74.33	73.31
LABORERS	53.65	53.65	53.65
MILLWRIGHTS	82.08	82.08	65.93
PAINTERS	91.91	91.91	91.91
PILEDRIVERS	85.37	47.99	37.34
PLASTERERS	23.44	20.38	13.76
PLUMBERS/PIPEFITTERS/ STEAMFITTERS	96.38	94.91	23.76
POWER EQUIP. OPERATORS	79.29	83.90	79.29
SHEET METAL WORKERS	37.47	23.25	21.84
SPRINKLER FITTERS	40.39	15.29	12.67
TRUCK DRIVERS	41.73	25.08	27.15

These rates have been adopted by New Castle County for this project and are enforced in accordance with the New Castle County Code, Section 2.05.303.D.11, and the Department of Public Works Prevailing Wage Requirements and Enforcement Procedures.

Questions regarding pay rates or job classifications should be referred to Prevailing Wage Rate Compliance Inspectors: **Jack Wolos at 302-395-5749** or **Bill McCloskey at 302-395-5383**, William J. Conner Building, 187-A Old Churchmans Road, New Castle, DE 19720.

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**INTRODUCTION**  
**DEPARTMENT OF PUBLIC WORKS**  
**NEW CASTLE COUNTY**  
**STATE OF DELAWARE**  
**SPECIFICATIONS FOR THE CONSTRUCTION OF:**

**Project Name:** West Wing Service Area Pump Station

**Contract Number:** 2022-04

**Project Number:** C309603

**General**

1. **Project Location:** West Wing Pump Station site, within the proposed Carter Farm Development, approximately 3500 linear feet north of the intersection of Choptank Road and Churchtown Road.
  
2. **Project Description:** Work includes, but is not limited to, the construction of a 0.246 MGD average (700 GPM Peak) flow, sanitary sewer pump station, including pump process room, generator room, electrical room, bathroom, and storage room. Exterior facilities include influent grinder wet well, process wet well, influent gravity collection sewers and manholes, 14-inch and 18-inch diameter wastewater discharge force mains, electric service transformer, domestic water supply, site grading and paving, including appurtenances and related work in accordance with the project plans and specifications. The work is located on New Castle County property in Middletown, New Castle County, Delaware.
  
3. **Accompanying Plans and Specifications:** The following plans and specifications, as amended and augmented by these Special Provisions, shall govern the construction of this project and the execution of this contract.
  - A. **Plans:** The drawings accompanying these specifications are identified as the West Wing Pumping Station.
  - B. **Supplementary-Specifications:** Attached
  - C. **Special Provisions:** Attached
  - D. **Standard-Specifications:** New Castle County Department of Public Works Standard Specifications for Construction, dated March 1975. Copies of this specification are available from the New Castle

County Contracts Office, Conner Building, 187A Old Churchmans Road, New Castle, Delaware 19720, and are issued separately.

The above-mentioned plans and specifications are hereby made part of this contract as fully and with the same effect as if attached or set forth at length herein.

## **DIVISION 01 – GENERAL PROVISIONS**



**SECTION 011001**  
**DEFINITIONS AND TERMS**

Section 10.01-1

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials

Access Connection - Any roadway facility by means of which vehicles can enter or leave an arterial highway. Included are intersections at grade, private driveways, and ramps or separate lanes connecting with cross streets or frontage roads.

ACI	American Concrete Institute
ACP	asbestos cement pipe
ACCOMP	asbestos coated corrugated metal pipe
ACCOMPA.	asbestos coated corrugated metal pipe arch

Additional Work - Increase in quantities of work above those shown in the Proposal Form.

Advertisement - The public announcement, as required by law, inviting bids for work to be performed or materials to be furnished.

AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute

Alley - An established passageway for vehicles and pedestrians affording a secondary means of access in the rear to properties abutting on a street or highway.



AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
BCCMP	bituminous coated corrugated metal pipe
BCCMPA	bituminous coated corrugated metal pipe arch

Belt Highway - Highway carrying traffic partially or entirely around an urban area or portions thereof. (Also sometimes called circumferential highway or beltway).

Bid Item - An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment and materials, described herein or described in any Supplemental Specifications or Special Provisions.

Bidder - An individual partnership, firm, or corporation formally submitting a Proposal for the work contemplated, acting directly or through a duly authorized representative.

Bridge - A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having an opening measured along the center of the roadway of more than twenty feet between undercopings of abutments or spring lines of arches or extreme ends of openings for multiple boxes; may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening.

Bridge length - The greater dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between ends of bridge floor.

Bridge roadway width - The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

B & S	Brown and Sharpe Wire Gauge
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Calendar Day - Every day shown on the calendar, Sundays and holidays included.

Change Order - A written order issued by the Engineer to the Contractor, covering changes in the plans or quantities or both, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the changes.

Channel - A natural or artificial water course.

CIP	cast iron pipe
CISPX	cast iron soil pipe, extra strength
CMP	corrugated metal pipe

Construction Strip - An area adjacent to the right-of-way or easement temporarily acquired for the use of the Contractor during the execution of the work. This area is only present when shown on the Plans.

Contingent Item - Any item listed on the Plans or called for in the Special Provisions and included in the Proposal merely for the purpose of obtaining a contract price in case it may be needed.

Contract - The written agreement executed between the County and the successful bidder, covering the performance of the work and the furnishing of labor, equipment and materials by which the Contractor is bound to perform the work and furnish the labor, equipment and materials, and by which the County is obligated to compensate him therefor at the mutually established and accepted rate or price. The Contract shall include the invitation for bids, instructions to bidders, Proposal, Contract form and Contract Bond, these Specifications, Supplemental Specifications, all Special Provisions, all Plans and Notice to Proceed, also any written Change Orders and Supplemental Agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions, thereof, all of which constitute one instrument:

Contract Bond - The approved form of security, executed by the Contractor and his surety or sureties, guaranteeing complete execution of the contract and all Supplemental Agreements pertaining thereto.

Contract Item - An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials, described herein or described in any Supplemental Specifications or Special Provisions.

Contractor - The party of the second part to the Contract; the individual, partnership, firm, or corporation undertaking the execution of the work under the terms of the Contract and acting directly or through his, their, or its agents or employees.

Contract Time or Completion Date - The number of working or calendar days shown in the Proposal indicating the time allowed for the completion of the work contemplated in the Contract.

In case a calendar date of completion is shown in the proposal, in lieu of the number of working or calendar days, such work shall be completed by that date.

Controlled Access Arterial Highway - The term "controlled access arterial highway" shall mean a major thoroughfare of two or more traffic lanes in each direction having the same characteristics as an expressway except that the conflict of cross streams of traffic need not be eliminated at every intersection by means of grade separation structures.

Controlling Operation - An operation of either major or minor proportions, which at the particular time under consideration has a controlling effect on the progress of the project as a whole.

County - New Castle County, Delaware, a body corporate and politic.

County Road - See State Road.

CRSI	Concrete Reinforcing Steel Institute
CSPA	Clay Sewer Pipe Association

Cul-de-Sac - A local street open at one end only and with special provision for turning around.

Culvert - Any structure not classified as a bridge which provides an opening under any roadway. These are normally structures in which all structural elements are integrated into a closed unit such as pipes, box culverts and rigid frames with paved inverts.

Dead-End Street - A local street open at one end only without special provision for turning around.

DIP	Ductile Iron Pipe
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Domestic Manufacture - When referring to metallic items such as structural steel, pipe, reinforcement, bridge rails, etc., the term "Domestic Manufacture" is intended to mean those metals whose final alloying has taken place within the confines of the Continental United States.

Drainage Ditch - In general, any open water course other than gutters, constructed beyond the limits of cut or fill slopes for excavation or embankment as indicated by the typical section shown on the plans.

Drawings - All drawings or reproductions thereof pertaining to the construction of the work which are approved by the Engineer.

Easement (Right-of-Way) - Refers to the Sanitary Sewer Easement, the Temporary Construction Easement and/or any other grant of a right of use of property required in connection with the Work to be performed under the Contract.

Engineer - The General Manager of Special Services, or other engineer executive of the County, acting directly or through his duly authorized representative, such representative acting within the scope of the particular duties assigned to him or of the authority given him.

Equipment - All machinery, together with the necessary supplies for upkeep and maintenance, and tools and apparatus necessary for the proper construction and acceptable completion of the work.

Expressway - The term "expressway" shall mean a major thoroughfare of two or more traffic lanes in each direction, designed to eliminate principal traffic hazards, and shall embrace all bridges, tunnels, overpasses, underpasses, interchanges, entrance plazas, approaches, and other structures, which the State may deem necessary to the operation of the expressway, together with all property, rights, easements, franchises, and interests acquired by the State for the construction and operation thereof, and having the following characteristics: (a) "a median divider separating opposing traffic lanes to eliminate head-on collisions and sideswiping; (b) grade separating structures to eliminate the conflict of cross streams of traffic at all intersections; (c) points of access and egress limited to predetermined locations; (d) vertical curves of lengths sufficient to provide long sight distances; and (e) shoulders of widths adequate to permit vehicles to stop or park off traffic lanes.

Extra Work - Work which was not provided for in the original contract as awarded but found by the Engineer essential to the satisfactory completion of the contract within its intended scope.

Extra Work Order - A change order concerning the performance of work or furnishing of materials involving extra work. Such extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications.

Federal Agencies - Whenever, in these Specifications, reference is made to any Federal Agency or officer, such reference shall be deemed made to any agency or officer succeeding in accordance with law to the powers, duties, jurisdiction, and authority of the agency or officer mentioned.

Fixed-Price Items - These unit prices are established and prescribed by the County to compensate for the cost of work and materials that may or may not be necessary for the proper completion of the contract, and the quantities of which are not amenable to reliable quantitative estimating prior to the construction.

The fixed-price items are shown on the proposal sheets with the estimated quantities, fixed-price, and the estimated total cost imprinted prior to the issuance of the contract documents to bidders.

Frontage Street or Service Road - A local street or road auxiliary to and located on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

Gabions - Open wire-mesh baskets filled with approved stone used for erosion protection of slopes and stream banks.

Gutter - Any prepared open water course, whether paved or not, constructed inside of the shoulder line in embankment or contiguous to both the shoulder line and the base of the cut slope in excavation sections. For the purpose of clarification of the above definition, a section shall be considered to be in embankment when the elevation of the extended shoulder slope is generally at or above the existing ground surface and shall be considered in excavation when the elevation of the shoulder-line is below the existing ground surface.

Holidays - In New Castle County, holidays will be observed on:

New Year's Day  
Lincoln's Birthday  
Washington's Birthday  
Good Friday  
Memorial Day  
Independence Day  
Labor Day  
Columbus Day  
Veteran's Day  
Thanksgiving Day  
Day after Thanksgiving  
Christmas Eve Day (one-half day)  
Christmas Day  
All Days of General Election

If any holidays listed above falls on a Sunday, the following Monday shall be considered a holiday. If any holiday listed above falls on a Saturday, the preceding Friday shall be considered a holiday.

Inspector - The authorized representative of the Engineer assigned to make detailed inspection of any or all portions of the work, or materials therefor.

Invitation for Bids - The advertisement for Proposals for all work or materials on which bids are required. Such advertisement will indicate with reasonable accuracy location





PCA Portland Cement Association

PCCP pre-stressed concrete cylinder pipe

Plans - The official approved plans, profiles, typical cross sections, working drawings, and supplemental drawings, or exact reproduction thereof which show the location, character, dimensions, and details of the work to be done, and which are to be considered as part of the Contract supplementary to these Specifications and which are identified as such.

Profile Grade - The trace of the elevations of the road surface or pipe invert usually located along the longitudinal centerline. Profile grade means either the elevation or gradient according to the context.

Project - The work included in the Proposal intended to be accomplished by the Contractor.

Proposal - The plans, these specifications, supplemental specifications, other specifications mentioned, and other documents will constitute the proposal.

Proposal Form - The approved form on which the County requires bids to be set forth and submitted.

Proposal Guaranty - The security designated in the Proposal, to be furnished by the bidder as a guaranty of good faith to enter into a Contract with the County if the work of constructing the improvement is awarded to him.

Questionnaire - The approved form or forms upon which the Contractor shall furnish the information as to his ability to perform the work, his experience in similar work, the equipment to be used, and his financial condition as related to his ability to finance the work.

Railroad Grade Separation - The term "railroad grade separation" shall mean any overpass or underpass which shall eliminate any railroad grade crossing, and shall embrace the overpass and underpass structure and the approaches thereto, and such entrance plazas, interchanges, connecting highways and other structures which the County may deem necessary in connection therewith, together with all property, rights, easements, franchises and interests acquired by the County for the construction and operation of such railroad grade separation.

Ramp - A connecting roadway between two intersecting highways at a highway separation.

RCSP reinforced concrete sewer pipe

RCCP reinforced concrete culvert pipe

Right-of-Way - The area which has been acquired and reserved by the County for use in constructing the proposed improvement and appurtenances thereto.

Road - Both the word "road" and the word "highway" include rights of way, roadway surfaces, roadway sub-grades, shoulders, median dividers, drainage facilities and structures, roadway cuts, roadway fills, guard rails, bridges, highway grade elimination structures, tunnels, overpasses, underpasses and other structures forming an integral part of a road or highway.

Roadbed - The graded portion of the arterial highway, expressway, freeway, highway, parkway, or road upon which base courses, surface courses, shoulders, median, etc., are constructed.

Roadside - A general term denoting the area adjoining the outer edge of the roadbed within the right-of-way. Extensive areas between the roadways of a divided highway may also be considered roadside.

SAE

Society of Automotive Engineers

Setback Line - A line established by law, deed restriction or custom, fixing the minimum distance of the exterior face of buildings, walls and any other construction from a street or highway right-of-way line.

Shoulder - The portion of the roadbed contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Sidewalk - That portion of the roadway primarily constructed for the use of pedestrians.

Slopes - The inclined graded area beyond the shoulder and extending from the shoulders to the natural undisturbed surface of the ground.

Specialty Item - An item not included in the listing of prequalification classes of work.

Special Provisions - Special directions, provisions, or requirements, peculiar to the project under consideration and not otherwise thoroughly or satisfactorily detailed or set forth herein.

Specifications - The general term comprising all directions, provisions and requirements contained herein, together with such as may be added or adopted as Supplemental Specifications.

Speed-change Lane - An auxiliary lane, including tapered areas, primarily for the acceleration or deceleration of vehicles entering or leaving the through traffic lanes.

S.S.P.C.

Steel Structures Painting Council

Standards - The official Book of Standard Details edited by New Castle County with latest incorporated revisions issued on or before the date of advertisement of the contract.

Standard Detail Drawings or Standard Details - See Standards.

State - The State of Delaware acting through its authorized representative.

State Highway System - The term "State Highway System" means that system of roads which are owned by the State.

State Road - The term "State Road" means any public road included in the State highway system. This also includes public roads designated as "County Roads".

Street - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way.

Structures - Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, under-drains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

Sub-base - The layer used in the pavement system between the subgrade and the base course.

Subcontractor - Any individual partnership, firm, or corporation undertaking the construction of a part of the work under the terms of the Contract, by virtue of an agreement with the Contractor, who, prior to such undertaking, receives the consent of the Surety and the approval of the County.

Subgrade - The material in excavations (cuts) embankments (fills), embankment foundations immediately below the first layer of sub-base, base or pavement and to such depth as may affect the structural design.

Substructure - All of that part of the structure below bottoms of bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls and wingwalls.

Superintendent - The executive representative of the Contractor authorized to receive and execute instructions from the Engineer, and who shall supervise and direct the construction.

Superstructure - All of that part of the structure above bottoms of bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, except as noted above for substructure.

Supplemental Agreement - When it is necessary to amend a Contract due to additional or extra work, revisions in or changes to the Contract, or conditions specifically prescribed in the Specifications, a Supplemental Agreement will be entered into by and between the Contractor and the County. Such Supplemental Agreement becomes a part of the Contract when it is approved and properly executed.

Supplemental Specifications - Specifications adopted subsequent to the publication of this book. They generally involve new construction items or substantial changes in the approved Specifications. Supplemental Specifications shall prevail over those published in this book whenever in conflict therewith.

Surety - The corporate body bound with and for the Contractor, for the full and complete performance of the Contract, and for the payment of all debts pertaining to the work. When applying to the Proposal Guaranty it refers to the corporate body which engages to be responsible in the execution by the Bidder of a satisfactory contract.

Through Street or Through Highway - Every highway or portion thereof at the entrance to which vehicular traffic from intersecting highways is required by law to stop before entering or crossing the same and when stop signs are erected.

Titles (or Headings) - The titles or headings of the sections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Toll Road, Bridge or Tunnel - A highway, bridge, or tunnel open to traffic only upon payment of a direct toll or fee.

Traffic Lane - The portion of a traveled way for the movement of a single line of vehicles.

Traveled Way - The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Trench - An excavation made for the purpose of installing or removing pipes, drains, catch basins, etc., and which is later refilled.

UCPX	unglazed clay pipe, extra strength
UL	Underwriters' Laboratories Incorporated

USSG United States Standard Gauge

WSSWG United States Steel Wire Gauge

Utilities - The word Utilities shall mean storm drains, sanitary sewers, water mains, gas mains, telephone and electrical lines, other special underground lines and their appurtenances.

VCPX vitrified clay pipe, extra strength

Work - Work shall be understood to mean the furnishing of all labor, materials, equipment, and other incidentals necessary to the successful completion of the project and the carrying out of all the duties and obligations imposed by the Contract.

Working Day - A day upon which, in the opinion of the Engineer, weather and soil conditions are such that the Contractor can advantageously work more than half of his current normal force for more than 5 consecutive hours or a major contract item then being performed, or the remaining principal work to be done. No working days will be charged on:

Saturdays, Sundays and State recognized holidays unless Contractor actually works more than 5 hours thereon.

Working Drawings - Stress sheets, shop drawings, fabrication details, erection plans, plans for false work, forms, centering, cribs, cofferdams and masonry layouts, bending and placing drawings, and bar schedules for reinforcing steel and any other supplementary plans or similar data which the Contractor may be required to furnish.

Work Order - A written signed by the Engineer, of a contractual status requiring performance by the Contractor without negotiation of any sort.

In order to avoid cumbersome and confusing repetition of expressions in these Specifications, whenever it is provided that anything is, or is to be, or to be done, if, or as, or when, or where "contemplated," "required," "directed," "specified," "authorized," "ordered," "given," "designated," "indicated," "considered necessary," "permitted," "suspended," "approved," "acceptable," "unacceptable," "suitable," "unsuitable," "satisfactory," "unsatisfactory," or "sufficient," it shall be taken to mean by or to the Engineer with the approval of the General Manager.

The sub-headings printed in these Specifications are intended for convenience or reference only, and shall not be considered as having any bearing on the interpretation thereof.

## SECTION 011002

### BIDDING REQUIREMENTS AND CONDITIONS

#### Section 10.02-1 Notice to Contractors

After the date is fixed for the letting of the work, the County will give notice of such letting to Contractors. The Notice to Contractors, which will usually be published as an advertisement will contain a description of the proposed work together with information to the Bidder regarding the proposal forms, plans and specifications, the nature of the proposal guaranty, and the reservation of the right of the County to reject any or all bids.

#### Section 10.02-2 Pre-qualification of Bidders

In most instances the County will require pre-qualification of bidders on major works. To be considered for pre-qualification each bidder must submit at least every two years, on the standard forms of the County, sworn statements as to experience, organization, construction equipment, and financial resources. These statements may be submitted at any time. If pre-qualification is granted, a pre-qualification certificate will be issued which identifies specific categories of pre-qualification. This certificate shall be renewable on May 31 of each odd-numbered year. The County reserves the right to waive pre-qualification requirements on all or part of any contract it advertises for bid.

Written requests may be made to the Engineer at any time for further qualifications because of changed conditions or estimated cost of the project. The County also reserves the right to request new qualification statements from any Bidder at any time.

Bidders may qualify at other times of the year provided such statements are properly executed and submitted. Bidders must be pre-qualified in order to have their bids considered. The applicant shall be informed of its prequalification approval or denial in writing (the "Prequalification Determination Letter") within fifteen (15) calendar days of New Castle County's receipt of the Application or, if prequalification is required by New Castle County for a specific project, the applicant will be notified not less than fourteen (14) calendar days prior to the closing bid date for the specific project.

Before awarding the Contract, the County may require a bidder to show that he has the ability, experience, necessary equipment, experienced personnel and financial resources to successfully carry out the work required by the Contract. In addition, where prequalification of subcontractors is required, the subcontractor must be prequalified prior to the award of contract.

#### Section 10.02-3 Contents of Proposal Forms

The proposal form shall describe location and type of work contemplated by the Contract and will include a listing of pay items. Where pay items are *unit* price items the proposal will further show the approximate estimate of quantities expected to occur *in* such *unit* price items. Should the County determine the need for special provisions, these will be attached to the proposal form.

The proposal form will also set forth the place, date and time of opening bids, proposal guaranty and the time to be allowed for completing the contract. The County will make a charge for each proposal and set of plans. The amount of such charge will be set forth in the Notice to Contractors. The sum charged for the proposal and the plan is not returnable.

All papers included in, bound thereto or attached to the proposal forms are necessary parts thereof and shall not be detached, separated or altered in their intent.

The plan, these specifications, supplemental specifications, other specifications mentioned, and other documents will be considered a part of the proposal whether attached thereto or not.

#### Section 10.02-4 Interpretation of Quantities in Bid Schedule

The quantities appearing in the prepared bid schedule are approximate and are prepared for the canvassing of bids. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the Contract. It is understood that the scheduled quantities of work to be done and materials furnished may be increased, diminished, or omitted without in any way invalidating prices bid, except as hereinafter provided for.

#### Section 10.02-5 Examination of Plans, Specifications, Special Provisions, and Site of Work

Each Bidder is required, prior to submitting his Proposal, to examine the site(s) of the proposed work as well as the plans and specifications. He shall familiarize himself with the general conditions of the Contract and all other matters which can affect the proposed work, and shall make necessary investigations relating to location and character of materials. He shall have no claim for damages, or an extension of time herein specified for completion of work, or any other concession, because of any misunderstanding, misinterpretation, or lack of information relative to this Contract for the work proposed in the plans or specifications. Borings, rock profiles, rock classifications, pipe or other underground objects where shown on the drawings, are approximately correct and should they be found otherwise or should the Contractor encounter quicksand, springs, or any materials other than shown, it shall be understood that the County does not warrant such plotting of underground objects to be correct or complete and claims arising from increased or decreased quantities, or otherwise, shall be disposed of in accordance with the requirements of the specifications governing the particular question at issue.

Test borings and rock profiles shown in the drawings are for the convenience of the Contractor. The County does not assume any responsibility for their accuracy should the Contractor rely on such information in preparing his bid or in the performance of the work.

#### Section 10.02-6 Taxes

The Contractor is responsible for and by submitting his bid agrees to pay all retail sales, income, real estate, sales and use, transportation and special taxes applicable to and assessable against any materials, equipment, processes and operation instant to or involved in the improvement. The Contractor is responsible for ascertaining and acquainting himself with such taxes and making all necessary arrangements to pay them.

#### Section 10.02-7 Preparation of Proposal

The Bidder shall submit his proposal upon the blank forms furnished by the County. The Bidder shall specify a unit price in dollars and cents in the format shown for each pay item given, except that alternates may be omitted unless otherwise stated. He shall show the products of the respective unit prices and quantities written in figures in the column provided for that purpose, together with the total amount of the proposal obtained from adding the amount of the several items.

The proposal forms shall be completely filled out in ink. The proposal if submitted by an individual shall be signed by the individual; if submitted by a partnership shall be signed by such member or members of the partnership as have authority to bind the partnership; if submitted by a corporation the same shall be signed in the name of such corporation by some authorized officer, or agent thereof, who shall subscribe his name and office and the seal of the corporation shall be affixed. If not signed by an officer, there must be attached a copy of that portion of the bylaws, or a copy of a board resolution, duly certified by the Secretary of the corporation, showing the authority of the person so signed on behalf of the corporation. In lieu thereof, the corporation may file such evidence with the County, duly certified by the Secretary of the corporation, together with a list of the names of those officers having authority to execute documents on behalf of the corporation, duly certified by the Secretary of the corporation, which listing shall remain in full force and effect until such time as the County is advised in writing to the contrary. In any case where a proposal is signed by an attorney in fact the same must be accompanied by a copy of the appointing document duly certified.

The completed proposal form shall include the Bidder's attested statement that he has the necessary work capacity to perform the Contract, either with his own organization or with sub-contractors as provided hereinafter. The Bidder is required by law to identify all subcontractors to be used on all public building work in excess of \$10,000. In the Proposal section, certain subcontract specialties are delineated. Participants in the pre-bid meeting will be asked to refine this list and any changes will be published by Addendum.

#### Section 10.02-8 Irregular Proposals

Proposals made on any other than the proposal form furnished by the County will not be considered. Changes in phraseology of the proposal, additions, or limiting provisions, will render the proposal informal and may cause its rejection.

Bidders may not change the unit price for contingent items if they have been stipulated by the County. Any change will cause rejection of the proposal.



Unbalanced proposals shall be liable to rejection.

#### Section 10.02-9 Proposal Guaranty

Each proposal must be accompanied by a certified check drawn on a solvent clearing house bank, made payable to New Castle County in the amount of 10% of the proposal. A satisfactory Bidder's Bond will be accepted in lieu of a check. The Bid Bond shall be good and sufficient bond to the County for the benefit of the awarding agency, with the corporate surety authorized to do business in the State of Delaware, and the form of the bond and the corporate surety shall be approved by the awarding agency. The Bid Bond shall be an original document containing original signatures, and original seals shall be attached if the corporate surety and/or bidder have corporate seals. The Power of Attorney shall be in an approved corporate form and subject to County's approval. It need not be for a specific sum but may be stated to be for a sum equal to ten (10) percent of the bid to which it relates and not to exceed a sum, if such sum is equal to at least (10) percent of the bid.

#### Section 10.02-10 Delivery of Proposals

Each proposal shall be submitted in a sealed envelope provided by New Castle County marked to clearly indicate its contents. If hand delivered or forwarded by mail, the above mentioned envelope shall be enclosed in another envelope addressed to the New Castle County Office of Administrative Services, Purchasing Division, 2nd Floor, New Castle County Government Center, 87 Reads Way, New Castle, Delaware 19720. Mailed proposals shall be sent by registered mail. Proposals received after the time of opening of bids will be returned to the Bidder unopened. The Bidder bears the risk of delays in delivery.

#### Section 10.02-11 Withdrawal of Proposals

Bidders may withdraw a proposal after it has been deposited with the County anytime prior to the stipulated time for the opening of such proposals. No proposal may be withdrawn within thirty (30) working days after the opening thereof.

#### Section 10.01-12 Opening of Proposals

Proposals will be received until the date and time stated in the proposal form and will be publicly opened and read at the place, time and date stated. No responsibility will be attached the County for the premature opening of a bid not properly addressed and identified. Bidders or their authorized agents are invited to be present at the opening of proposals.

#### Section 10.02-13 Material Guaranty

Before any Contract is awarded, the Bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work together with samples, these samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

#### Section 10.02-14 Rejection of Proposal After Opening

No Contract will be awarded any Bidder who in the judgment of the County is not a responsible Bidder; or is not prepared with all the necessary experience, capital, organization, and equipment to conduct and complete the work for which the Bidder proposes to contract, in strict accordance with all of the terms and provisions of the Contract Documents.

## Section 10.02-15 Wage Rates

All Contractors and Subcontractors performing work on Special Services' contracts are required to comply with Section 2.05.303.D of the *New Castle County Code* (reproduced below) and as may be subsequently amended.

11.a. *Wage requirements in Special Services contracts.* The specifications for every Special Services contract or aggregate of contracts relating to contract construction in excess of \$100,000 for new construction (including painting and decorating) or \$15,000 for alteration, repair, renovation, rehabilitation, demolition or reconstruction (including painting and decorating of buildings or works) for which the County appropriated any part of the funds and which requires or involves the employment of mechanics and/or laborers shall contain a provision stating the minimum wages to be paid various classes of laborers and mechanics which shall be the wages determined by the Delaware Department of Labor, Division of Industrial Affairs, to be prevailing in New Castle County.

b. The scale of wages to be paid shall be posted by the employer in a prominent and easily accessible place at the site of the work. The wage scale shall include the name, address, and phone number of the County representative who is to be notified of violations. If no stationary structure is available on the construction site for the posting of the wages, the employer shall provide individual notices to the employees and shall provide proof of same upon request. Any employer who fails to post or provide notice as required by this Subsection shall be subject to a civil penalty of \$500 for each violation.

c. The County or its agents shall be authorized to inspect the employer's payroll records and other records relating to the Special Services Contract at any time to ensure compliance with this Section.

d. The County is authorized to monitor all contract construction for compliance with this Section and/or investigate all claims that the prevailing wage rates as provided for under this Section are not being or have not been paid. Upon finding that an employer has not paid or is not paying the prevailing wage rates, the County shall provide the employer with a written notice of alleged violation(s) by personal service or by certified mail and shall make an effort to obtain compliance. The notice of violation shall describe the violation(s), in addition to stating applicable sanctions and/or penalties. Upon failure to obtain compliance within ten business days from the date the letter was received by the employer, the County may withhold so much of accrued payments as may be considered necessary to pay to laborers and mechanics the difference between the rates of wages required by the contract to be paid laborers and mechanics on the work and the rates of wages received by such laborers and mechanics, and the accrued payments will be distributed upon resolution of the matter. An employer who disputes the alleged violation(s), sanctions or penalties may, within ten days from receipt of the notice of violation, file a written request for a hearing before the General Manager of the Department of Special Services or his/her designee. The General Manager shall issue a final order within two business days from the conclusion of the hearing. If no hearing is requested, the notice shall become a final order upon expiration of the ten day period. Payment of the penalty is due when a final order is issued or when the notice becomes a final order. Failure to provide timely payment shall constitute a separate violation of this Section. Any sum collected as a fine or penalty pursuant to this section shall be applied toward enforcement and administration costs of the Department of Special Services.

e. As an alternative to or in addition to any other sanctions provided by law for violations of this or any other wage law, when the General Manager of the Department of Special Services finds that an

employer has violated this Section, the General Manager is authorized to assess and collect administrative penalties, up to a maximum of \$500 for a first violation and up to a maximum of \$1,000 for a second violation. An employer who violates this Section a third time shall be barred from bidding and/or working on county-funded construction projects for a period of three years. When determining the penalty, the General Manager shall consider factors which include the history of previous violations by the employer, the seriousness of the violation, and the good faith of the employer. An employer with no violations within the five-year period preceding any violation shall be deemed to have no previous violations.

f. Any laborer or mechanic, or the County on behalf of any laborer or mechanic, who is paid in a sum less than the prevailing wage rates provided for under this section shall have a right of action against the employer in any court of competent jurisdiction to recover treble the difference between the amount so paid and the prevailing wage rate. Such action may be brought by the County in the name and for the benefit of the laborer or mechanic with or without an assignment of the claim from the employee, and upon notice to the aggrieved employee, the County shall have the power to settle and adjust any such claim to the same extent as would the aggrieved employee. Any judgment entered for plaintiff shall include an award for reasonable attorney's fees and costs of prosecution. The County shall have the authority to join various claimants in one preferred claim lien and, in case of suit, to join them in one cause of action.

No action to recover wages and damages under this section shall be brought after the expiration of two years from the accruing of the cause of action.

Any wages collected but not claimed by the employee within one year from the date the wages were collected shall be retained by the County for enforcement purposes.

g. Any employer who discharges or in any manner discriminates against an employee because that employee has made a complaint or has given information to the County pursuant to this section, or because that employee has caused to be instituted or is about to cause to be instituted any proceedings under this section, or has testified or is about to testify in any such proceedings, shall be deemed in violation of this Section and shall be barred from working on County-funded projects for three years from the date of the violation and shall be subject to a civil penalty of \$5,000 payable to the aggrieved employee.

h. The County shall have the power to make and revise or rescind such regulations as it may deem necessary or appropriate to administer or enforce this Section.

i. Payroll information, as required by the County, shall be furnished electronically at such time as the County is able to receive such reports online, not to exceed six months from the enactment of the Ordinance.

j. Refer to the Special Notice to Bidders in the Appendix Section, and elsewhere in this contract document, regarding the use of Prevailing Wages on this project.

k. The Prevailing Wages for Heavy Construction have been included in the Appendix section for the convenience of bidders. It shall be the responsibility of each prospective bidder and the successful contractor to verify that the wage rates included herein are current, and/or to secure the appropriate version that was in effect at the time of advertisement.

l. The wage rates published in this contract are issued by the State of Delaware Department of Labor on the date indicated. The County, the Engineer, and/or the Construction Manager accept no

responsibility for the accuracy or applicability of any rates included herein. The actual wage rate determinations, which will apply to work will be those in effect on the first day of public advertisement for bids as determined by the State Department of Labor. It will be the responsibility of each bidder to contact the State Department of Labor and to incorporate these rates in his bid.

**SECTION 011003**  
**AWARD AND EXECUTION OF CONTRACT**

Section 10.03-1 Consideration of Proposals

After the proposals have been publicly opened and read, bids will be compared by the Engineer and the results of such comparisons will be immediately available to the public. The right is reserved by the County to reject any and all bids, to advertise for new proposals, to proceed to do the work otherwise, or to abandon the work, if in the judgment of the County the best interest of the County will be promoted thereby.

In the event of a discrepancy between the unit bid price and the extension, the unit price will govern. In the case of a discrepancy between prices written in words and those written in figures, the written words will govern.

The County further reserves the right to waive technicalities in construing the irregularity of proposals submitted by the Contractor provided the technicality so waived does not change the meaning, substance or intent of the proposal and the proposal remains unmistakably clear as to its intent and meaning.

Section 10.03-2 Award of Contract

The award of Contract, if it be awarded will be to the lowest responsible Bidder whose proposal complies with all the requirements prescribed. The successful Bidder will be notified, by letter mailed to the address shown on his proposal, that his bid has been accepted and that he has been awarded the contract.

Section 10.03-3 Return of Proposal Guaranty

As soon as the bid prices have been checked and compared, the County will return the proposal guarantees accompanying the proposals of all except the three lowest Bidders. Bid bonds will not be returned.

The proposal guarantees of the three lowest bidders will be held until the contract is awarded. When the contract is awarded, the proposal guarantees of two remaining unsuccessful bidders will be returned. The proposal guaranty of the successful bidder will be retained until after the contract and contract bond have been executed, after which it too will be returned.

Section 10.03-4 Contract Bond Requirement

The successful Bidder will be required to give bond of a surety company, acceptable to the County, and licensed to do business in the State of Delaware, within fifteen days of the award of contract in the amount of the contract price in the for attached hereto. Whenever the surety or sureties on the bond so furnished in accordance with the preceding paragraph shall be deemed by the County to be insufficient or unsatisfactory the Engineer may, in his discretion, within ten days after notice to that affect, mailed to the address of the Contractor,

require the Contractor to furnish and deliver a new bond with surety satisfactory to the Engineer. Upon failure of the Contractor to furnish the aforesaid bond within ten days after such notice is mailed to his address, the Engineer may withhold all payments due to the Contractor, stop all further work under the contract, and re-advertise the unfinished work at the expense of the Contractor, or in any manner which may be deemed best to protect the interests of the County.

#### Section 10.03-5 Execution of Contract

The successful bidder shall be notified of his selection and the intention of the County to award the Contract. Within fifteen (15) calendar days after receipt of the County's Letter of Intent to Award Contract, the successful bidder shall promptly execute a formal Special Services Contract to be approved as to its form, terms and conditions by the County, and also the bond required by Section 2.05.303, subsection D of the New Castle County Code.

#### Section 10.03-6 Failure to Execute Contract

In the event that a successful Bidder shall fail to properly execute a contract and file acceptable bond within the time prescribed above then, at the sole option of the County, the award may at any time thereafter be annulled and proposal guaranty forfeited to the County, not as a penalty but in liquidation of damages sustained. Awards may be then made to the next lowest responsible Bidder or the work may be re-advertised and constructed under contract or otherwise, as the County may decide.

**SECTION 011004**  
**SCOPE OF WORK**

Section 10.04-1 Intent of Contract

The intent of the contract is to prescribe a complete work or improvement for which the Contractor undertakes to do in full compliance with the plans, specifications, proposal and contract, together with any authorized alterations, special provisions and supplemental agreements. A Contractor shall perform all items of work covered and stipulated in the specifications, proposal and contract, together with any authorized alterations, special provisions, extra work and supplemental agreements, all in accordance with the lines, grades, cross sections and dimensions shown on the plans. The Contractor shall furnish, unless otherwise provided in these specifications and special provisions, all materials, implements, machinery, equipment, tools, supplies, transportation and labor necessary to the prosecution and completion of the work.

Section 10.04-2 Special Provisions

Requirements not covered by the plans or these specifications shall be known as special provisions and attached to the proposal form and shall be considered in addition to these specifications. In the event that there shall be any conflict between special provisions, plans, specifications and/or supplemental specifications, special provisions shall govern over the latter three and plans shall govern over the latter two.

Section 10.04-3 Increase or Decrease of Quantities and Alterations

The County reserves the right to increase or diminish the quantity of material to be furnished for work to be done under any item of the proposal, wherever it deems it advisable or necessary so to do, and such increase or diminution shall in no way vitiate the contract.

When total alterations involve an increase or decrease of more than 25% of the total cost of the work calculated from the original contract price, or an increase or decrease of more than 25% in the quantity of any one major contract item, or an extension or shortening of the project of more than 25% of the length shown on the Plans, either party shall be entitled to demand a supplemental agreement on that portion of the work above 125% or below 75% of the quantity stated in the proposal.

The County reserves the right to change the alignment, grade, form, length, dimensions or materials of the work under the contract, whenever any conditions or obstructions are met that render such changes desirable or necessary. In case such alterations make the work less expensive to the Contractor, a proper deduction shall be made from the unit prices and the Contractor shall have no claim on this account for damages or for anticipated profits on the work that may be dispensed with. In case such alterations make the work more expensive, a proper addition shall be made to the unit prices. Any such deduction or addition shall be negotiated by the Engineer with the Contractor.

The foregoing provisions in this Section do not apply to any contract items that are designated as contingent items in the Contract. Increases or decreases in the quantities of any contingent items are expected to occur or in the total contract amount due to variances in the quantities of contingent items. All of the quantities for contingent items are estimates for the purposes of comparing bids to perform the work. Thus, no adjustment for the contract prices for contingent items will be considered by the County, and the County shall not be liable to the Contractor for any additional compensation based on any variance between the estimated quantities in the Contract and the actual quantities encountered during the project. Contractor shall be paid solely for the actual quantities at the bid price.

#### Section 10.04-4 Extra Work

When required alterations involve work for which no quantity and price have been included in the proposal, such work shall be done at a price agreed upon previously, in writing, by the Contractor and the Engineer, or where such price cannot be satisfactorily agreed upon by both parties, or where this method of payment is impracticable, the Engineer may, in writing, order the work to be done on a force account basis to be paid for as hereinafter specified.

#### Section 10.04-5 Unauthorized Work

Work done without lines and grades being given, work done beyond the lines and grades shown on the plans or as given, and except as herein provided, materials removed from borrow pits without preliminary cross sections having been taken, or any work done without written authority, will be considered as unauthorized and at the expense of the Contractor and will not be measured or paid for by the County. Work so done may be ordered removed and replaced at the Contractor's expense.

Borrow or other materials shall not be obtained from the right of way without the written approval of the Engineer.

#### Section 10.04-6 Removal and Disposal of Structures and Obstructions

All fences, buildings, structures or encumbrances of any character on or within the limits of the right of way shall be removed by the Contractor and stored, replaced, or otherwise disposed of as shown on the plans, provided for in the specifications, or directed by the Engineer. No payment will be made for this work unless a pay item or items for such work is shown in the proposal.

In case any pipe, structure, or other obstruction, so located or placed as to interfere with the work, is unexpectedly encountered, the Contractor shall at once notify the Engineer, in writing, of the locality and circumstances, and the work at this location shall be suspended until satisfactory arrangements are made, without any claims for damages or extra compensation arising from the delay, but the Contractor will be allowed an equitable extension of time.



#### Section 10.04-7 Right In and Use of Material Found on the Work

Except as provided herein the Contractor, with the approval of the Engineer, may use in the proposed construction, suitable stone, gravel, topsoil or sand found in the excavation, but he shall replace at his own expense with other suitable material all of that portion of the material so removed and used as was contemplated for use in the embankments, backfills, approaches or otherwise. No charge for materials so used will be against the Contractor except the replacement herein provided for, which item when deductible shall be made from the respective item of excavation used for its replacement. The Contractor shall not excavate or remove any material from within the right of way which is not within the excavation as indicated by the slope and grade lines, without written authorization from the Engineer.

#### Section 10.04-8 Final Cleanup

Upon completion of the work and before acceptance and final payment shall be made; the Contractor shall clean and remove from the improvement and its approaches, footways, lawns and adjacent property, all surplus and discarded materials, falsework, rubbish and temporary structures and buildings, restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of the work, and shall leave the improvement and its approaches in a neat and presentable condition throughout the entire length of the improvement under Contract.

**SECTION 011005**  
**CONTROL OF THE WORK**

Section 10.05-1 Authority of Engineer

To prevent misunderstanding and litigation, the Engineer shall decide any and all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of said work, and shall decide all questions which may arise as to the interpretation of any or all plans relating to the work and of the specifications, all questions as to the acceptable fulfillment of the contract on the part of the Contractor.

In all cases where periodic payments are to be made, the Contractor shall estimate the amount and quantity of several kinds of work performed and materials furnished which are to be paid for under the contract. The preparation and issuance of such a determination and approval by the Engineer shall be a condition precedent to the receipt of any such periodic payments by the Contractor. Nothing herein, however, shall preclude the Contractor or Engineer from disputing the priority or correctness of such determination(s) and estimate(s) at such time as the final payment under the contract shall become due and payable.

Any doubt as to the meaning of or any obscurity as to the wording of these specifications and contract, and all directions and explanations requisite or necessary to complete, explain or make definite any of the provisions of the specifications or contract and to give them due effect, will be resolved by the Engineer.

The decision of the Engineer shall be final and conclusive and he shall have the authority hereunder to enforce and make effective such decisions and orders as the Contractor fails to carry out promptly.

Section 10.05-2 Plans and Working Drawings

The approved plans will be supplemented by such working drawings as are necessary to adequately control the work. It is mutually agreed that all authorized alterations affecting the requirements and information given on the approved plans shall be in writing and approved by the Engineer. When at any time reference is made to "The Plans", the interpretation shall be the Plans as affected by all authorized alterations then in effect.

The Contractor shall submit four copies of all pipe laying schedules and working drawings required for the prosecution of the work, that are not included in the plans, for the review of the Engineer.

Work drawings shall include shop details, erection plans, masonry layout diagrams, and bending diagrams for reinforcing steel, plans for cribs, cofferdams, false work, centering and form work. They shall be reviewed by the Engineer before any work involving these plans shall be performed. It is understood that the approval by the Engineer of the Contractor's working drawings and pipe laying schedules does not relieve the Contractor of any responsibility. Cost of furnishing all working drawings shall be borne by the Contractor.

The final limits of any and all earthwork, pavements, sidewalks, pipe lines, structures, or any other items shall conform, in all cases, to the lines, grades, cross sections and dimensions shown on the plans and no deviations shall be permitted other than allowed by tolerance indicated or authorized herein.

#### Section 10.05-3 Conformity with Plans and Specifications

All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions, and material requirements, including tolerances shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modifications which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgment.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the plans and specifications, and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

#### Section 10.05-4 Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions

These Specifications, the Supplemental Specifications, the Plans, Special Provisions, and all supplementary documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In the event of any discrepancy between the drawing and figures written thereon, the figures unless obviously incorrect, are to govern over scale dimensions. In the case of any discrepancy between the Plans and the Specifications, the Plans are to govern. If there is a discrepancy between these Standard Specifications and Supplemental Specifications, the Supplemental Specifications are to govern. Special Provision shall govern over Specifications, Supplemental Specifications and Plans.

If, in the progress of the work, the Contractor should discover any errors or omissions in the Plans, Specifications, or lines and grades furnished by the County, or in the work undertaken and executed by him, he shall immediately notify the Engineer and shall not proceed with the work until the corrections shall have been made.

#### Section 10.05-5 Construction Plans to Successful Bidder

The successful bidder on each contract advertised by the County will be furnished, upon award, five sets of Plans free of charge. Any additional sets required by the Contractor may be purchased at the price noted in "Notice to Contractors."

#### Section 10.05-6 Cooperation by Contractor

The Contractor will keep available on the work at all times, one set of Plans, Specifications and Special Provisions and any Supplemental Plans and Specifications.

The Contractor shall give the work the constant attention necessary to insure the progress thereof, and shall cooperate with the Engineer, his Inspectors, and other Contractors in every way possible.

The Contractor shall assign to the Contract as his agent, a competent superintendent or foreman capable of reading and thoroughly understanding the Plans and Specifications, thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or his authorized representatives. The superintendent or foreman shall have full authority to execute the orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet. The County reserves the right to require the removal of the Superintendent or foreman for legitimate cause.

Each successful contractor will be required to furnish the Engineer the names, addresses, and telephone numbers of at least two members of his organization that may be contacted in an emergency.

#### Section 10.05-7 Cooperation with Utility Owners

It shall be the responsibility of the Contractor, upon receipt of Notice of Award, to notify all public utility corporations, municipal bureaus, or others to make all necessary adjustments to such public utility fixtures and appurtenances which are, at the time and prior to the beginning of construction, within the limits of construction, in order that the Contractor may coordinate his work with that of the work of revising the location of the public utility, thereby avoiding delays and additional construction costs.

Water mains, storm drains, sanitary sewers, gas mains and other utilities are shown on the drawings in accordance with the best information available, for the information of the Contractor. The County assumes no responsibility for accuracy of information shown. Existing mains and services shall be carefully protected and any damage to them caused by the work, shall be immediately repaired to the satisfaction of the Engineer at the expense of the Contractor.

It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions and that no additional compensation will be allowed for delays, inconvenience, or damage sustained by him due to the interference of said utility appurtenances or the operation of moving them, except the Contractor may be granted an equitable extension of time.

#### Section 10.05-8 Cooperation Between Contractors

The County reserves the right at any time to contract for and perform other or additional work on or near the work covered by any contract.

When separate contracts are let within the limits of anyone project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other and in case of dispute the Engineer shall be the referee and his decision shall be final and binding on all.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the County from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operation of other Contractors working within the limits of the same project and he shall assume all responsibility for all work not completed or accepted because of the presence and operations of the other Contractors.

The Contractor shall as far as possible arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of the other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and he shall perform it in proper sequence to that of the others.

#### Section 10.05-9 Duties of Inspectors

Inspectors shall be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the material to be used. The inspector is not authorized to revoke, alter or waive any requirements of the Contract, nor is he authorized to approve or accept any portion of the complete project. He is authorized to call the attention of the Contractor to any failure of the work or any failure of material to conform to the Specifications. He shall have the authority to reject materials or suspend work until any questions at issue can be referred to and decided by the Engineer. Inspectors shall perform their duties at such time and in such manner so as not to unnecessarily impede the progress on the Contract.

The inspector shall in no case act as a foreman or perform other duties for the Contractor, nor interfere with the management of the work at hand. Any advice which the inspector may give the Contractor shall not be construed as binding the Engineer in any way, or releasing the Contractor from fulfilling all of the terms of the Contract.

Where there is disagreement between the Contractor and the inspector, such as refusal by the Contractor to use approved materials; for performing work not in compliance with the Plans and Specification; and/or refusing to suspend work until problems at issue can be referred and decided by the Engineer, the inspector will immediately direct these matters to the attention of the Engineer. If the Contractor still refuses to make corrections, comply or suspend work, the Engineer will prepare and deliver in writing to the Contractor, by mail or otherwise, a written order suspending the work and explaining the reason for such suspension. As soon as the inspector is advised of the delivery of the suspension order, the inspector shall immediately leave the site of the work and any work performed during the absence of the inspector will not be accepted or paid for.

#### Section 10.05-10 Inspector's and/or Engineer's Office

The Contractor shall provide, if indicated in the Special Provisions or Proposal, a suitable office in an acceptable location on or in the immediate vicinity of the project for the exclusive use of the Engineer and inspector in making reports, checking drawings and Specifications, conducting tests of materials, and for storing field equipment, testing apparatus and records of the Engineer and inspector.

#### Section 10.05-11 Construction Stakes

The Engineer will typically provide initial control survey information, e.g.; benchmark elevation and/or Geographic Information System (GIS) coordinates. It will then be the Contractor's responsibility to proceed with the remaining stakeout work to include, but not be limited to, furnishing and setting construction stakes establishing all lines (e.g. Pipe, Rights of Limits, etc.), grades, and measurements necessary for the proper prosecution of the work contracted for under the Contract.

The Contractor will be expected to preserve the construction stakes and markers after being set. The Contractor will be held responsible for such preservation and if, in the opinion of the Engineer, they are willfully or carelessly disturbed or destroyed by the Contractor, the Contractor shall replace them. It shall be within the Engineer's discretion to determine whether the cost to perform and maintain the construction stake out will be listed as a separate bid item. If not listed as a separate bid item, then the cost to perform and maintain the construction stake out shall be considered as incidental to other items and included in the price bid for them.

#### Section 10.05-12 Inspection of Work

All materials and each part or detail of the work shall be subject at all times to inspection of the Engineer or his authorized representative. The Contractor will be held strictly to the Contract in regard to quality of materials, workmanship, and the diligent execution of the Contract. Such inspection- may include mill, plant, or shop inspection, and any material furnished under the Specification is subject to such inspection. The Engineer or his representative shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor that may be required to make a complete and detailed inspection.

The Engineer may request the Contractor at any time before acceptance of the work to remove or uncover such portions of the finished work as may be directed. After the uncovered area has been examined, the Contractor shall restore these portions of the work to the standard required by the Specification. Should the work exposed or examined prove to be acceptable, the uncovering or removing, and the replacement of the covering for making good the parts removed shall be paid for as extra work and the number of working days to remove and/or uncover said work and thereafter restore it shall be allowed as an extension of time.

Should the work so exposed or examined prove unacceptable, the uncovering or removing and the replacing and/or repair shall be at the expense of the Contractor.

Any work done or materials used by the Contractor to knowingly avoid supervision or inspection by a County representative may be ordered removed and replaced at the expense of the Contractor.

When the United States Government or any railroad, corporation or other agency has an interest in the work or is to pay a portion of the cost of the work covered under this Contract, their authorized representatives shall also have the right to inspect the work.

#### Section 10.05-13 Removal of Defective and Unauthorized Work

Defective work and materials or unauthorized work shall be removed and disposed of immediately after rejection. Failure of the Contractor to remove and properly dispose of rejected work or materials immediately after receiving formal notice to do so, shall be sufficient cause for the County to declare the Contract forfeited. In this case the County, at their option, may purchase material, tools, and equipment and employ labor or may contract with any other individual firm or corporation to perform and complete the work. All costs and expenses incurred thereby shall be charged against the defaulting Contractor and the amount deducted from any monies or which may become due him or shall be charged against his Contract Bond. Any work performed as described in this Section shall not relieve the Contractor in any way from his responsibility for the work that was performed by him.

No work shall be done without lines and grades having been given, except as herein provided. Any work which may be done by the Contractor prior to the approval of the Contract, work done contrary to or regardless of the instructions of the Engineer, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work and without authority will be considered as unauthorized and will not be paid for under the provisions of the Contract. Work so done may be ordered removed or replaced at the expense of the Contractor.

#### Section 10.05-14 Claims for Adjustment and Disputes

In any case where the Contractor deems extra compensation is due him for work or materials not clearly covered in the Contract, or not ordered by the Engineer as an extra, as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such extra compensation before he begins the work on which he bases the claim. A notation on the daily report of the inspector which is confirmed in writing to the Engineer within three days will be considered to comply with this provision.

If such notification is not given, or if the Engineer is not afforded proper facilities by the Contractor for keeping strict account of the actual cost of the work, then the Contractor automatically waives the claim for such extra compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost of the work, shall not in any way be construed as proving validity of the claim. The claim must be considered by the Engineer and if found to be just, it will be allowed and paid as an extra as provided for herein.

Changes in the cost of labor, materials, or equipment, will not be considered as a basis for additional payment and/or adjustment in contract prices except where labor rates are set forth in the Proposal and are revised subsequent to the opening of bids.

Overhead costs or home office support costs, under an Eichleay formula calculation or any other method of calculation, shall not be paid by the County in the event any claim is authorized under this Contract.

#### Section 10.05-15 Maintenance of Work During Construction

The Contractor shall maintain the work during construction and until final acceptance. This maintenance shall constitute continuous and effective work, prosecuted as required, with adequate equipment and personnel, to the end that the project is kept in satisfactory condition at all times.

Particular attention shall be given to drainage, both permanent and temporary. The Contractor shall use all possible precautionary measures to avoid damage or loss that might result from accumulations and concentrations of drainage waters, and material carried by such waters. Drainage shall be diverted or dispersed when necessary to prevent damage to excavations, embankments, surfacing, structures or property.

The cost of all maintenance work during construction and before final acceptance shall be included in the unit prices on the various pay items and the Contractor will not be paid any additional money for such work unless otherwise provided in the contract documents.

In the event that the Contractor is ordered to stop work for failure to comply with the provisions of the contract, the Contractor shall maintain the work as provided herein, and provide such ingress and egress for local residents as may be necessary during the period of suspension or until the contract has been declared in default.

Failure on the part of the Contractor at any time to maintain the work satisfactorily will result in the immediate notification of the Contractor by the Engineer to comply with the required maintenance provisions. In the event that the Contractor fails to remedy unsatisfactory maintenance within 24 hours after the receipt of such notice, the Engineer will immediately proceed with adequate forces and equipment to maintain the project or withhold further payment on those items of the contract on which the cleanup is necessary until the work is performed in a satisfactory manner. The Engineer may stop further work in other areas of the project until the cleanup work is performed. The entire cost of this maintenance will be chargeable to the Contractor and shall be deducted from monies due him on the contract or charged against his Contract Bond.



## Section 10.05-16 Final Acceptance

Upon due notice from the Contractor of presumptive completion of the project, the Engineer shall make a semi-final construction inspection and if at such inspection, all construction provided for and contemplated by the contract is found completed such inspection shall constitute the final inspection and the Engineer shall establish the date of final acceptance and the Contractor shall be notified of such acceptance in writing within ten days. After final acceptance the County will assume responsibility for maintenance except where otherwise provided by the contract.

If, however, at any semi-final construction inspection any work in whole or in part is found unsatisfactory, the Engineer shall give the Contractor the necessary instructions as to the replacement of material and performance and/or re-performance of work necessary and prerequisite to final completion and acceptance. The Contractor shall comply with and execute such instructions. Upon the satisfactory replacement of such material and performance or re-performance of such work, another inspection will be made which shall constitute the final inspection if said material is found to have been replaced and the work completed satisfactorily. In such event the Engineer shall make the final acceptance and the Contractor shall be notified as previously mentioned. After final acceptance, the County will assume responsibility for maintenance except where otherwise provided by the contract.

**SECTION 011006**  
**CONTROL OF MATERIALS**

Section 10.06-1 General

The materials used on the work shall meet all quality requirements of the contract. In order to expedite the inspection and testing of materials the Contractor shall notify the Engineer in writing of the sources from which he proposes to obtain all materials required for completion of the project as soon as possible after receipt of notification of award of the contract.

Section 10.06-2 Approval of Material Sources

The Engineer will inform the Contractor as to the acceptability of each material source as soon as an evaluation of the sources proposed can be made. No material may be incorporated into the work until approval of the source has been given. Where delivery of materials to the job site is made prior to approval, such delivery is made at the Contractor's risk and subject to immediate removal at no cost to the County in cases where it is determined that the source is not acceptable.

Material sources may be rejected even though prior samples meet the applicable specifications where it is evident that the material tends to be of marginal quality as compared to the specification limits in one or more of its properties.

All source approvals are made subject to continuing production of materials meeting the specifications. Where this condition is not met the approval of any source may be withdrawn by the Engineer at any time.

Section 10.06-3 Approval of Plants and Shops

Immediately upon receipt of notice of award of contract, the Contractor shall submit in writing for the approval of the Engineer the location and ownership of those plants or fabricating shops at which materials for the project will be processed. The Engineer will inform the Contractor as to the acceptability of the proposed plants or shops as soon as an evaluation can be made. No material is to be shipped from these sources until this approval has been given. Plant or shop approvals are made subject to continuing production of materials meeting the specifications. Where this condition is not met the approval of any plant or shop may be withdrawn by the Engineer at any time.

Section 10.06-4 Samples, Tests, Cited Specifications

All materials used in the work will be inspected, sampled and tested in accordance with these requirements and such others as are set forth elsewhere in these specifications or in the Special Provisions in which particular reference is made to a specific material. Unless otherwise designated, tests will be made in accordance with the most recently published cited standard, tentative or interim methods of AASHO or ASTM which are current on the date of advertisement for bids. These tests will be made by and at the expense of the County unless otherwise noted.

Acceptance testing by the County as described here and elsewhere is not to be considered as a replacement for control testing conducted by the Contractor or a manufacturer producing materials for the Contractor. When the Contractor or manufacturer is not providing adequate control testing facilities in his own behalf the Engineer may refuse to carry out resampling and testing of materials which have been shown to be defective by normal sampling and testing routines. The Engineer may also refuse to resample and test defective materials until and unless corrective action has been taken by the Contractor or manufacturer.

#### Section 10.06-5 Plant and Field Laboratories

At proportioning, batching, mixing or other manufacturing plants the Contractor shall provide quarters suitable for a plant laboratory in which to house and use the equipment necessary for the Engineer to conduct the various tests required. These quarters shall be for the exclusive use of the Engineers and Inspectors for testing and recording purposes. The quarters shall be so located that they are convenient to the plant and that the plant shall be in full view from at least one window.

#### Section 10.06-6 Control of Materials

Materials from approved sources, plants or shops will be subjected to control tests by the Engineer at such locations with such frequency as he deems appropriate. The point or points of sampling will be those points at which required physical or chemical requirements are to be met. It is intended that insofar as is practical these points will be the points in the productive process just prior to inclusion into the work or into combination with other materials. It is also intended that sampling and testing will be conducted in such a manner and at such points as to minimize interference with the maintaining of an efficient schedule by the Contractor. Where the nature of the work precludes the attainment of both of these ends simultaneously the Engineer will designate the point of sampling in a manner so as to insure that the specifications are met.

While it is required that all materials will conform to the specified values for all properties, the Engineer may designate different points of sampling and different sampling intervals for separate characteristics of any material. The Contractor will assist in the sampling of materials and make provision for safe and reasonable access. The Engineer may elect, where possible, to sample and test lots of material at the point of manufacture. In this case lots may be given approval and, where practicable, so marked by the Engineer. This procedure assumes that consistent production and appropriate storage, handling and shipping practices will be maintained by the manufacturer, the hauler, and the Contractor. Such approval does not preclude subsequent inspection, sampling and testing of materials at the job site with acceptance or rejection being predicated on the results of the later procedures.

#### Section 10.06-7 Storage of Materials

The Contractor, upon consultation with the County, shall arrange for delivery and storage, protection and security for all materials, systems and equipment which are a part of the Project, until such items are incorporated into the Project, including owner-furnished materials, systems and equipment.

Materials shall be so stored as to assure the preservation of their quality and acceptability for the work. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located so as to facilitate their prompt inspection. Approved portions of the right of way may be used for storage purposes and for the placing of the Contractor's plant and equipment; such storage areas must be restored to their original condition by the Contractor at his expense. Any additional space required must be provided by the Contractor at his expense.

#### Section 10.06-8 Handling of Materials

Materials shall be handled in such a manner as to preserve their quality and acceptability for the work. Handling equipment and hauling vehicles shall be so constructed as to prevent loss, contamination, or segregation of materials during or after loading.

#### Section 10.06-9 Unacceptable Materials

Materials represented by samples taken and tested in accordance with the specified tests and failing to meet required values shall be considered to be defective regardless of prior tests or approvals. Unless otherwise allowed by the Engineer as set forth below defective materials will be removed from the site with any tags, stamps or other markings implying conformance with the specifications removed or obliterated.

Where defects can be corrected the Contractor may propose such corrective action as he deems appropriate to the Engineer. The Engineer may approve the corrective action, but in so doing does not assume the responsibility for the success thereof. Retests will be made to determine the acceptability of the material after corrective measures have been taken. The cost of replacing, correcting and/or removal of defective material will be the responsibility of the Contractor. The cost of repairing or replacing other materials damaged by the installation, correction and/or removal of defective materials will be the responsibility of the Contractor also.

## **SECTION 011007**

### **LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC**

#### Section 10.07-1 Laws to be Observed

The Contractor shall keep himself fully informed of all Federal and State laws, all local laws, ordinances and regulations and all orders and decrees of bodies having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the County and its representatives against any claim or liability arising from or based on any violation of any law, ordinance, regulation, order or decree, whether by himself or his employees. It is understood that 29 Del C §6913 requires that in the construction of all public works, preference in employment of laborers, workmen, or mechanics shall be given to bona fide legal citizens of the State of Delaware, who have established citizenship by residence of at least 90 days in the state. It is therefore stipulated that any person, company, or corporation who violates this section, shall pay a penalty to the Secretary of Finance equal to the amount of compensation paid to any person in violation of this section. This section shall not apply to the extent that it conflicts with, or is preempted by the Federal Constitution, or any statutes, rules or regulations, of the federal government applicable to the project.

#### Section 10.07-2 Permits, Licenses and Taxes

Unless otherwise provided in the Special Provisions, the Contractor and all Subcontractors shall procure all permits and licenses, pay all charges, fees, taxes, and give all notices necessary and incidental to the due and lawful prosecution of the work.

Prior to the execution of any contract the successful bidder will be required to show that he has satisfied the requirements of Sections 2502 and 2503, Chapter 25, Title 30, of the Delaware Code, and if bidder is a non-resident corporation, the bidder has complied with the requirements of Subchapter XIV of Title 8 of the Delaware Code.

#### Section 10.07-3 Patented Devices, Materials and Processes

If the Contractor is required or desires to use any design, device, material or process covered by patent or copyright, the right for such use shall be provided for by suitable agreement with the patentee or owner, and a copy of this agreement shall be filed with the Engineer. If no such agreement is made or filed as noted, the Contractor and the Surety shall indemnify and save harmless the County from any and all claims or infringement by reason of the use of any such patented design, device, material or process or any trademark or copyright in connection with the work agreed to be performed under the Contract. The Contractor shall further indemnify the County for any costs, expenses and damages which it may be obliged to pay, by reason of any such infringement, at any time during the prosecution or after the completion of the work.

#### Section 10.07-4 Restoration of Surfaces Opened by Permits

The right to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time, is expressly reserved by the Delaware Division of Highways for the proper authorities of the municipality in which the work is done and the County will obtain the necessary permit for a street opening from the DELDOT before the initiation of work.

The Contractor shall perform all work within the limits of the right-of-way of the Highway Department in accordance with the provisions of the permit. Applicable unit prices bid for the construction of the work within these limits shall include all work necessary and no additional compensation will be permitted. The Engineer reserves the right to order the Contractor to make necessary repairs when directed to minimize any danger or inconvenience to the traveling public.

#### Section 10.07-5 Federal Participation

When the United States Government pays all or a portion of the cost of a project, the Federal Laws authorizing such participation and the rules and regulations made pursuant to such laws particularly the President's Executive Order 11246, the Davis-Bacon Act, and the Copeland Anti-Kickback Law, must be observed by the Contractor, and the work shall be subject to the inspection of the appropriate Federal Agency.

Such inspection shall in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party hereunder.

#### Section 10.07-6 Sanitary Provisions

The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees that may be necessary to comply with State and local health requirements or of other bodies or tribunals having jurisdiction, and shall commit no public nuisance.

#### Section 10.07-7 Public Convenience and Safety

In carrying on the work the Contractor shall interfere as little as possible with traffic. The Contractor shall provide and maintain ingress and egress for all residences and places of businesses located along the construction route. So far as practicable materials will not be stored upon the highway. When it is absolutely necessary to do so they shall be placed so as to cause as little obstruction to the traveling public as possible. If, in the opinion of the Engineer, it is necessary to keep the road or any portion of the road open to travel during the construction, the Contractor shall carry on his work in such a manner as to provide such means that travel will not be obstructed or endangered. The Contractor shall provide and maintain in an acceptable condition such temporary roadways and bridges as may be necessary to accommodate the traffic using or diverted from a highway where construction is taking place. He shall also provide and maintain in a safe condition temporary approaches to and crossings of intersecting roadways. Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times and no material or obstruction shall be placed within fifteen feet of any such hydrant. All footways, gutters, sewers, inlets, and portions of the highway adjoining the construction shall be kept free of obstructions insofar as possible. Work areas closed down for any length of time shall be left entirely accessible at all points to fire apparatus. The Contractor shall not disturb the surface of an existing road further in advance of the new construction than can be completed in a reasonable length of time as determined by the Engineer.

## Section 10.07-8 Barricades and Warning Signs

The Contractor shall provide and maintain properly illuminated signs and barricades for the information, protection and safety of the traveling public. These shall conform to the State of Delaware, Department of Highways and Transportation publication entitled "Traffic Controls for Street and Highway Construction and Maintenance Operations". They shall be erected at all points of active construction, points which are dangerous and hazardous to the traveling public, and intersecting roads, on each end of roads or sections of roads close to traffic, and on each end of the contract during periods of active construction or during periods of temporary or indefinite suspension of construction activities, and at such other locations as may be designated by the Engineer.

The Engineer shall determine the location, and the number of barricades, the color of flashing flares, and other appurtenances to be placed by the Contractor for the proper maintenance of traffic both highway or pedestrian or public safety in non-traffic areas. Amber flasher flares shall be used at all locations so determined, except where a stop condition is intended, and at such locations, red flasher flares shall be used.

The Contractor shall maintain the lighting units used to insure light without interruption during all weather conditions. All lighting shall function throughout the hours of darkness which shall be considered to extend from one hour before sunset to one hour after sunrise, or at other times as required.

All barricades, danger, warning, or detour signs erected by the Contractor on the project shall be kept in proper condition, cleaned and at all times legible to an ordinarily observant person. All damaged or defective barricades or signs shall be replaced immediately.

The Contractor shall employ watchmen and flagmen to direct traffic when and where necessary to maintain proper standards of safety for the traveling public.

Where river, hydraulic, or marine work is involved the Contractor shall provide and maintain at his own expense all lights, signals, barriers, buoys, etc., as may be required by law or ordinances or by Federal Authorities for the safety of river or marine traffic and the traveling public.

## Section 10.07-9 Detours

Detours may be indicated on plans in the Special Provisions, or at the Contractor's request, traffic may be detoured over approved routes along existing roads when acceptable to the Engineer and the Delaware State Highway Department. When detours are indicated on the plans, the designation, marking and maintenance of the detour signs will be accomplished by the State Highway Department and the expense borne by the County. When the detour is at the request of the Contractor such signing may be accomplished by the Contractor in a manner acceptable to the State Highway Department or by the State Highway Department with the cost of erection and maintenance to be borne by the Contractor.

#### Section 10.07-10 Maintenance of Traffic

Unless otherwise noted in the Special Provisions, it shall be the responsibility of the Contractor to maintain both highway and pedestrian traffic safely, adequately and continuously on all portions of the work.

The cost of maintaining traffic as noted above will normally be included as a bid item in the Proposal. Where this item is not included it shall be considered as incidental to other items and included in the price bid for them.

In addition to maintenance of traffic for paved right-of-way construction work, the Contractor is responsible to maintain traffic flow and safety for any work outside of the right-of-way in private accessways or parking areas.

The Contractor shall provide and maintain ingress and egress for all residences and places of businesses located along the work area

#### Section 10.07-11 Railroad Crossings

In case the Contractor is required to haul materials across the tracks of any railroads, or elects to do so, he shall make his own arrangements with that railroad for any new private crossings required or for the use of any existing private crossings.

All work to be performed by the Contractor on the railroad right-of-way shall be done in a manner satisfactory to the Engineer of the railroad company and shall be performed at such time and in such manner as not to unnecessarily interfere with the movement of trains or traffic upon the tracks of the railroad company. The Contractor shall use all care and caution in order to avoid accidents, damage, or unnecessary delay or interference with the railroad company trains or other property.

All work on portions of structures over and under railroads rights-of-way shall conform to all rules and regulations of the owners of the right-of-way. The Contractor is hereby made responsible for acquiring full knowledge of these rules and regulations and complying therewith to the satisfaction of the owners of the railroad right-of-way.

Prospective bidders on contracts crossing railroad rights-of-ways are advised that the railroad company will require the Contractor to obtain, pay for and have approved by the railroad, certain broad forms of public liability and proper damage insurance policies before entering upon the railroad property. As a general rule details of such policies are set forth in the Special Provisions, but in case of omission from the Special Provisions, the Contractor is hereby required to communicate with the railroad company so as to ascertain the type of insurance, if any, required and make provisions for the cost of this in his bid.

#### Section 10.07-12 Work in or Over Navigable Waters

All work in, on or over waters declared navigable by the Department of the Army of the United States shall conform to all applicable Federal Rules and Regulations. All such rules and regulations are hereby made a part of the Contract. The Contractor is cautioned and charged with the responsibility of obtaining complete knowledge thereof and complying therewith. The Contractor shall also comply with the provisions of other applicable Federal, State and local laws which pertain to work in these locations including all insurance requirements applicable.



#### Section 10.07-13 Use of Explosives

The use of explosives will not be permitted adjacent to or on any existing structures unless authorized in writing by the Engineer. When the use of explosives is permitted, the Contractor- shall use the utmost care, so as not to endanger life or property. Whenever necessary the number of charges and size of the charge shall be reduced. The Contractor's attention is directed to the necessity of safeguarding the public during dynamiting operations and a sufficient number of watchmen, flagmen, signs, etc., shall be used to warn motorists during the periods of blasting. All explosives shall be stored in a secure manner and all such storage places shall be clearly marked, and shall be in care of competent watchmen at all times. Explosives shall be stored and handled in conformity with the provisions of the statutes of the State of Delaware, and local laws and ordinances.

The Contractor shall notify each public utility company, having structures in proximity to the site of the work, of his intention to use explosives and such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury. Such notice shall not relieve the Contractor of responsibility for any damage resulting from his blasting operations.

#### Section 10.07-14 Protection and Restoration of Property

The Contractor shall not enter upon private property for any purpose without first obtaining the written permission of the property owner and he shall be responsible for the preservation of all public and private property, trees, monuments, highway signs and markers, fences along and adjacent to the work, and shall use every precaution necessary to prevent damage or injury thereto. The highway signs and markers shall be carefully removed when grading or trench excavation begins, stored in such a manner to keep them clean and dry and shall be re-erected at such new location as may be directed by the Engineer. He shall take suitable precautions to prevent damage to underground or overhead public utility structures and shall carefully protect from disturbances or damages all land monuments and property markers until the Engineer has witnessed or otherwise referenced their location, shall not remove them until directed, and shall replace them as directed by the Engineer at the expense of the Contractor.

The Contractor shall take all risks attendant to the presence or proximity of pipes, poles, tracks, walls, buildings and other structures and property, of every kind and description in or over his trenches or in the vicinity of his work, whether above or below the surface of the ground. He shall be responsible for all damage and assume all expense for direct or indirect injury, caused by his work, to any of them, or to any person or property by reason of injury to them, whether such structures are shown on the drawing or not.

The Contractor shall be responsible for all damage or injury to property of any character during the prosecution of the work, resulting from any act, omission, neglect or misconduct in his manner or method of executing said work, or due to his non-execution of said work, or at any time due to the defective work or materials, said responsibility shall not be released until the work shall have been completed and accepted. When and where any direct or indirect damage or injury is done to public or private property by or on account of his act, omission, neglect or misconduct in the execution of the work or in the consequence of the non-execution thereof on the part of the Contractor, he shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage or injury

was done, by repairing, rebuilding or otherwise restoring as may be directed, or he shall make good such damage or injury, in an acceptable manner. In case of the failure on the part of the Contractor to restore such property or make good such damage or injury, the Engineer may upon forty-eight hours notice, proceed to repair, rebuild or otherwise restore' any property as he may deem necessary and the cost thereof will be deducted from any money due or which may become due the Contractor under his contract.

#### Section 10.07-15 Forest Protection

In carrying out work within or adjacent to State, County or National forests and/or parks, the Contractor shall comply with all regulations of the State Fire Marshall, Conservation Commission, State Forestry Department, or other Authority having jurisdiction, governing the protection of forests and the carrying out of work within forests, and shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of the State Forester.

The Contractor shall take all responsible precautions to prevent and suppress forest fires and shall require his employees and sub-contractors, both independently and at the request of the forest or park officials, to do all reasonably within their power to prevent and suppress and to assist in preventing and suppressing forest fires and make every possible effort to notify a forest or park official at the earliest possible moment of the location and extent of any fire seen by them.

#### Section 10.07-16 Responsibility for Damage Claims

The Contractor shall assume the responsibility and liability for, and shall indemnify and save harmless the County, its officers, and employees and any property owner or franchise owner whose property on which the Contractor is performing work, from and against all suits, actions, claims, and all damages, direct or indirect, of whatever nature, caused to any person(s) or property or resulting to the work from any act, work, or plan performed or submitted by the Contractor or upon its behalf; including but not limited to responsibility of the Contractor to provide for the protection and safety of all persons and property. These indemnification and save harmless requirements shall apply, but not be limited to, all suits, actions, claims brought, and all damages resulting from any death, injury, or damage received or sustained by any person(s), third person(s), or property based upon:

- A. Operations of the Contractor, including but not limited to work performed; neglect in safeguarding the work; use of unacceptable materials; any act, work, or plan performed or submitted by the Contractor on its behalf or resulting from performance, nonperformance of the work, or any omission, neglect, or misconduct occurring during the course of the Contract.
- B. Any claim(s) or amount(s) recovered from any infringement(s) of patent, trademark, or copyright.
- C. Any claim(s) or amount(s) arising or recovered under the "Workers Compensation Act", for any violation or alleged violation of any law, ordinance, rule, regulation, order, or decree.

The County may withhold as retainage to pay any amount claimed or anticipated, as determined by the Engineer, except that such money shall not be withheld when the Contractor produces satisfactory evidence that it is adequately protected by public liability and property damage insurance. In any event, the surety shall be liable to pay any amount recovered as a result of any suit, action, claim, injuries, or damages sustained and until such time as the matter has been settled or otherwise legally resolved.

Nothing in this Section is intended to waive sovereign immunity of New Castle County or the immunity granted to New Castle County and its employees in the County and Municipal Tort Claims Act contained in the Chapter 40 of the Delaware Code.

#### Section 10.07-17 Insurance

New Castle County shall be named as an insured under all policies with respect to the contract. The minimum requirements of insurance to be carried by the Contractor shall be as follows or greater where required by laws and regulations.

**a. – Workers Compensation Insurance-Employer’s Liability**

“Employer’s Liability-\$1,000,000.” “Workers Compensation Insurance” – Statutory Limits

**b. – Contractor’s Comprehensive General Liability Insurance, Including Contractual Liability Insurance**

(1) “Bodily Injury Liability with a limit of One Million Dollars (\$1,000,000).” And “an aggregate limit of One Million Dollars (\$1,000,000).”

(2) “Property Damage Liability with a limit of One Million Dollars (\$1,000,000).”

**c. – Comprehensive Automobile and Truck Liability Insurance**

(1) “Bodily Injury Liability with a limit of One Million Dollars (\$1,000,000).” “Aggregate limit of One Million Dollars (\$1,000,000).”

(2) “Property Damage Liability with a limit of One Million Dollars (\$1,000,000).”

**d. – Additional Requirements**

(1) Contractor shall, as a minimum, purchase and maintain excess liability insurance in the umbrella form with a combined single limit of not less than \$5,000,000 per claim and in the aggregate. Evidence of such excess liability shall be delivered to County in the form of a certificate indicating the policy numbers and limits of all underlying insurance.

(2) If the aggregate limits of liability indicated in Contractor insurance provided are not sufficient to cover all claims for damages arising from his operations under this Contract and from any other work performed by him or if policies of insurance do not provide that the aggregate limits of liability for bodily injury and property damage apply to each contract or project separately, Contractor shall have such policies amended so that the aggregate limits of liability required by this Contract will be available to cover all claims for damages due to operations under this Contract.

#### Section 10.07-18 Contractor's Responsibility for Work

Until final written acceptance of the work by the Engineer, the Contractor shall have charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, use water when so directed to control dust and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not restricted to acts of God, of a public enemy, or of governmental authority.

In case of suspension of work, the Contractor shall be responsible for the project and shall take such precautions as may be necessary to prevent damage to the project, provide for normal drainage and normal traffic operations, and to erect any necessary temporary structures, signs, or other facilities at his expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings, furnished under the contract, shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

#### Section 10.07-19 Furnishing Right of Way

The County has secured certain rights of way, also depicted as permanent and temporary construction easements, in advance of construction for the Contractor's use, depicted on the Construction Drawings as the "limit of disturbance."

Where the work is to be built in rights of ways, such rights of ways will be secured by the County without cost to the Contractor. The County will also obtain permission from the owners of property to be occupied during construction, strips of land outside of the limits of these rights of ways as shown on the drawings. The Contractor shall not move any equipment or materials in the rights of ways until authorized to do so by the Engineer. The Contractor shall confine his operations strictly within the limits of the right of way and construction strip unless he has the written permission of the owner of the adjacent property to occupy additional ground. A copy of the written permission shall be furnished to the Engineer.

Unless otherwise shown, trees with a butt diameter of 3" or less in temporary construction easements may be felled by the Contractor. Trees of larger size may be designated on the plans for removal, if, in the opinion of the Engineer this is necessary for construction and permission has been obtained from the property owner by the County. If no such information is shown, the Contractor may not remove trees in construction strips with butt diameters in excess of 3" unless he negotiates with the property owners for their removal and furnishes the Engineer with written evidence of having secured such permission. Trees within the limits of the right of way may be cut down unless otherwise indicated on the plans, or directed by the Engineer.

The Contractor shall so conduct his work in rights of ways that there will be a minimum of disturbance of the properties crossed. Fences shall be disturbed as little as possible and if damaged or removed shall be replaced to their original condition or better at the expense of the Contractor.

Upon completion of the work, the Contractor shall, at his own expense, clean up within the construction strips and shall restore them to their original condition or better. Any damage to property outside the limits of the rights of ways or construction strips shall be repaired or replaced by the Contractor at his own expense.

No arrangements will be made for any means of access to the rights of ways or temporary construction easements by the County other than that which shown on the plans; the Contractor shall therefore be required to make his own arrangements for any additional access to the work that he desires. Contractors are cautioned that only those areas designated on the plans have been obtained for their construction operations by the County. If they feel that these areas are insufficient for their needs they must account for the cost of additional rights of ways and/or special construction methods in the bidding of the work.

#### Section 10.07-20 No Waiver of Legal Rights

The County shall not be estopped by an estimate or certificate made or given by the Engineer or his agents either before or after the final completion and acceptance of the work and payment therefore from showing the true and correct amount, quantity, and character of the work done and materials furnished by the Contractor or any other person under this agreement or from showing at any time that such estimate or certificate is untrue and incorrect, or improperly made in any particular or that the work or materials or any part thereof, do not in fact conform to the contract; the County shall not be estopped, notwithstanding any such estimate or certificate and payment in accordance therewith, from demanding and recovering from the Contractor and Surety such damages as it may sustain by reasons of his failure to comply with the terms of the contract.

#### Section 10.07-21 Use of Section of the Work

Whenever, in the opinion of the Engineer, any portion of the work is completed or is in acceptable condition for use, it may be used for its intended purpose, as may be directed, and such shall be subject to the correction of any defects noted in the partial inspection prior to use.

#### Section 10.07-22 Personal Liability of Public Officials

In carrying out any of the provisions of these specifications, or in exercising any power or authority granted to them or within the scope of the contract, there shall be no liability upon the Director, Engineer, or other authorized representatives, either personally or as officials of the County, it being understood that in all such matters they act solely as agents and representatives of the County.

## Section 10.07-23 Erosion Control and Water Pollution

The Contractor shall schedule and conduct his operation to minimize erosion of soils and to prevent silting and muddying of streams, rivers, irrigation systems and impoundments. Construction of drainage facilities and performance of other contract work which will contribute to the control of erosion and sedimentation shall be carried out in conjunction with earth work operations as soon thereafter as practicable. The area of bare soil at any one time by construction operations shall be kept to a minimum. The Engineer reserves the right to order the initiation of clean-up work as soon as possible after portions of other work are completed.

When the contract requires the connection of new construction to existing sanitary sewers or the repair of existing sanitary sewers, the Contractor shall include in his bid price the cost of conveying said sewage around the work location and back into the sewer. The discharge of sanitary sewage into storm sewers or any streams in the State of Delaware is strictly prohibited.

Prior to suspension of construction operations for appreciable length of time the Contractor shall shape the earthwork in a manner that will permit storm runoff with a minimum of erosion. Temporary erosion and sediment control measures such as berms, dikes, slope drains, or sedimentation basins deemed necessary by the Engineer shall be provided and maintained until permanent drainage facilities and erosion control features are completed and operative. Unless otherwise provided in the contract, temporary erosion control measures will not be paid for directly, but will be considered as a subsidiary obligation of the Contractor covered under the various contract items of work.

## **SECTION 011008**

### **PROSECUTION AND PROGRESS**

#### Section 10.08-1 Subletting or Assigning of Contract

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of his right, title, or interest therein, without written consent of the Engineer. Work can only be sublet to licensed Contractors possessing current prequalification in the class of work to be performed. In case such consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 50% of the total contract bid price, except that any items designated in the contract as specialty items may be performed by subcontract and the cost of such specialty items so performed by subcontract may be deducted from the original total bid price before computing the amount of work required to be performed by the Contractor with his own organization. If the Contractor to whom a contract is awarded proposes to subcontract any part of the work, the scope and value of the work to be done by Subcontractor shall be outlined at the time that his bid is submitted. The cost of the materials to be used by the Subcontractor shall be included in the value of this subcontracted work. The work of the Subcontractor shall be listed as to its value in relation to the entire contract.

As a precedent to payment to the Contractor for any part of the work performed by a Subcontractor or by the personnel and equipment of any other person or organization other than the Contractor, the Engineer may require the Contractor to file with the County certified copies of documents indicating compliance with contractual requirements.

No subcontracts, or transfer of contract, shall in any case release the Contractor of his liability under the contract and bonds.

A Contractor may be permitted by the Engineer to sublet more than 50% of the work if the best interest of the County will be promoted thereby.

#### Section 10.08-2 Notice to Proceed

After the Contract has been executed, the County will issue to the Contractor a Notice to Proceed and this notice will inform the Contractor of when the Contract Time will begin. No work is to be started before receipt of the Notice to Proceed.

If the County fails to issue the Notice to Proceed within ninety (90) Calendar Days from the date the Contract was executed, the Contractor, at its option, may request the County to rescind the contract. The County shall not be liable for any costs, including but not limited to the cost of materials fabricated and/or delivered to the site, before the Notice to Proceed is issued. The County shall not be liable for any overhead expenses or any profits (anticipated or otherwise) associated with the materials or work. If the Contractor agrees to proceed with the contract or begins work despite passage of the ninety (90) day window, the Contractor will be deemed to have waived the assertion of the right to rescind in this Section.

#### Section 10.08-3 Work Schedule and Prosecution of Work

The Contractor, prior to the Notice to Proceed, will be required to submit for the Engineer's approval his proposed Work Schedule in detail, including proposed dates for ordering and receiving construction material and similar items which will control the items of work. His proposed Work Schedule shall be based on the number of working days, calendar days, or other increments as set forth in the contract, that he expects to require in completing the project, recognizing the capabilities of his labor, equipment, arrangements for materials, and other related matters. A submission of a proposed Work Schedule will not entitle the Contractor to an increase in the contract time.

The Contractor shall begin work promptly within the time specified by the Engineer and shall notify the Engineer of his intention to start work at least 48 hours in advance of the proposed starting time.

After the work has once been started, it shall be prosecuted continuously on all acceptable working days without stoppage until the entire contract is completed and the rate of progress shall be at least that which was anticipated in his construction schedule so that the work can be completed within the allotted time.

Should the prosecution of the work for any reason be discontinued by the Contractor with the consent of the Engineer, he shall notify the Engineer at least 24 hours before again resuming operations.

#### Section 10.08-4 Limitation of Operations

The Contractor shall conduct the work at all times in such a manner and in such sequence as will insure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started, and the Engineer may require the Contractor to finish a section on which is in progress before work is started on any additional sections.

No night, Sunday or holiday work requiring the presence of an Engineer or Inspector will be permitted except in case of an emergency and/or with written permission of the Engineer. The Contractor shall notify the Engineer in writing at least two days in advance of such holiday, Sunday or night that he desires to work, stating the place where said work is to be conducted and setting forth the reasons for working on a night, Sunday or holiday. By doing so, the Contractor agrees to reimburse New Castle County for the cost to provide inspection.

#### Section 10.08-5 Character of Workmen, Methods and Equipment

The Contractor shall employ sufficient labor and equipment for prosecuting the several classes of work to full completion in the manner and time required by these specifications.

Workmen must have sufficient skill and experience to perform properly the work assigned to them. All workmen engaged in special work or skilled work, shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.



Equipment to be used on the work shall safely meet the requirements of the work and produce a satisfactory quality of work. The Engineer may order the removal and require replacement of any unsatisfactory or unsafe equipment.

Any foreman or workman employed by the Contractor or by any Subcontractor who does not perform his work in a proper manner or is intemperate or disorderly shall be removed forthwith by the Contractor, or Subcontractor employing such foreman or workman, and shall not be employed again in any portion of the work without the approval of the Engineer.

Should the Contractor fail to remove such person or persons as required above, or fails to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may withhold payment which are or may become due on the contract until a satisfactory understanding has been reached.

#### Section 10.08-6 Temporary Suspension of Work

The Engineer shall have the authority to suspend the work, wholly or in part, for such periods or period as he may deem necessary, due to unsuitable weather, or such other conditions as are considered unfavorable for the suitable prosecution of the work or for such time as is necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract. If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and he shall take every precaution to prevent damage or deterioration of the work performed, provide suitable drainage by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. The Contractor shall not suspend the work without written authority and shall resume work after such suspension upon written notice of the Engineer.

#### Section 10.08-7 Determination of Contract Time

The Contractor shall complete the work contracted for in a manner acceptable to the County within the time stated in the contract. The number of days allowed for the completion of the work included in the contract will be fixed by the County, will be stated in the Proposal and Contract, and will be known as the Contract Time.

When the contract time is on a working day basis the Engineer will make available to the Contractor at his request, a record showing the number of days charged to the contract for the preceding period, and the number of days specified for completion of the contract. The Contractor will be allowed one week in which to protest and thirty days in which to file a written statement, setting forth in what respects said time charges are incorrect, otherwise the record shall be deemed to be accepted by the Contractor as correct under the previously stated definition of working days.

When the contract time is on a calendar day basis it shall consist of the number of calendar days stated in the contract, including all Sundays, holidays, and non-work days, but excluding all calendar days elapsing between the effective dates of any orders of the Engineer to suspend and resume operation. When the contract time is on a calendar day basis, all overrun in time between the calendar date set in the proposal and the completion of the project will be counted on a calendar day basis as set forth above.

The number of days for performance allowed in the contract as awarded is based on the Proposal quantities. If satisfactory fulfillment of the contract with extensions and increases authorized shall require the performance of work in greater quantities than those set forth in the Proposal, the contract time allowed for performance shall be increased in the same ratio that the total cost of the work actually performed shall bear to the total cost of the items in the Bid Schedule, unless other contract time allowances are agreed upon and set forth in a supplemental agreement.

#### Section 10.08-8 Extension of Contract Time

If the Contractor finds it impossible to complete the work within the contract time as specified or as extended in accordance with the provisions of the specifications, he may at any time prior to the expiration of the contract time as extended, make a written request to the Engineer for an extension of time setting forth therein the reasons which he believes will justify the granting of this request. If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, he shall extend the time for completion in such amounts as the conditions justify. The extended time for completion shall then be in full force and affect, the same as though it were the original time for completion.

In case of total suspensions, not due to any fault of the Contractor, no time will be charged. During such periods, if the Contractor elects and is permitted to do any work, the time charged shall bear the same ratio to the total time allowed for the completion of the work, as the value of the work done during such time bears to the total value of the contract.

Work of an emergency nature ordered by the Engineer for the convenience of the traveling public or for the production or delivery of materials for storage, if performed during the period of suspension, shall not be charged to the contract time.

Following the date on which all work has been completed except those landscaping items on which work is restricted to specific seasons of the year and when final inspection and acceptance is being deferred pending completion of those landscaping items on which work is not permissible at the time because such work is apparently out of season, and for no other reason, no time shall be charged against the Contractor until such time as it is again permissible to proceed with such work. However, when the season changes to a time that work is permissible (such determination to be made in the sole discretion of the Engineer), time shall be charged for any delays.

The specified contract time shall begin on the day work actually starts or on the day stipulated in the Notice to Proceed whichever is earlier. When the conditional acceptance has been duly made by the Engineer, the daily time charges shall cease.

#### Section 10.08-9 Failure to Complete Work on Time

Time is an essential element of the contract and it is important that the work be vigorously prosecuted until completion, as the cost to the County of the administration of the contract, including engineering, inspection and supervision, will increase as the time required for the work is increased.

For each day that any work required under the Contract (including but not limited to the landscaping items) shall remain uncompleted after the expiration of the contract time specified, or as amended by extra work, change orders and supplemental agreements, the sum per calendar day, or working day, as the case may be, written in the Proposal and Schedule of Prices Form shall be deducted from any money due the Contractor, not as a penalty, but as liquidated damages. In the case that the amount of liquidated damages due to the County exceeds the amount due the Contractor, the Contractor shall be liable and pay to the County the amount of said excess. Due account shall be taken of any adjustments of the contract time for the completion of the work granted by the County.

#### Section 10.08-10 Default and Annulment of Contract

If the Contractor fails to begin the work under the contract within the time specified in the Notice to Proceed, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to secure the prompt completion of said work, or shall perform the work unsuitably or shall neglect or refuse to remove materials or perform again such work as shall be rejected as defective and unsuitable, or shall without authority discontinue the prosecution of the work, or shall fail to resume within a reasonable time after notice to do so, work which has been discontinued, or the Contractor shall become insolvent or be declared bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment stand against him unsatisfied for a period of ten days, or shall make an assignment for the benefit of creditors, or shall not carry on the work in a manner acceptable to the County; the Engineer shall give notice in writing to the Contractor and his Surety of such delay, neglect or default.

If the Contractor or Surety, within a period of ten days after such notice shall not proceed in accordance therewith, then the County shall, upon written notification from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the prosecution of the work out of the hands of said Contractor. The County may appropriate or use any or all materials and equipment intended to be incorporated in the contract, as may be suitable and acceptable and may enter into an agreement for the completion of said Contract according to the terms and provisions thereof, or use such other methods as in their opinion shall be required for the completion of said contract in a manner acceptable to the County.

All additional costs and charges incurred by the County, together with the cost of completion the work under contract shall be deducted from any monies due or which may become due said Contractor. In case the expense so incurred by the County shall be less than the sum which would have been payable under the contract if it had been completed by said Contractor, then the said Contractor shall be entitled to receive the difference and in case such expense shall exceed the sum which would have been payable under the contract, then the Contractor and the Surety shall be liable and shall pay to the County the amount of said excess.

#### Section 10.08-11 Successful Termination of Contractor's Responsibility

A contract will be considered as successfully fulfilled when the work has been completed in accordance with the terms of the contract; when final acceptance has occurred; when final payment has been authorized; when all the obligations of the Contractor and his surety have been complied with; when final payment has been made, when a release of liens has been furnished by the Contractor; and when the stipulated guarantee period has expired.

## Section 10.08-12 Termination of Contract

Upon ten (10) calendar days written notice to the Contractor, the County may terminate the Contract or any portion of the Contract when such termination would be in the best interest of the County. In the event such termination occurs without fault and for reasons beyond the control of the Contractor, all completed items as of the date of termination will be paid for at the Contract price.

Upon receipt of the written notice from the County, the Contractor shall cease operations as directed by the County in the notice and take actions necessary, in that the County may direct, for the protection and preservation of the work and securing the job site.

Acceptable materials, obtained by the Contractor for the work, but which have not been incorporated therein, may, at the option of the County, be purchased from the Contractor at actual cost delivered to a prescribed location, or otherwise disposed of as mutually agreed.

After receipt of notice of termination from the County, the Contractor shall submit, within 60 days of the effective termination date, its claim for additional damages or costs not covered above or elsewhere in these specifications. The intent of negotiating the claim would be that an adjusted figure be reached with the Contractor. In no event, however, will loss of anticipated profits or overhead be considered as part of any settlement.

The Contractor agrees to make its financial records available to the extent necessary to determine the validity and amount of each item of cost claimed. The County will not pay any of the submittals unless appropriate financial records, as determined in the County's sole discretion, are provided. Termination of the Contract or portion thereof shall not relieve the Contractor of its contractual responsibilities for the work completed, nor shall it relieve the surety of its obligation for and concerning any just claim arising out of the work performed.

## **SECTION 011009**

### **ACCEPTANCE, MEASUREMENT AND PAYMENT**

#### Section 10.09-1 Measurement of Quantities

After the work is completed and before final payment is made, the Engineer shall make final measurements to determine the quantities of various items of work performed as a basis of final settlement. The Contractor, in case of unit price items, will be paid for the actual amount of work performed and for the actual amount of materials in place, in accordance with these specifications as shown by the final measurements. All work completed under the contract shall be measured by the Engineer according to the standards of weight and the measures recognized by the National Bureau of Standards.

All longitudinal measurements for area will be made along the actual surface and not horizontally, and no deductions will be made for individual fixtures in the surface material having an area of nine square feet or less. For all transverse measurements for area, the dimensions to be used in calculating the pay area shall be the neat dimensions shown on the plans or changes ordered in writing by the Engineer.

Structures will be measured according to neat lines shown on the plans or as ordered in writing unless otherwise provided for elsewhere in the specifications or in the Special Provisions.

Volumes of excavation, land fill, and borrow excavation will be calculated from cross sections, and the use of the average end area method. Volumes of other work such as masonry, removal of masonry, etc., will be calculated by using standard arithmetical formulae.

#### Section 10.09-2 Scope of Payment

The Contractor shall accept the compensation as herein provided as full payment for furnishing all materials, labor, tools, and equipment necessary to complete the work, and for performing all work contemplated and embraced by the contract. This compensation shall also include all loss or damage arising from the nature of the work, action of the elements, unforeseen difficulties which may be encountered during the prosecution of the work, and for all expense occurred in consequence of the suspension or discontinuance of the work under the contract.

The Contractor shall promptly make payments to all persons supplying labor and materials for the execution of the contract. The Engineer may require satisfactory evidence to that effect before the payment of any estimate, and such evidence must be presented before the final acceptance and payment by the County.

### Section 10.09-3 Payment for Extra Work

Extra work shall be paid for at the unit price or lump sum, which amount will be agreed upon in writing by the Contractor and Engineer before such work begins. Where such prices or sums cannot be agreed upon, or where this method of payment is impracticable, the Engineer shall issue a written order to the Contractor to do such work by force account. Supplemental work will be paid for according to the terms of the supplemental agreement.

### Section 10.09-4 Force Account Work

All extra work done on the force account basis, the use of which has been authorized by the Engineer, will be paid for in the following manner:

**Labor.** For all labor and foremen in direct charge of the specific project, the Contractor shall receive as shown on his weekly payroll the basic hourly wage, overtime and fringe benefits not paid in cash to the employee for each and every hour that said labor and foremen are actually engaged in such work, to which cost shall be added an amount equal to 26 percent of the sum thereof. The Superintendent's time will not be allowed.

**Materials.** For materials accepted by the Engineer and used, the Contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid by him to which the cost of 15 percent will be added.

**Equipment.** For any machinery or special equipment including fuel and lubricants, plus transportation costs, the use of which has been authorized by the Engineer, the Contractor shall receive the rental rate agreed upon in writing before such work is begun for the actual time that such equipment is in operation on the work, to which rental sum 15 percent will be added. In addition to the above, the actual transportation costs for one move in and one move out may be allowed. When the County is obligated to pay for idle equipment the allowance shall be seventy-five percent of the agreed on equipment rental rate. To compute hourly rates use eight hours per day, forty hours per week and one-hundred and seventy-six hours per month.

**Miscellaneous.** No additional allowance shall be made for the general superintendence of the project, the use of small tools, or other costs for which no specific allowance is herein provided.

**Compensation.** The compensation as set forth above shall be received by the Contractor as payment in full for extra work done on a force account basis. At the end of each day the Contractor's representative and the Inspector shall prepare and sign records of the cost of work as ordered on a force account basis.

**Statements.** No payment will be made for work performed on a force account basis until the Contractor furnishes the Engineer duplicate itemized statements of the cost of such force account work.

#### Section 10.09-5 Eliminated Items

Should any items contained in the Proposal be found unnecessary for the proper completion of the work contracted, the Engineer may upon written order to the Contractor, eliminate such items from the contract and such action shall in no way invalidate the contract, and no allowance will be made for the items so eliminated in making final payment to the Contractor except for such actual work as may have been done, materials actually purchased, and actual equipment costs prior to notification of the elimination of the items except as noted in Section 10.04-3.

#### Section 10.09-6 Partial Payment

The Engineer or Contractor if so directed shall once in each month make an estimate, in writing, of the total amount of work done on the contract and the value thereof to the date of such estimate. Ten percent of the value of the work done as indicated by the estimate shall be retained as security for fulfillment of the contract until a total of five percent of the total bid price plus approved extras has been retained, unless otherwise determined by the Engineer. No such estimates or payments shall be required to be made when in the judgment of the Engineer the work is not proceeding in accordance with the provisions of the contract.

Whenever liquidated damages are assessable, such damages shall be deducted from the monthly and final estimates. The payment of any current or final estimate or of any retained percentage shall in no way affect the obligation of the Contractor to repair or renew any defective parts of the construction and to be responsible for all damage due to such defects.

If at any time there is evidence of any lien or claim for which, if established, the County might become liable, and which is chargeable to the Contractor, the County shall have the right to retain out of any payment then due or to become due an amount sufficient to completely indemnify the County against such lien or claim. If there should prove to be any such claim after all payments are made, the Contractor shall refund to the County all monies that the County may be compelled to pay in discharging any liens made obligatory in consequence of the Contractor's neglect or default.

Partial payment for stored electrical or mechanical equipment with a single item value exceeding \$25,000 shall be subject to the following conditions being met or satisfied:

1. The materials and/or equipment shall be received in a condition satisfactory for incorporation in the work.
2. The materials and/or equipment shall be stored in such manner that they will not be damaged due to weather, construction operations or any other cause.
3. An invoice from the supplier shall be furnished for each item on which payment is requested.
4. The contractor shall, on request of the Engineer, furnish written proof from the supplier of ninety percent (90%) payment for the materials and/or equipment no later than thirty (30) days after receipt of payment for same from the County. The County shall have the right to deduct from the next payment estimate an amount equal to the payment for said materials and/or equipment if reasonable and adequate proof is not submitted.

5. The contractor warrants and guarantees that title to all work, materials, and equipment covered by an Application for Payment, whether incorporated in the project or not, will pass to the County upon the receipt of such payment by the contractor, free and clear of all liens, claims, security interests or encumbrances (except ten percent (10%) retainage which may be withheld from suppliers and subcontractors to guarantee completion and performance.)

#### Section 10.09-7 Conditional Acceptance

Upon due notice from the Contractor of completion of all work items, the Engineer will make an inspection of the work. After the completion of any repairs or renewals which may be required, in the judgment of the Engineer, he shall notify the Contractor of conditional acceptance. The date of the conditional acceptance will be the beginning of a six month retained percentage period, during which period the County will retain five percent of the amount of the final estimate cost.

The Contractor shall, at his own cost and expense, make all repairs and replacements of the work which, in the judgment of the Engineer, may become necessary during the six month period on account of any failures or defects, due to improper work done or materials furnished by the Contractor. Should the Contractor fail to make needed repairs and replacements during the six month retained percentage period, the County shall be empowered to make any required repairs or replacements and the cost of the required repairs or replacements shall be deducted from the retained five percent due the Contractor.

At any time after the approval of the final estimate the County may accept from the Contractor a maintenance bond in favor of the County in the amount which would otherwise be retained by the County. Such bond shall be in a form and with a Surety approved by the County, binding the Contractor as principal and the Surety to promptly and properly replace any improper work or materials that may become apparent within a period of six months following the conditional acceptance of the work. Upon acceptance by the County of such a bond the sum retained by the County will be paid to the Contractor.

After receiving notice of conditional acceptance, the contractor may request that the County accept a maintenance bond in favor of the County in an amount which would otherwise be retained by the County. The County shall review overall contract performance and may elect to accept a maintenance bond for some portion of the retained monies if it is in the best interests of the County. Such bond shall be in a form and with a surety approved by the County, binding the contractor as principal and the surety to promptly and properly replace any improper work or materials that may become apparent within a period of six (6) months following the conditional acceptance of the work. Upon acceptance by the County of such a bond the sum retained by the County will be paid to the contractor.

After the Contractor has indicated his acceptance of the final quantities, the Engineer shall prepare a final estimate indicating the amount of money to be paid to the Contractor, excepting such sum or sums that can be lawfully retained under the provisions of the contract.



#### Section 10.09-8 Final Acceptance

At the expiration of the six month retained percentage period, the Engineer will inspect the work done by the Contractor and advise him of any deficiencies found and order their correction. After these items have been cared for, the Engineer shall make final acceptance of the work and return any retained monies or release any bonds posted to secure the performance of the Contractor during the retained percentage period.

#### Section 10.09-9 Guarantee

The Contractor shall guarantee the work for a period of three (3) years after final acceptance against all faulty or imperfect materials and against all imperfect, careless and/or unskilled workmanship except for plant material which shall carry a one (1) year guarantee as specified under Section 35.06, 'Planting'. All equipment shall be made to operate during the guarantee in a satisfactory and efficient manner in accordance with the requirements of the contract. All structures shall be kept water-tight and leak-proof at every point and in every particular during the period of guarantee.

The guarantee obligations assumed by the Contractor shall not be in any way impaired because of the Specifications or approval by or on behalf of the County of any articles or materials used in the construction, performance and completion of the work. Also, no use by the County or replacements or corrections made by the County due to failure by the Contractor to comply with any of his obligations under the Contract shall impair in any way the guarantee obligations assumed by the Contractor.

## **SPECIAL PROVISIONS**

SECTION 011100  
SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Access to site.
4. Work restrictions.
5. Specification and drawing conventions.

B. Related Requirements:

1. Division 01 Section "Temporary Facilities" for limitations and procedures governing temporary use of Owner's facilities.

1.02 PROJECT INFORMATION:

A. Project Identification: West Wing Service Area Force Main.

B. Owner: New Castle County Department of Public Works.

1. Owner's Representative for Design: Edwin Kuipers, P.E., Assistant County Engineer, New Castle County.
2. Owner's Representative for Construction: Harry Ryan, P.E., Chief of Project Management, New Castle County.

C. Engineer: AECOM  
248 Chapman Road  
Suite 101  
Newark, DE 19702  
(302) 781-5900

D. Contractor: [ ] has been engaged as Contractor for this Project.

1.03 WORK COVERED BY CONTRACT DOCUMENTS:

A. The Work of Project is defined by the Contract Documents and generally includes, but is not limited to, the following:

1. Site preparation
2. Errosion and Sediment Control
3. Construction of a 0.246 MGD average (700 GPM Peak) flow, sanitary sewer pump station, including:
  - a. Sewage Grinder Chamber,
  - b. Wetwell,
  - c. Pump process room,
  - d. Generator room,
  - e. Electrical room,
  - f. Bathroom,
  - g. and Storage room.
4. Exterior facilities include:
  - a. Influent gravity collection sewers and manholes,
  - b. 14-inch and 18-inch diameter wastewater discharge force mains,
  - c. Electric service and transformer,
  - d. Domestic water supply,
  - e. Site grading and paving,
  - f. Appurtenances and related work in accordance with the project plans and specifications.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.04 ACCESS TO SITE:

- A. General: The work is located on New Castle County property in Middletown, New Castle County, Delaware. The Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Use of Site: Limit use of Project site to work areas and areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.
  - 1. Driveways, Walkways and Entrances: Keep driveways, parking areas, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

1.05 WORK RESTRICTIONS:

- A. Work Restrictions, General: Comply with restrictions in Section 011200
  - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Comply with restrictions in Section 011200; Part 1.3, B
- C. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor-air intakes.
- D. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- E. Employee Identification: Provide corporate identification tags (i.e., company name and logo) for Contractor personnel working on Project site. The Contractor's personnel shall wear corporate identification tags at all times.
- F. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
  - 1. Maintain list of approved screened personnel with Owner's representative.

1.06 SPECIFICATION AND DRAWING CONVENTIONS:

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
  - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
  - 2. Abbreviations: Materials and products are identified by abbreviations in Section 011001 and scheduled on the Drawings.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

## SECTION 011200

### GENERAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. Section includes:
1. Access to site.
  2. Work restrictions.
  3. Inspection of Work Away from the Site.
  4. Dimensions of Existing Structures.
  5. Pipe Location.
  6. Precautions during Adverse Weather.
  7. Storage of Materials.
  8. Information Not Guaranteed.
  9. Safety.
  10. Interference with Existing Works.
  11. Protection of Existing Utilities.
  12. Maintaining Sewage Flows.
  13. Hydraulic Uplift of Structures.
  14. Unacceptable Materials.

##### 1.2 ACCESS TO SITE

- A. Limit use of Project site to areas within the limit of disturbance indicated. Do not disturb portions of the Project site beyond areas in which the Work is indicated.
1. Confine all construction operations to within the limit of disturbance as set forth on the construction drawings.
  2. Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    - b. Schedule deliveries to minimize space and time requirements for storage of material and equipment on-site.

##### 1.3 WORK RESTRICTIONS

- A. Comply with limitations on use of public streets and other requirements of authorities having jurisdiction.

- B. Construction work hours are subject to limitations as set forth in New Castle County Code Section 22.02.007, paragraph B, sub-paragraph 2f, which recites in part that “construction noise” is prohibited “Between the hours of 9:00 p.m. and 7:00 a.m. the following day on weekdays and between 10:00 p.m. on Friday and Saturday evening and 9:00 a.m. on Saturday and Sunday mornings or between 10:00 p.m. the day before and 9:00 a.m. the day of a legal holiday...”
- C. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated.
- D. Coordinate operations that may result in high levels of noise and vibration, odors, or other disruptions to respective property owners.
  - 1. Notify Engineer and affected property owners not less than two (2) days in advance of proposed disruptive operations.

1.4 INSPECTION OF WORK AWAY FROM THE SITE

- A. If work to be done away from the construction site is to be inspected on behalf of the Owner during its fabrication, manufacture, or testing, or before shipment, the Contractor shall give notice to the Engineer of the place and time where such fabrication, manufacturer, testing, or shipping is to be done. Such notice shall be in writing and delivered to the Engineer in ample time so that the necessary arrangements for the inspection can be made.

1.5 DIMENSIONS OF EXISTING STRUCTURES

- A. The Contractor shall verify all dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

1.6 PIPE LOCATION

- A. Exterior pipelines will be located substantially as indicated on the Drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings, etc., are noted on the Drawings, such notation is for the Contractor’s convenience and does not relieve him from laying and jointing different or additional items where required. Small interior piping is indicated diagrammatically on the Drawings, and the exact location is to be determined in the field. Piping shall be arranged in a neat, compact, and workmanlike manner, with a minimum of crossing and interlacing, so as not to interfere with equipment or access ways, and, in general, without diagonal runs.

1.7 PRECAUTIONS DURING ADVERSE WEATHER

- A. During adverse weather and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly done and satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood and building-paper



shelters, or other suitable means. During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently warm so that a proper bond will take place and a proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means which will result in a moist or a dry atmosphere according to the particular requirements of the work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used.

- B. When Work or construction operations are indicated in the public road right of way, the Contractor shall be responsible to keep public access free and clear of all obstructions. This includes temporary maintenance of the public road right of way, including the removal of snow and/or providing salt for the removal of ice. This work shall not be measured, nor additional compensation provided by the Owner.

#### 1.8 INFORMATION NOT GUARANTEED

- A. All information given in the Contract Documents relating to subsurface and other conditions, natural phenomena, existing pipes, and other structures is from sources of information presently available to the Owner. All information is furnished only for the information and convenience of Bidders and is not guaranteed.
- B. It is agreed and understood that the Owner does not warrant or guarantee that the subsurface information, including natural phenomena, existing pipes, structures, utilities or other conditions encountered during construction will be the same as those indicated in the Contract Documents.
- C. It is agreed further and understood that no Bidder or Contractor shall use or be entitled to use any of the information made available to him by the County in any manner as a basis of or grounds for any claim or demand against the County or the Engineer, arising from or by reason of any variance which may exist between the information made available and the actual subsurface or other conditions, natural phenomena, existing pipes or other structures actually encountered during the construction work, except where conditions, natural phenomena, existing pipes or other structures are expressly provided for in the Contract Documents.

#### 1.9 SAFETY

- A. The Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work. The Contractor will be solely responsible for means, methods, techniques, sequences and procedures of construction.
- B. The Contractor shall take all necessary precautions and provide all necessary safeguards to prevent personal injury and property damage. The Contractor shall provide protection for all persons including but not limited to his employees and employees of other Contractors or Subcontractors; members of the public; and employees, agents, and representatives of the Owner, the Engineer, and regulatory agencies that may be on or about the Work. The Contractor shall provide protection for all public and private property including but not limited to structures, pipes, and utilities, above and below ground.

- C. The Contractor shall provide and maintain all necessary safety equipment such as fences, barriers, signs, lights, walkways, guards and fire prevention and fire-fighting equipment and shall take such other action as is required to fulfill his obligations under this subsection.
- D. The Contractor shall comply with all applicable Federal, State and local laws, ordinances, rules and regulations and lawful orders of all authorities having jurisdiction for the safety of persons and protection of property.
- E. The Contractor shall designate a responsible member of his organization at the site whose duty shall be the prevention of accidents. This responsible person shall have the authority to take immediate action to correct unsafe or hazardous conditions and to enforce safety precautions and programs.

#### 1.10 INTERFERENCE WITH EXISTING WORKS

- A. The Contractor shall conduct his operations to minimize interference with existing works. The Contractor shall develop a program, in cooperation with the Engineer and interested officials, which shall provide for the construction and placing the new works into service in the most orderly manner possible. This program shall be adhered to except where deviations there from are expressly permitted. All work of connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to interfere with the operation of the existing facilities for the shortest possible time when the demands on the facilities best permit such interferences, subject work restrictions, to meet these requirements. Before starting work which will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand. The Contractor shall make such minor modifications in the work relating to existing structures as may be necessary, without additional compensation. The Contractor shall have no claim for additional compensation by reason of delay or inconvenience in adapting his operations to the need for continuous flow of sewage.

#### 1.11 PROTECTION OF EXISTING UTILITIES

- A. Existing utilities have been shown on the contract drawings in accordance with the best available information. Consequently no guarantee can be given that these locations are exact or that all utilities in the construction area have been noted. The Contractor shall contact "MISS UTILITY" to coordinate with them concerning their utilities in the construction area. During construction, the Contractor shall locate all utilities and allow for their locations. The Contractor shall exercise extreme care in making the trench excavation so as to insure that no existing utility is disturbed. Any subsequent damage done to an existing utility due to the Contractor's negligence shall be immediately and competently repaired at his expense.
- B. Should any existing utility incur damage as a result of the construction operations, the Contractor shall immediately notify its owner of the location and extent of damage. The Contractor shall satisfactorily protect, store, and replace any and all mail boxes, road signs, and other items of like nature that are disturbed by construction at no extra cost to the Owner.

1.12 MAINTAINING SEWAGE FLOWS

- A. The Contractor is responsible for all labor, equipment and maintenance necessary for controlling the existing flow of sanitary sewer. If necessary to successfully complete the Work, bypass pumping requirements are provided in this specification.

1.13 HYDRAULIC UPLIFT OF STRUCTURES

- A. The Contractor shall be responsible for the protection of all structures and piping against hydraulic uplift. If conditions conducive to hydraulic uplift are observed during construction, it shall immediately be brought to the attention of the Engineer, so that appropriate measures can be taken for the long term protection of the facility.

1.14 UNACCEPTABLE MATERIALS

- A. Unacceptable materials, excess materials, and/or spoils not used as backfill shall be removed from the project, and disposed of at locations approved by the DNREC Solid and Hazardous Waste Management Branch.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**END OF SECTION 011200**

## SECTION 011300

### NOTIFICATIONS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor shall perform work in accordance with Section 10.07-7 of this Specification and as specified herein. The Contractor shall coordinate work with the Owner, Engineer, utility owners, and all property owners affected by the Work and provide the required notices as set forth herein.

##### 1.2 DEFINITIONS

- A. "Days" as used herein refers to consecutive calendar days.

##### 1.3 NOTICES TO ENGINEER

- A. The Contractor shall notify the Engineer as follows:
  - 1. In writing at least ten (10) days in advance of beginning any work on the site.
  - 2. In writing at least five (5) days before starting excavation work.
  - 3. In writing within two (2) days after marking limits of disturbance and any trees bushes and other structures or obstacles for removal, relocation, protection or demolition.
  - 4. By telephone at least two (2) days in advance of beginning any sewage bypass operations.
  - 5. In writing two (2) days in advance of acceptance testing as set forth in Section 333001.
  - 6. In writing when the Contractor believes that all contracted work has been completed in preparation of conditional acceptance.
  - 7. In writing at the completion of all restoration activities.

##### 1.4 NOTICES TO OTHER AUTHORITIES/UTILITIES

- A. Notifications shall be made in accordance with the DELDOT Permit.
- B. Notify owners of adjacent utilities when prosecution of the Work may affect their respective utilities.

- C. Utilities shall be notified at least 72 hours prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines. See construction plans for a list of local utilities and contacts.
- D. Notify the Delmarva Power Area Engineer (302-454-4439) four weeks prior to work adjacent to overhead power lines to obtain authorization to begin work. Contractor is responsible for coordinating the temporary relocation and restoration of electrical lines with Delmarva's Electrical Division.
- E. Notify Delmarva Power's Gas Division (302-429-3706) at least two weeks prior to crossing any gas lines. The Contractor is responsible for coordinating the disconnection and reconnection of gas lines with Delmarva's Gas Division.

## 1.5 NOTICES TO PROPERTY OWNERS

### A. NOTIFICATION CONTENT

- 1. All notifications with property owners shall be in writing unless otherwise specified. At a minimum, the notice to property owners shall contain the following information:
  - a. Contractor's company name,
  - b. Contractor's address,
  - c. Contractor's phone number,
  - d. Date,
  - e. Project name,
  - f. Most probable construction dates,
  - g. Brief explanation of work to be accomplished,
  - h. Potential for noise, odors, disruption of services and other nuisances,
  - i. Expectations for property owner participation,
  - j. Statement that work is being done for New Castle County,
  - k. Phone number for contact at New Castle County.
- 2. The Contractor shall provide the Engineer an example of all written notifications prior to distribution.

### B. Notify all property owners affected by the Work:

- 1. Between two (2) and four (4) days before marking out the limits of construction.
- 2. Within two (2) days after marking trees, bushes or other obstacles for removal, relocation, protection, or demolition.
- 3. Between five (5) and ten (10) days before starting excavation work.
- 4. One (1) day before and immediately prior to disruption of service or access, in writing and in person, by knocking on doors of the dwellings of or adjoining the affected property. Include the time proposed to begin any work that will interfere with normal passage or service and the anticipated time of return of normal services.
- 5. Immediately after return of normal services, in person, by knocking on doors.
- 6. At the completion of all property restoration, in writing.

## 1.6 EMERGENCY NOTIFICATION

- A. In circumstances where prosecution of the Work causes a potentially hazardous situation or where property owners are affected by an unplanned loss of utility service, the Contractor shall immediately control the situation and pursue action to remedy the situation. If the Contractor believes there is serious threat of life or property damage, the Contractor shall call 911 immediately.
- B. The Contractor shall notify all affected business and property owners, utilities and authorities as soon as practical. Those entities may include but are not limited to the appropriate utility company(ies), service provider(s) and/or authority(ies), those with loss of service(s) or otherwise inconvenienced by the emergency situation. Communication to business and property owners shall be in person.
- C. The Contractor shall also notify New Castle County Dispatch (302-395-5700) and the Engineer as soon as practical. At a minimum, the Contractor shall provide a description of the emergency circumstances, what authority has jurisdiction over the emergency situation, what entities have been notified, what actions are being taken to address the emergency situation and how much time it will take to address the emergency.
- D. If the Engineer determines the Contractor is not pursuing appropriate or timely action to remedy the emergency situation, the County may provide the corrective action necessary. All actions taken by the County shall be fully reimbursed by the Contractor.
- E. The Contractor shall provide prompt, complete and accurate information on the emergency situation to all interested parties for the duration of the emergency.
- F. The emergency notification shall remain in effect until the entity having jurisdiction over the emergency has stated that corrective action has taken place to their satisfaction.
- G. Upon resolution of the emergency, the Engineer will investigate the situation to determine the root cause of the emergency and who should bear the cost of the emergency. The Contractor may be required to revise how they prosecute the Work. Changes to the prosecution of Work due to an emergency situation shall be made at no extra cost to the County.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION (NOT USED)**

**END OF SECTION 011300**

## SECTION 012250

### DEFINITION OF BID ITEMS

#### PART 1 – GENERAL

##### 1.1 SUMMARY

- A. The intent of this section is to explain, in general, what is and what is not included in a bid item, and the limits or cut-off points where one bid item ends, and another begins.
- B. If no bid item exists for a portion of the work, include the costs in a related bid item. All costs for work shown on the Contract Drawings shall be included in one of the bid items defined herein, even if not explicitly called out.
- C. Bid items listed for this project may not be in consecutive order.
- D. The work includes the construction of a 0.246 MGD average (700 GPM Peak) flow, sanitary sewer pump station, including pump process room, generator room, electrical room, bathroom, and storage room. Exterior facilities include influent grinder wet well, process wet well, influent gravity collection sewers and manholes, 14-inch and 18-inch diameter wastewater discharge force mains, electric service transformer, domestic water supply, site grading and paving, including appurtenances and related work in accordance with the project plans and specifications.

##### 1.2 DEFINITIONS

- A. Unit price is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

##### 1.3 PROCEDURES

- A. The prices bid shall include indirect costs related to the performance of this contract in accordance with the provisions contained on the drawings and as specified in these special provisions and the Standard Specifications for Construction.
- B. Work as shown on the Contract Drawings and/or included in the specifications is to be paid for under the items listed in the proposal. The absence from the proposal of bid items for any specific category of work shall be interpreted as meaning that the cost of such work accomplished as defined by the drawings and specifications shall be included in the prices bid for related items which are listed in the proposal.
- C. The Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. A schedule of unit prices is included in Part 3 of this Section. Specification Sections referenced in the schedule contain requirements for materials and execution of work described under each unit price.

- E. Requests for payment shall be made on Owner provided forms, which will be distributed at the pre-construction meeting. The Contractor shall complete and present required information in typewritten form.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **Base Bid Items**

#### **3.1 Bid Item 1 – Construction of West Wing Pump Station**

- A. Measurement – This item will not be measured. The lump sum payment for this item is for the construction of a 0.246 MGD average (700 GPM Peak) flow, sanitary sewer pump station and all related appurtenances.
- B. Payment – Payment will be based upon completion of the work in accordance with the Plans and Specifications and will be paid based on the percentage of work completed over the duration of the construction. The price bid shall include, but not be limited to pump process room, generator room, electrical room, bathroom, and storage room. Exterior facilities include influent grinder wet well, process wet well, influent gravity collection sewers and manholes, 14-inch and 18-inch diameter wastewater discharge force mains, electric service transformer, domestic water supply, site grading and paving, disposal of excess materials, coordination with utility companies, coordination with neighboring development project testing, startup, O&M Manuals, and coordination with New Castle County including appurtenances and related work in accordance with the project plans and specifications.

#### **3.2 Bid Item 2 – Project Sign (Section 012250)**

- A. Measurement – This item will not be measured. The Lump Sum payment for this item will be full compensation for providing and erecting a Project Sign and removing the sign at the close of the project.
- B. Payment – This bid item includes all labor, materials, equipment, and appurtenances required to provide and erect a project sign in accordance with the construction site sign requirements shown in Example, Figure 1 of the Delaware Water Pollution Control Revolving Loan Fund Program requirements added to the contract in Addendum #1. Payment shall also include removal and disposal of the project sign and restoration of the sign location at the close of the project.

#### **3.3 Bid Item 3 – Mobilization (Not to exceed 5% of total)**

- A. Measurement – This item will not be measured. The Lump Sum payment for this item will be full compensation for providing services and facilities required to mobilize for and commence the work of this project as shown, specified, and required to provide a complete project.
- B. Payment – The payment for mobilization will be made at 50% on the first payment requested with



the remainder paid in even monthly increment spread out over the Contract Time. Costs to be included under this item shall include such items as bonds, insurance, shop drawings, submittals, temporary facilities, and controls, permits, the installation of E&S Controls, mobilization of equipment, notifications along with other costs and incidentals associated with initiating the work.

### **Contingent Bid Items**

#### **3.4 Bid Item 4 – Contingent Borrow Type C (Backfill)**

- A. Measurement – This item of work shall consist of furnishing and placing complete in addition to that which is required as shown on the Drawings, specified, or as included in other Bid Items and in the event that sufficient suitable material is not available from the excavations at the Contract sites, and in accordance with the written direction of the Engineer. This item will be made on the basis of the actual in-place cubic yard volume of material satisfactorily furnished and placed in compliance with the Contract Documents, as directed by the Engineer. The maximum width for payment for utilities shall be as indicated on the Drawings and shall apply from trench sub-grade or top of required bedding material up to finished grade, less any thickness required for stone aggregate, bituminous concrete, concrete, topsoil, or other surface restoration materials.
- B. Payment – Payment for this item shall include the disposal of all unsuitable or excess materials excavated from the site at a permitted off-site disposal location of the Contractor's own choosing.

#### **3.5 Bid Item 5 – Contingent Rock Excavation**

- A. Measurement – This contingent bid item shall consist of rock excavation, of all unsuitable material below subgrade for structures or pipe bedding, or of all material in addition to that shown on the Drawings, specified, or included in other Bid Items, and in accordance with the written direction of the Engineer. Measurement under this item will be made on the basis of the volume of material excavated in compliance with the Contract Documents, in cubic yards measured in place, as directed and approved by the Engineer.
- B. Payment – Payment for work completed under this item will be made at the unit price bid per cubic yard for Contingent Unclassified Excavation which price shall include and cover furnishing all labor, materials, equipment, tools and incidentals required to perform the unclassified excavation, and includes excavation support, loading, hauling, disposal (at permitted disposal location) and all related work required to satisfactorily complete the work as shown, specified or directed.

#### **3.6 Bid Item 6 – Contingent Trench Excavation and Stone Bedding**

- A. Measurement – This item of work shall consist of trench excavation, of all unsuitable material below subgrade for structures or pipe bedding, or of all material in addition to that shown on the Drawings, specified, or included in other Bid Items, and in accordance with the written direction of the Engineer. Measurement under this item will be made on the basis of the volume of material excavated in compliance with the Contract Documents, in cubic yards measured in place, as directed and approved by the Engineer.
- B. Payment – Payment for work completed under this item will be made at the unit price bid per cubic

yard for Contingent Unclassified Excavation which price shall include and cover furnishing all labor, materials, equipment, tools and incidentals required to perform the unclassified excavation, and includes excavation support, loading, hauling, disposal (at permitted disposal location) and all related work required to satisfactorily complete the work as shown, specified or directed.

### **3.7 Bid Item 7 - Contingent Crusher Run**

- A. Measurement – This item of work shall consist of furnishing and placing complete, porous fill material, crusher run in addition to that shown on the Contract Drawings, specified, or as included in other Bid Items, and in accordance with the written direction of the Engineer. Measurement under this item will be made on the basis of the actual in-place tons of approved material satisfactorily furnished and placed in compliance with the Contract Documents, as directed by the Engineer.
- B. Payment – Payment of this bid item shall be as agreed upon by the Contractor and Engineer. Payment under this item will be made at the unit price bid per ton, as referenced in paragraph (2) above, which shall include and cover furnishing all labor, materials, and equipment necessary to complete the work as shown, as specified, or as directed by the Engineer.

### **3.8 Bid Item 8 – Contingent Filter Fabric**

- A. Measurement – This item of work shall consist of furnishing and placing complete filter fabric in addition to that shown on the Contract Drawings, specified, or as included in other Bid Items, and in accordance with the written direction of the Engineer. Measurement under this item will be made on the basis of the actual in-place square yards of approved material satisfactorily furnished and placed in compliance with the Contract Documents, as directed by the Engineer.
- B. Payment – Payment of this bid item shall be as agreed upon by the Contractor and Engineer. Payment under this item will be made at the unit price bid per square yard, as referenced in paragraph (2) above, which shall include and cover furnishing all labor, materials, and equipment necessary to complete the work as shown, as specified, or as directed by the Engineer.

### **3.9 Bid Item 9 –Contingent Work Allowance**

- C. Measurement – This item will not be measured. The Lump Sum payment for this item will be full compensation for providing services and facilities required for any additional work required to provide a complete project as determined by the Engineer in accordance with Section 12800 of the Special Provisions.
- D. Payment – Payment will be based on the contract unit price bid for contingent work for Phase 1 requirements of the Contract Documents and necessary to complete additional work authorized by New Castle County as shown in the contract documents in accordance with Section 012800 of the Special Provisions.

**END OF SECTION**

**SECTION 012800**  
**WORK ALLOWANCE**

**PART 1 - GENERAL**

1.1 DESCRIPTION

- A. This section will provide for payment of authorized additional work.

1.2 PAYMENT

- A. For the timely completion of the Work, an allowance is included for payment of additional work necessary to maintain advancement of the project. Payment for this work will be made from the fixed price lump sum allowance designated in the bid proposal. To be eligible, all work must be authorized in conformance with New Castle County protocols, and payment will not be made without written authorization. This section shall not be used to make interim payment for work which is being processed as disputed work.

1.3 DESCRIPTION OF PROTOCOL

- A. If during the performance of the Work, conditions arise which necessitate additional work, which is determined by the Engineer to be critical to the advancement of the project and, hence, requiring prompt performance, the Contractor may be directed to perform such additional work. Upon receipt of direction, the Contractor shall commence work with payments made from the contingency allowance.
- B. Payment for work performed under this section shall be determined from time and materials records or negotiated lump sum.
- C. The tracking of contingency approvals, payments, and registration of contingency work allowances shall be submitted in monthly invoices.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

END OF SECTION 012800

## SECTION 013300

### PROJECT MANAGEMENT AND COORDINATION

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor is subject to the requirements of Article 10.05 of these specifications and the following provisions for project management and coordination.

##### 1.2 DEFINITIONS

- A. Request(s) For Information (RFI): Request(s) from the Engineer or Contractor seeking information from the other during construction.

##### 1.3 COORDINATION

- A. The Contractor shall coordinate construction operations depicted in all Sections of the Specifications to ensure efficient and orderly installation of each part of the Work.
- B. The Contractor shall schedule construction operations in an appropriate sequence to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 1. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 2. Make adequate provisions to accommodate items scheduled for later installation.
- C. The Contractor shall prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
  - 1. Prepare similar memoranda for Owner and Subcontractors if coordination of their Work is required.
- D. The Contractor shall coordinate scheduling and timing of required administrative procedures with other construction activities and activities of sub-contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
  - 1. Preparation of Contractor's construction schedule.
  - 2. Installation and removal of temporary facilities and controls.
  - 3. Delivery and processing of submittals.

4. Progress meetings.
5. Project closeout activities.

#### 1.4 PROJECT MEETINGS

##### A. Preconstruction Meeting

1. The Engineer will schedule and conduct a preconstruction meeting before starting construction, at a time convenient to the Contractor, after award of the contract but prior to beginning work.
2. Authorized representatives of the Owner, Engineer; Contractor and its Superintendent; major Subcontractors and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
3. Significant items discussed at the preconstruction meeting shall include the following:
  - a. Tentative construction schedule.
  - b. Phasing.
  - c. Critical work sequencing and long-lead items.
  - d. Designation of key personnel and their duties.
  - e. Procedures for processing field decisions and Change Orders.
  - f. Procedures for testing and inspecting.
  - g. Procedures for processing Applications for Payment.
  - h. Distribution of the Contract Documents.
  - i. Submittal procedures.
  - j. Preparation of record documents.
  - k. Work restrictions (including permit conditions and requirements).
  - l. Working hours.
  - m. Responsibility for temporary facilities and controls.
  - n. Procedures for disruptions and shutdowns.
  - o. Parking availability.
  - p. Security.
  - q. Progress cleaning.
  - r. Progress meeting interval
4. The Engineer will record and distribute meeting minutes to all attendees. Comments to the meeting minutes shall be provided to the Engineer in writing within ten (10) working days from their distribution. If no comments are received, the meeting minutes are considered accepted with no comment.

##### B. Progress Meetings

1. The Engineer will schedule and conduct progress meetings at intervals agreed upon at the Preconstruction meeting.

2. The Engineer shall provide an agenda to the Superintendent five (5) working days prior to the Progress Meeting. The agenda shall include the time, location and list of attendees required, topics for discussion as appropriate to the status of the Work, and minutes of the previous Progress Meeting. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**END OF SECTION 013300**

## **SECTION 013400**

### **CONSTRUCTION SUBMITTAL AND SUBSTITUTION PROCEDURES**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This Section establishes compliance with Sections 011006 and 011008, Paragraph 10.08-3 for submittal procedures, or as revised in this Section.
- B. This Section also establishes criteria and procedure for submission of requests for material substitutions by the Contractor and evaluation by the Engineer.

##### **1.2 DEFINITIONS**

- A. Submittals shall include but are not limited to those described herein:
  - 1. Section 011006, Paragraph 10.06-2 material source documents;
  - 2. Section 011006, Paragraph 10.06-3 plant or shop fabrication locations;
  - 3. Section 011006, Paragraph 10.06-4 material sampling and testing certifications to cited specifications; and
  - 4. Shop drawings provided to the Engineer to verify that the correct products will be installed on the Project.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

##### **1.3 REQUIRED SUBMITTALS**

- A. The Contractor shall submit the required submittals as listed in the following specification sections for review:
  - 1. Construction Schedule (Section 013300)
  - 2. Notifications (Section 011300)
  - 3. Precast Reinforced Concrete Vaults (Section 034818)
  - 4. Cast-In-Place Concrete (Section 033000)
  - 5. Grout (Section 031014)
  - 6. Dewatering (Section 312319)
  - 7. Excavation Support Systems (Section 315000)

8. Fill Materials (Section 311004)
9. Horizontal Directional Drilling (Section 330523.13)
10. Planting (321001)
11. Force Main Installation and Testing (Section 333000)
12. Casing Pipes (Section 335001)

## **PART 2 - PRODUCTS**

### **2.1 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES**

- A. Submittals shall show the principal dimensions, weight, structural and operating features, performance characteristics, type, composition and/or brand of pipe, etc., depending on the subject of the drawing. When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer or fabricator as correct for this Contract.
- B. Where required by the individual specifications or requested by the Engineer, submit samples to illustrate functional characteristics of the product. Coordinate sample submittals with interfacing work. Include identification on each sample, with full project information.
- C. Following the Engineer's review, distribute in accordance with submittal procedures detailed above.

### **2.2 MANUFACTURER'S INSTRUCTIONS**

- A. Submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and curing. Identify conflicts between manufacturers' instructions and Contract Documents.

### **2.3 CERTIFICATIONS AND TESTS**

- A. Two copies of certifications and reports of tests, when required under the various sections of the specifications, shall be submitted to the Engineer.

### **2.4 CONSTRUCTION PROGRESS SCHEDULES**

- A. The Contractor shall provide the schedule in Gantt chart format using Microsoft Project or format agreed upon by the Engineer.
- B. Submit three (3) copies of the initial construction schedule at the Preconstruction Meeting.



- C. Revise and resubmit progress schedule as needed and present at progress meetings or as otherwise arranged by the Engineer.

**PART 3 - EXECUTION**

3.1 PROCEDURE

- A. A letter of transmittal shall accompany each submittal and shall provide a reference heading indicating the following:

- 1. Contractor's Name \_\_\_\_\_
- 2. Project Name \_\_\_\_\_
- 3. Contract Number \_\_\_\_\_
- 4. Submittals Included \_\_\_\_\_

- B. Mail or deliver submittals to the address provided by the Engineer.

- C. If a Submittal deviates from the requirements of the Contract Documents, the transmittal letter shall clearly indicate that a substitution is being submitted for review, and specifically note each variation. All substitutions are subject to evaluation and maybe accepted or rejected based upon information submitted.

- D. All Submittals submitted for review shall have a title block with identification information and bear the stamp of approval and signature of the Contractor as evidence that they have been reviewed by the Contractor. Submittals without this stamp of approval will not be reviewed by the Engineer and will be returned to the Contractor. The Contractor's stamp shall contain the following minimum information:

- 1. Project Name: \_\_\_\_\_
- 2. CONTRACTOR'S Name: \_\_\_\_\_
- 3. Date: \_\_\_\_\_
- 4. Item: \_\_\_\_\_
- 5. Specifications:
  - a. Section: \_\_\_\_\_
  - b. Page No.: \_\_\_\_\_
  - c. Para. No.: \_\_\_\_\_
  - d. Drawing No.: \_\_\_\_\_ of \_\_\_\_\_

- e. Location: \_\_\_\_\_
- f. Submittal No.: \_\_\_\_\_
- g. Approved By: \_\_\_\_\_

6. Initially, present to the Engineer two (2) copies of submittals or manufacturer supplied submittals. One marked up print or copy of the submittal will be returned to the Contractor, unless otherwise arranged.

E. After the Engineer completes his review, Submittals will be marked with one of the following notations:

- 1. "No Exception Taken"
- 2. "Revise and Resubmit"
- 3. "Rejected"
- 4. "Make Corrections Noted"

F. Upon return of a submittal marked "No Exception Taken" or "Make Corrections Noted" the Contractor shall submit additional sets (the total number of submittals shall be agreed upon by both parties) to the Engineer for stamping and distribution. The Contractor may order, ship, or fabricate the materials included on the submittal, provided it is in accordance with the corrections indicated.

G. Upon return of a submittal marked "Revise and Resubmit," make the corrections indicated and repeat the initial approval procedure.

H. Upon return of a submittal marked "Rejected," address the reasons for rejection and repeat the initial approval procedure. The Engineer can reject submittals for any reason.

I. Any related Work performed or equipment or materials purchased or installed without a "No Exception Taken" or "Make Corrections Noted" Submittal will be at the sole responsibility of the Contractor.

J. Submittals shall be submitted in advance of the need for the material or equipment for construction and with ample allowance for the time required to make delivery of material or equipment after data covering such is approved. The Contractor shall assume the risk for all materials or equipment which are fabricated or delivered prior to the approval of Submittals. Materials or equipment will not be included in periodic progress payments until approval thereof has been obtained in the specified manner.

K. The Engineer will review and process all submittals and notify Contractor of status, unless otherwise identified.

- L. It is the Contractor's responsibility to review submittals made by his suppliers and Subcontractors before transmitting them to the Engineer to assure proper coordination of the Work and to determine that each submittal is in accordance with his desires and that there is sufficient information about the materials and equipment for the Engineer to determine compliance with the Contract Documents. Incomplete or inadequate submittals will be returned for revision without review.

### 3.2 SUBMITTALS FOR SUBSTITUTION

- A. If the Contractor wishes to use a product other than that specified, the Contractor shall show compliance with requirements for substitutions and the following, as applicable:
  - 1. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
  - 2. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, which will be necessary to accommodate proposed substitution.
  - 3. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
  - 4. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - 5. Samples, where applicable or requested.
  - 6. Certificates and qualification data, where applicable or requested.
  - 7. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
  - 8. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - 9. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's

letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

10. Cost information, including a proposal of change, if any, in the Contract Sum.
  11. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
  12. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- B. A request for substitution constitutes a representation that the Contractor:
1. Has investigated the proposed product and determined that it is equal to or superior in all respects to the specified product.
  2. Will provide the same warranties or bonds for the substitution as for the product specified.
  3. Will coordinate the installation of an accepted substitution into the work, and make such other changes as may be required to make the work complete in all respects.
  4. Waives all claims for additional costs, under his responsibility, which may subsequently become apparent as a result of the substitution.
  5. The Engineer shall be the judge of the acceptability of the proposed substitution.
  6. Only one request for substitution will be considered for each product. When a substitution is not accepted, provide specified product.

**END OF SECTION 013400**

## SECTION 01 41 20

### SEISMIC AND WIND REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section establishes the minimum seismic and wind loading design requirements for architectural, mechanical, electrical and non-structural components.
- B. The Contractor shall be responsible for compliance with the seismic and wind requirements specified including conformance by all Subcontractors, manufacturers and Suppliers.

##### 1.02 REFERENCES:

- A. American Society of Civil Engineers (ASCE):
  - 1. ASCE/SEI 7: Minimum Design Loads for Buildings and Other Structures
- B. American Society of Mechanical Engineers (ASME):
  - 1. [B31](#): Code for Pressure Piping
- C. International Code Council (ICC):
  - 1. International Building Code
- D. Manufacturers Standardization Society of the Valve and Fitting Industry:
  - 1. [SP-58](#): Pipe Hangers and Supports - Materials, Design and Manufacture
- E. National Fire Protection Association (NFPA):
  - 1. Standard for the Installation of Sprinkler Systems

##### 1.03 DEFINITIONS:

- A. Components are defined as systems, equipment, parts, or other elements, including supporting structures and attachments.
- B. The reference Building Code is the building code cited on the structural drawings or specified herein for the design of the basic structure.
- C. The specified seismic criteria is defined as the seismic criteria cited on the structural drawings or specified herein for the design of the basic structure.

- D. The specified wind criteria is defined as the wind criteria cited on the structural drawings or specified herein for the design of the basic structure.

#### 1.04 SEISMIC AND WIND DESIGN REQUIREMENTS:

- A. Refer to structural drawings for project specific seismic and wind requirements and also conform to the requirements specified herein.
- B. Seismic and wind design shall conform to the International Building Code and ASCE/SEI 7.
- C. Architectural, mechanical, electrical and non-structural components shall be designed and constructed to resist the seismic and wind forces and displacements based upon ASCE/SEI 7, the reference building code, and the specified seismic and wind criteria. In the case of conflict the more stringent requirements shall govern.
- D. The interrelationship of components and their effect on each other shall be such that the failure of one component shall not cause the failure of any other component.
- E. Components shall be anchored to the building structure to transfer seismic and wind forces. Connections shall be bolted, welded or otherwise positively anchored to the structure. Anchorage shall not rely on friction for force transfer.
- F. Post-installed anchors in concrete shall be prequalified for seismic applications in accordance with ACI 355.2, ICC-ES AC-193, or ICC-ES AC-308. Drop-in anchors are prohibited for concrete anchorage.
- G. Post-installed anchors in masonry shall be prequalified for seismic applications in accordance with ICC-ES AC-01, or ICC-ES AC-58. Drop-in anchors are prohibited for masonry anchorage.
- H. Exceptions: Exemption from the requirements for seismic and wind analysis and design are permitted only to the extent permitted by applicable codes and standards.

#### 1.05 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00.
- B. Where specified in the technical specifications, provide and complete the Certificate of Unit Responsibility form in Section 01 33 00 and submit to Engineer prior to manufacture of components.
- C. In addition, submit the following support data along with Certificate of Unit Responsibility:
  - 1. Certification, signed and sealed by a Professional Structural Engineer registered in the jurisdiction in which the project is located stating that all systems, equipment,

and other elements, including supporting structures, attachments and connections are designed to withstand the required seismic and wind forces and displacements.

2. Codes and specifications to which structural design conforms.

1.06 SPECIFIC COMPONENTS:

- A. Compound Equipment: Connecting elements for equipment combinations such as pumps and motors, valves and operators, engines and generators, etc. which are not capable of transferring seismic and/or wind loads or accommodating seismic and wind displacements shall be protected by appropriate design.
- B. Storage Tanks: Tanks, supporting structures and anchorages shall be designed for the weight of the tank, appurtenances and the tank contents at the maximum capacity. Tank contents shall not be considered in resistance to seismic and wind loads.
- C. Ductwork: Equipment installed within ductwork shall be independently supported and braced. Support and bracing of heating and cooling coils shall account for the weight of the contents.
- D. Piping Systems: Support and bracing of piping systems shall account for the weight and hydrodynamic effects of the contents.
- E. Pressure Piping: Pressure piping support and bracing shall conform to ASME B 31 in addition to the force and displacement requirements of the reference code.
- F. Sprinkler Systems: Sprinkler system support and bracing shall conform to NFPA 13 in addition to the force and displacement requirements of the reference code.
- G. General Supports: Pipe, duct, raceways and cable tray supports and bracing shall conform to the AISC Manual of Steel Construction and MSS SP-58 in addition to the force and displacement requirements of the reference code.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 43 00

QUALITY ASSURANCE

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. This section covers Quality Assurance and Control requirements for this contract.
- B. The Contractor is responsible for controlling the quality of work, including work of its subcontractors, and suppliers and for assuring the quality specified in the Technical Specifications is achieved.
- C. Refer to the Article 6 - Contractor's Responsibilities, paragraphs 6.01, 6.02, and 6.03.

1.02 CONTRACTOR FURNISHED TESTING LABORATORY SERVICES:

- A. An independent commercial testing laboratory acceptable to the Engineer shall perform all tests that require the services of a laboratory to determine compliance with the Contract Documents. The laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards.
- B. Preliminary Testing Services: The Contractor shall be responsible for all testing laboratory services in connection with concrete materials and mix designs, the design of asphalt mixtures, gradation tests for structural and embankment fills, backfill materials, and all other tests and engineering data required for the Engineer's review of materials and equipment proposed to be used in the Work. The Contractor shall obtain the Engineer's acceptance of the testing laboratory before having services performed, and shall pay all costs for services.
- C. The Contractor shall not retain any testing laboratory against which the Owner or the Engineer have reasonable objection, and if at any time during the construction process the services become unacceptable to the Owner, or the Engineer, either the Owner or the Engineer may direct in writing that such services be terminated. The request must be supported with evidence of improper testing or unreasonable delay. If the Engineer determines that sufficient cause exists, the Contractor shall terminate the services and engage a different testing laboratory.
- D. Transmittal of Test Reports: Written reports of testing and engineering data furnished by the Contractor for the Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings.
- E. The Contractor's testing laboratory shall furnish four copies of a written report of each test performed by laboratory personnel within three days after each test is completed.



Distribution shall be two copies of each test report to the Engineer's Representative, one copy to the Owner, and one copy for the Contractor.

#### 1.03 OWNER FURNISHED TESTING AND INSPECTION SERVICES:

- A. The Owner will employ the services of an independent testing agency to conduct the Program Of Structural Tests And Inspections as described in Section 01 45 33 and perform all quality control tests of materials of construction in the field or in the laboratory during and after their incorporation in the Work. Field sampling and testing shall be performed in the general manner indicated in the specifications, with minimum interference with construction operations.
- B. The Contractor shall furnish a construction schedule and a minimum of 48 hour notice of readiness for testing and inspection of the work. The Engineer shall determine the exact time and location of field sampling and testing, and may require such additional sampling and testing as necessary to determine that materials and equipment conform with data previously furnished by Contractor and with the Contract Documents.
- C. The Contractor shall schedule the work to permit adequate time for testing and re-testing should test results not conform to the contract documents. Lack of testing or inspection which is attributable to insufficient notice by the Contractor or failure of the Contractor to cooperate, will be cause for rejection of the work.
- D. The Contractor shall deliver materials in sufficient quantities to the Owner's testing agency as may be required. Laboratory testing shall be performed within a reasonable time, consistent with the specified standards.
- E. The Contractor shall furnish material samples and cooperate in the field sampling and testing activities, interrupting the work when necessary. The Contractor shall furnish personnel, facilities and access to assist in the sampling and testing activities.

#### 1.04 QUALITY ASSURANCE:

- A. Codes and Standards: Refer to Article 3 - Contract Documents: Intent, Amending, Reuse, paragraph 3.03 of the General Conditions.
- B. Copies of applicable referenced standards are not included in the Contract Documents. Where copies of standards are needed by the Contractor for superintendence and quality control of the work, the Contractor shall obtain a copy or copies directly from the publication source and maintain at the jobsite, available to the Contractor's personnel, subcontractors, and Engineer
- C. Quality of Materials: Unless otherwise specified, all materials and equipment furnished for permanent installation in the Work shall conform to applicable standards and specifications and shall be new, unused, and free from defects and imperfections, when installed or otherwise incorporated in the Work. The Contractor shall not use material

and equipment for any purpose other than that intended or specified unless the Engineer authorizes such use.

- D. Where so specified, products or workmanship shall also conform to the additional performance requirements included within the Contract Documents to establish a higher or more stringent standard or quality than that required by the referenced standard.

#### 1.05 OFFSITE INSPECTION:

- A. When the specifications require inspection of materials or equipment during the production, manufacturing, or fabricating process, or before shipment, such services shall be performed by the Owner's independent testing laboratory, or inspection organization acceptable to Engineer in conjunction with or by the Engineer.
- B. The Contractor shall give appropriate written notice to the Engineer not less than 30 days before offsite inspection services are required, and shall provide for the producer, manufacturer, or fabricator to furnish safe access and proper facilities and to cooperate with inspecting personnel in the performance of their duties.

#### 1.06 MATERIALS AND EQUIPMENT:

- A. The Contractor shall maintain control over procurement sources to ensure that materials and equipment conform to specified requirements in the Contract Documents.
- B. The Contractor shall comply with manufacturer's printed instructions regarding all facets of materials and/or equipment movement, storage, installation, testing, startup, and operation. Should circumstances occur where the contract documents are more stringent than the manufacturer's printed instructions, the Contractor shall comply with the specifications. In cases where the manufacturer's printed instructions are more stringent than the contract documents, the Contractor shall advise the Engineer of the disparity and conform to the manufacturer's printed instructions. In either case, the Contractor is to apply the more stringent specification or recommendation, unless approved otherwise by the Engineer.

#### 1.07 SHOP AND FIELD TESTING:

- A. The Contractor is responsible for providing advance notice of and access for the shop and field testing specified in the technical specification sections.
- B. The Contractor and its Subcontractor shall permit inspections, tests, and other services as required by the Contract Documents.
- C. Contractor shall provide twenty one days written notice to the Engineer so that the Engineer may schedule and witness off site and on site tests. The Engineer's witnessing of tests does not relieve the Contractor and/or Subcontractors of their obligation to comply with the requirements of the Contract Documents.

#### 1.08 MANUFACTURER'S FIELD SERVICES:

- A. When specified in the technical specifications sections, the Contractor shall arrange for and provide technical representation from manufacturer's of respective equipment, items or components. The manufacturer's representative shall be a factory trained service engineer/technician with the type and length of experience specified in the technical specifications.
- B. Services Furnished Under This Contract: An experienced, competent, and authorized factory trained service engineer/technician representative of the manufacturer of each item of equipment for which field services are indicated in the specifications shall visit the site of the Work and inspect, operate, test, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's service representative shall be present when the equipment is placed in operation. The manufacturer's service representative shall revisit the jobsite as often as necessary until all problems are corrected and the equipment installation and operation are satisfactory to the Engineer.
- C. Refer to Section 017823 - Operations and Maintenance Data for additional requirements.

#### 1.09 CERTIFICATION FORMS AND CERTIFICATES:

- A. The Contractor shall be responsible for submitting the certification forms and certificates in conformance with the requirements specified in Section 01 33 00 - Submittals.

#### PART 2 - PRODUCTS (NOT USED)

#### PART 3 – EXECUTION

#### 3.01 QUALITY CONTROL:

- A. Quality control is the responsibility of the Contractor, and the Contractor shall maintain control over construction and installation processes to assure compliance with specified requirements.
- B. Certifications for personnel, procedures, and equipment associated with special processes (e.g., welding, cable splicing, instrument calibration, surveying) shall be maintained in the Contractor's field office, available for inspection by the Engineer. Copies shall be made available to the Engineer upon request.
- C. Means and methods of construction and installation processes are the responsibility of the Contractor, and at no time is it the intent of the Engineer to supersede or void that responsibility.

END OF SECTION

## SECTION 01 45 33

### STRUCTURAL TESTS AND INSPECTIONS

#### PART 1 - GENERAL

##### 1.01 GENERAL:

- A. The Structural Engineer of Record (SER) is required to prepare a program describing the structural tests and inspections that will be performed for this project. The SER is the structural engineer (an individual) who is in responsible charge of the preparation of the structural drawings and structural specifications for this project and whose professional engineering seal appears on said structural drawings. The parties responsible for the performance of the structural tests and inspections are noted on the Program of Structural Tests and Inspections prepared by the SER.
- B. The SER has prepared a Program of Structural Tests and Inspections (the "Program"), which has been or will be submitted to the building official who has jurisdiction over this project. A copy of this program is included in this specification as Attachment No 1 for reference.
- C. The Program shall not relieve the Contractor or its subcontractors of their responsibilities and obligations for quality control of the Work, their other obligations for supervising the work, for any design work, which is included in their scope of services, and for full compliance with the requirements of the Contract Documents. The detection of, or failure to detect, deficiencies or defects in the Work during the testing and inspection conducted pursuant to the Program shall not relieve the Contractor or its subcontractors of their responsibility to correct all deficiencies or defects, whether detected or undetected, in all parts of the Work, and to otherwise comply with all requirements of the Contract Documents. Further, while the SER, and the Resident Engineer shall perform certain tasks in the Program requiring the review of certain construction activities, the SER and Resident Engineer shall only perform such tasks to ensure compliance with the SER approved submittals and the specifications. Neither the SER nor the Resident Engineer shall assume any responsibility or liability for the means, methods, procedures or techniques used by any construction contractor.
- D. The program of structural tests and inspection does not apply to the Contractor's equipment, temporary structures used by the Contractor to construct the project, the Contractor's means, methods, and procedures, and job site safety.

##### 1.02 CONTRACTOR'S RESPONSIBILITIES:

- A. Where the Program of Structural Tests and Inspections indicates that a structural component or system is subject to structural tests and inspections and that the SER for the project has not been retained to design said component or system or to prepare a performance specification for said component of system, the Contractor shall retain, or

require others under his aegis to retain, a professional engineer registered in the jurisdiction where the project is located to design said component or system and to provide the required program of structural tests and inspections for said component or system.

- B. The Contractor shall provide free and safe access to the Work for the SER and all other individuals who are observing the Work or performing structural tests or inspections. The Contractor shall provide all ladders, scaffolding, staging, and up-to-date safety equipment, all in good and safe working order, and qualified personnel to handle and erect them, as may be required for safe access.

#### 1.03 CONTRACTOR FURNISHED TESTING LABORATORY SERVICES:

- A. An independent commercial testing laboratory acceptable to the Engineer shall perform all tests that require the services of a laboratory to determine compliance with the Contract Documents. The laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards.
- B. Preliminary Testing Services: The Contractor shall be responsible for all testing laboratory services in connection with concrete materials and mix designs, the design of asphalt mixtures, gradation tests for structural and embankment fills, backfill materials, and all other tests and engineering data required for the Engineer's review of materials and equipment proposed to be used in the Work. The Contractor shall obtain the Engineer's acceptance of the testing laboratory before having services performed, and shall pay all costs for services.
- C. The Contractor shall not retain any testing laboratory against which the Owner or the Engineer have reasonable objection, and if at any time during the construction process the services become unacceptable to the Owner, or the Engineer, either the Owner or the Engineer may direct in writing that such services be terminated. The request must be supported with evidence of improper testing or unreasonable delay. If the Engineer determines that sufficient cause exists, the Contractor shall terminate the services and engage a different testing laboratory.
- D. Transmittal of Test Reports: Written reports of testing and engineering data furnished by the Contractor for the Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings.
- E. The Contractor's testing laboratory shall furnish four copies of a written report of each test performed by laboratory personnel within three days after each test is completed. Distribution shall be two copies of each test report to the Engineer's Representative, one copy to the Owner, and one copy for the Contractor.

#### 1.04 OWNER FURNISHED TESTING AND INSPECTION SERVICES:

- A. The Owner will employ the services of an independent testing agency to conduct the Program of Structural Tests and Inspections as described in Section 01 45 33 and

perform all quality control tests of materials of construction in the field or in the laboratory during and after their incorporation in the Work. Field sampling and testing shall be performed in the general manner indicated in the specifications, with minimum interference with construction operations.

- B. The Contractor shall furnish a construction schedule and a minimum of 48 hour notice of readiness for testing and inspection of the work. The Engineer shall determine the exact time and location of field sampling and testing, and may require such additional sampling and testing as necessary to determine that materials and equipment conform with data previously furnished by Contractor and to the Contract Documents.
- C. The Contractor shall schedule the work to permit adequate time for testing and re-testing should test results not conform to the contract documents. Lack of testing or inspection which is attributable to insufficient notice by the Contractor or failure of the Contractor to cooperate, will be cause for rejection of the work.
- D. The Contractor shall deliver materials in sufficient quantities to the Owner's testing agency as may be required. Laboratory testing shall be performed within a reasonable time, consistent with the specified standards.
- E. The Contractor shall furnish material samples and cooperate in the field sampling and testing activities, interrupting the work when necessary. The Contractor shall furnish personnel, facilities and access to assist in the sampling and testing activities.

## PART 2 - PRODUCTS

(Not Used)

## PART 3 - EXECUTION

(Not Used)

**ATTACHMENT NO. 1  
PROGRAM OF STRUCTURAL TESTS AND INSPECTIONS**

Project: NCC West Wing Pumping Station

Location: Choptank Road, Middleton New Castle County, Delaware 19709

Owner: New Castle County Department of Public Works

Owner's Address: 18A Old Churchmans Road, New Castle, DE 19720

Architect of Record: Gerald Otterson, AIA

Structural Engineer of Record (SER): Anthony Catalano Jr., PE

This program of structural tests and inspections is submitted as a condition for issuance of the building permit in accordance with the International Building Code.

The following firms, agencies, or individuals (hereinafter referred to collectively as agents) will perform the tests and inspections under the direction of the SER:

<u>Abbreviation</u>	<u>Agent</u>
SER	Structural Engineer Of Record Listed Above
RES	The Resident Representative
ITA(C)	Independent Testing Agency Employed By Contractor
ITA	Independent Testing Agency Employed By Owner
RPE(C)	Registered Professional Engineer Employed By Contractor
GEO	The Project Geotechnical Engineer
IWI	Independent Welding Inspector

The above abbreviations will be used on the attached pages to identify which agent is performing the particular tests or inspections.

The following categories of structural tests and inspections, if checked, are included in the program for structural tests and inspections for this project. The specific tests and inspections required for each checked category are listed on the page noted opposite the category and further described in the various technical specification sections.

<u>Category</u>	<u>Page</u>	<u>Category</u>	<u>Page</u>
<input checked="" type="checkbox"/> Steel Construction	6	<input checked="" type="checkbox"/> Controlled Structural Fill	11
<input checked="" type="checkbox"/> Cast-in-Place Concrete	7	<input type="checkbox"/> Pile Foundations	
<input checked="" type="checkbox"/> Precast Concrete Construction	8	<input type="checkbox"/> Pier Foundations	
<input checked="" type="checkbox"/> Masonry Construction	10	<input checked="" type="checkbox"/> Aluminum Construction	12
<input checked="" type="checkbox"/> In-situ Bearing Strata	11	<input checked="" type="checkbox"/> Special Cases	12

The following items of construction, if checked, are specified in the structural plans or specifications on a performance basis. The structural design of these items will be performed by the RPEC and reviewed by the SER. The construction of these items is included in the program for tests and inspections on the attached sheets.

<u>Category</u>	<u>Category</u>
<input type="checkbox"/> Curtain Walls	<input type="checkbox"/> Metal Buildings
<input checked="" type="checkbox"/> Precast Concrete Components	<input checked="" type="checkbox"/> Metal Stairs
<input type="checkbox"/> Post-Tensioning Steel	<input checked="" type="checkbox"/> Metal Railings
<input checked="" type="checkbox"/> Structural Steel Connections	<input checked="" type="checkbox"/> Metal and Composite Gratings
<input checked="" type="checkbox"/> Structural Aluminum Connections	<input checked="" type="checkbox"/> Metal Plate Covers

The following items are excluded from this program of structural tests and inspections, since other structural engineers not under the aegis of the SER designed them and the SER has no duties or responsibilities with respect to such performance specifications or designs. The Owner shall assign other architects, or construction contractors, as applicable; to be special SER's for their respective designs and such architects and/or contractors shall be responsible for all such structural tests and inspections for their respective designs.

- Seismic design of mechanical or electrical components, systems and their anchorage to the structure.
- Excavation support systems.
- Temporary bracing, temporary platforms, scaffolding, temporary guards and railings.
- Anything related to jobsite safety or construction means and methods.

Structural Engineer of Record:

Name:

Signature: \_\_\_\_\_

Firm: AECOM

Date: \_\_\_\_\_

Registration Seal



## STEEL CONSTRUCTION

Item	Agent	Scope	Frequency
1. Fabricator Certification/ Quality Control Procedures.	SER	Review to ensure that quality control procedures have been adopted for each Fabricator.	Start of project
2. Fabricator Inspection	SER	Review to ensure that an Independent Inspection Agency has approved each Fabricator.	Start of project
3. Material Certification	SER	Review for conformance to the specifications.	Each product
4. Bolting	ITA	Test and inspect bolted connections in accordance with specifications. Verify bolt size and grade in accordance with AISC specifications A325/A490.	Periodic
5. Welding	IWI	Check welder qualifications. Verify filler material in accordance with AWS D1.1. Visually inspect fillet welds. Test complete and partial penetration groove welds full length by dye penetrant, ultrasonic, or radiographic testing in accordance with the contract documents.	Periodic
6. Shear Connectors	IWI	Inspect for size and placement. Test for proper weld attachment.	Periodic
7. Structural Framing, Details and Assemblies	RES	Review for conformance with specifications and shop drawings.	Continuous
8. Open Web Steel Joists	RES	Inspect for size, placement, bridging, bearing and connection to structure.	Continuous
9. Open Web Steel Joists	IWI	Visually inspect all welds of a minimum of 5 percent of the joists, randomly selected.	Periodic
10. Steel Decking	RES/ IWI	Verify gage, width, and type. Inspect placement, laps, welds, side lap attachment and screws or other mechanical fasteners (IWI). Check welder qualifications (RES).	Periodic

### CAST-IN-PLACE CONCRETE CONSTRUCTION

Item	Agent	Scope	Frequency
1. Mix Design	ITA(C)	Design Concrete Mixes	Each mix
2. Materials Certification	SER	Review mix designs.	Each mix
	SER	Review for conformance to specifications.	Each product
3. Batching Plant	ITA/SER	Review to ensure that Plant quality control procedures have been adopted.	Start of project
4. Reinforcement Installation	RES	Inspect reinforcing for size, quantity, condition and placement.	Prior to each placement
5. Formwork Geometry	RES	Inspect form sizes for compliance with specifications.	Prior to each placement
6. Concrete Placement	RES	Review for conformance with specifications.	Each placement
	ITA	Perform slump, density and air content tests at point of discharge.	Each truck
7. Curing and Protection	ITA/RES	Observe procedures for conformance to the specifications.	Each placement
8. Evaluation of Concrete Strength	ITA	Test and evaluate in accordance with the specifications.	Every 50 cubic yards or part thereof
<p>Note: The Contractor may elect to have the Contractor's independent testing agency (ITA(C)) perform additional tests <u>in addition</u> to the testing by the Owner's Independent Testing Agency (ITA) at no cost to the Owner.</p>			

**PRECAST CONCRETE CONSTRUCTION**

<b>Item</b>	<b>Agent</b>	<b>Scope</b>	<b>Frequency</b>
1. Plant Certification/Quality Control Procedures	SER/ ITA	Review to ensure that Plant quality control procedures have been adopted (SER). Inspect plant storage and handling procedures (ITA). Confirm that approved submittals are being used for fabrication; review welder's certifications (SER). Monitor finished product for structural defects (cracks) (ITA).	Start of project
2. Material Certification	SER	Review for conformance to ACI 318.	Each product
3. Formwork Geometry	ITA	Inspect form sizes.	Selected placements
4. Reinforcement Installation	ITA	Inspect reinforcing and prestressing strands for size, quantity, condition and placement for conformance with Contract Documents, SER approved submittals, and ACI 318. Inspect welding.	Selected placements
5. Mix Design	ITA(C)	Design Concrete Mixes	Each mix
	SER	Review for conformance with specifications (SER).	Each mix
6. Concrete Placement	RES/ ITA	Inspect concrete placement procedures for conformance to ACI 318, Sections 5.9 and 5.10 (ITA), and for conformance with specifications (RES).	Selected placements
7. Curing and Protection	RES/ ITA	Inspect for maintenance of specified curing temperatures and techniques per ACI 318 (ITA), and for conformance with specifications (RES).	Each placement
8. Evaluation of Concrete Strength	ITA	Test for conformance to specifications in accordance with ACI 318.	Every 50 cubic yards or part thereof

Item	Agent	Scope	Frequency
9. Prestress Operation	ITA	Inspect application of prestressing forces per ACI 318. Inspect grouting of bonded, post-tensioned, prestressing tendons.	Selected placements
10. Assembled/Erected Precast Elements.	RES	Inspect for compliance with SER approved submittals and specifications. Review site storage and handling procedures for consistency with design of precast elements. Verify that SER approved erection drawings are on site and are being used for erection. Verify that SER approved erection procedures are being followed. Review welder's certifications.	Each unit
11. Connections/ Embedded Items	ITA	Inspect interface connections including end and edge doweling. Inspect embedment for proper location. Inspect shimming, bearing, bolting and welding of connections.	Each unit

## MASONRY CONSTRUCTION

Item	Agent	Scope	Frequency
1. Material Certification	SER	Review for conformance to specifications.	Each product
2. Evaluation of Masonry Strength	ITA	Verify strength in accordance with the specifications.	Periodic
3. Proportioning, Mixing and Consistency of Mortar and Grout	ITA	Inspect field-mixing procedures for conformance to the specifications.	Continuous
4. Installation of Masonry	RES	Inspect placement for conformance to the specifications.	Continuous
5. Reinforcement Installation	RES/ IWI	Inspect reinforcing steel for conformance to SER approved submittals and specifications (RES) Inspect welding of reinforcement and review welder's certifications (IWI).	Periodic
6. Grouting Operations	RES	Review grouting procedures for conformance with the specifications.	Periodic
7. Weather Protection	RES	Review procedures for protection for cold and hot weather for conformance with the specifications.	Periodic
8. Anchorage	RES	Inspect anchorage of masonry to other construction for conformance with specifications.	Periodic

**IN-SITU BEARING STRATA FOR FOUNDATIONS**

<b>Item</b>	<b>Agent</b>	<b>Scope</b>	<b>Frequency</b>
1. Bearing strata for foundations	GEO/ RES	Review strata for conformance to the structural drawings, specifications, and/or geotechnical report.	Prior to foundation placement
2. Bearing surfaces of foundations	GEO/ RES	Review for conformance to the requirements of the structural drawings, specifications, and/or geotechnical report.	Prior to foundation placement

**CONTROLLED STRUCTURAL FILL (PREPARED FILL)**

<b>Item</b>	<b>Agent</b>	<b>Scope</b>	<b>Frequency</b>
1. Fill Material	ITA	Test material for conformance to specifications or geotechnical report. Perform laboratory compaction tests in accordance with the specifications to determine optimum water content and maximum dry density.	Each Material
2. Installation of Controlled Structural Fill	RES/ ITA	Provide review of the installation, in accordance with the specifications. Verify maximum lift placement thickness (ITA).	Each lift
3. Density of Fill	ITA	Perform field density tests of the in-place fill in accordance with the specifications.	Each lift
NOTE: Above testing is confirmatory testing by the Owner's independent testing agency (ITA). These tests are <u>in addition</u> to the testing required by the Contractor's independent testing agency (ITA(C)).			

### ALUMINUM CONSTRUCTION

Item	Agent	Scope	Frequency
1. Fabricator Certification/ Quality Control Procedures.	SER	Review to ensure that quality control procedures have been adopted for each Fabricator.	Start of project
2. Fabricator Inspection	SER	Review to ensure that an Independent Inspection Agency has approved each Fabricator.	Start of project
3. Material Certification	SER	Review for conformance to the specifications.	Each product
4. Bolting	ITA	Test and inspect bolted connections in accordance with specifications. Verify bolt size and grade in accordance with AISC specifications A325/A490.	Periodic
5. Welding	IWI	Check welder qualifications. Verify filler material in accordance with AWS D1.1. Visually inspect fillet welds. Test complete and partial penetration groove welds full length by dye penetrant, ultrasonic, or radiographic testing in accordance with the contract documents.	Periodic
6. Structural Framing, Details and Assemblies	RES	Review for conformance with specifications and shop drawings.	Periodic

### SPECIAL CASES

Item	Agent	Scope	Frequency
1. Tank Leakage Testing	RES	Witness testing in accordance with contract documents.	Each tank
2. Concrete Anchor Installation	RES	Verify diameters, depth and cleaning of holes conforms to manufacturer's instructions.	Each anchor

END OF SECTION

## SECTION 015100

### TEMPORARY FACILITIES AND CONTROLS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. The Contractor shall provide all temporary facilities necessary for the proper completion of work, including but not limited to:
  - 1. Potable water.
  - 2. Electricity and lighting.
  - 3. Telephone.
  - 4. Fire protection.
  - 5. Sanitary and first aid facilities.
  - 6. Cleaning and other process water.
  - 7. Equipment, tool, and material storage.
  - 8. Project identification signage.
  - 9. Construction offices.

##### 1.2 USE CHARGES

- A. Allow other entities associated with the Project to use temporary services and facilities without cost, including, but not limited to the Engineer, and authorities having jurisdiction.
- B. The Contractor shall make arrangements and pay for all water necessary for completion of construction operations under this contract.
- C. The Contractor shall make all necessary applications and arrangements and pay all fees and charges for electrical energy for power and light as necessary for the proper completion of the Work and during its entire progress. The Contractor shall provide and pay for all temporary wiring, switches, connections, and meters. The Contractor shall provide sufficient electric lighting so that all work may be done in a workman like manner when there is insufficient daylight.



### 1.3 PROJECT CONDITIONS

- A. Engage an installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before the Engineer's acceptance, regardless of previously assigned responsibilities.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve the Project adequately and result in minimum interference with the Work. Relocate and modify facilities as required by the progress of the Work.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

### 3.2 TEMPORARY UTILITY INSTALLATION

- A. Arrange with utility company, Owner, and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Provide temporary toilets and wash facilities for use of construction personnel.
- C. The Contractor shall furnish and maintain safe a drinking water supply for all employees.
- D. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

### 3.3 SUPPORT FACILITIES INSTALLATION

- A. Provide temporary parking areas for construction personnel.
- B. Comply with requirements of authorities having jurisdiction concerning dewatering. Maintain Project site, excavations, and construction free of water.
  - 1. Dispose of rainwater in a lawful manner that will not result in flooding adjoining properties nor endanger permanent Work or temporary facilities.
  - 2. Remove snow and ice as required to minimize accumulations.
- C. Project Signs: Provide and maintain project signs as indicated. Unauthorized signs are not permitted.
  - 1. Identification Signs: Provide Project identification signs as indicated on Drawings.

2. Maintain signs so they are legible at all times.
- D. Waste Disposal Facilities: Provide facilities for temporary accumulation of waste materials and rubbish.
1. Periodically dispose of waste materials and rubbish off-site.
  2. Clean and repair damage caused by installation or use of waste disposal facilities.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- B. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

**END OF SECTION 015100**

## SECTION 01 73 29

### CUTTING, CORING AND PATCHING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This Section covers the cutting, coring, rough and finish patching of holes and openings in existing and new construction.
- B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.

##### 1.02 ALTERATIONS, CUTTING, AND PROTECTION:

- A. Survey and record condition of existing facilities to remain in-place that may be affected by alteration operations. After alteration work is complete, survey conditions again and restore existing facilities to pre-alteration condition.
- B. Perform Work of moving, removal, cutting, and patching with trades qualified to perform Work in manner causing least damage to each type of Work.
- C. Cut finish surfaces such as masonry, tile, plaster or metals, by methods to terminate surfaces in a straight line at a natural point of division.
- D. Protect existing finishes, equipment, and adjacent Work which is to remain, from damage.
- E. Provide shoring, needling, and bracing to keep structures structurally secure and free of damaging deflection during cutting or coring operations.

##### 1.03 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Adhere strictly to the manufacturer's current printed recommendations regarding temperature at time of application for all work involving epoxy, cement base coating and protective coating.
- C. Use only products of the specified Repair Mortar System Manufacturer(s) or equal.
- D. Any changes in the specified repair mortar work methods shall be allowed only with the written acceptance of the Engineer.

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Concrete repair mortar shall be a non-shrink, commercial formulation requiring only the addition of water with minimum 28-day compressive strength of 5,000 psi.
- B. Provide a non-shrink cementitious repair mortar material as manufactured by:
  - 1. Sika Repair 224 manufactured by Sika Corporation,
  - 2. MasterEmaco S 488CI manufactured by BASF Corporation,
  - 3. Restokrete Underlayment No. F-120 by Sauereisen, Inc.,
  - 4. Or acceptable equivalent product.
- C. Materials for finish patching shall be equal to those of adjacent construction.

## PART 3 - EXECUTION

### 3.01 GENERAL:

- A. All cutting and coring shall be performed in such a manner as to limit the extent of patching.
- B. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise accepted. No structural members shall be cut without acceptance of the Structural Engineer of Record and all such cutting shall be done in a manner directed by the SER. No holes may be drilled in beams or other structural members. All work shall be performed by mechanics skilled in this type of work.
- C. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown. Finish patching shall match existing surfaces.
- D. Reinforcing steel cut by cutting and coring operations shall be coated with a three-component, solvent free, moisture tolerant, epoxy-modified cementitious product specifically formulated as an anti-corrosion coating; installed in accordance with the manufacturer's printed instructions.

### 3.02 CUTTING:

- A. Inspect existing conditions of Work, including components subject to damage or movement during cutting or patching.
- B. Do not cut or notch structural members without specific written acceptance of the Engineer.

- C. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.
- D. Corners of square or rectangular openings shall be cored. Do not overcut corners of openings. Corners shall be chipped out square, if required, so as not to cause cracking at the corners.
- E. Provide for control of slurry generated by sawing operation on both sides of element.
- F. When cutting reinforced concrete, the cutting shall be done so as not damage bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
- G. Adequate bracing and/or shoring of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- H. Provide equipment of adequate size to remove cut panel.

### 3.03 CORING:

- A. Coring shall be performed with an accepted non-impact rotary tool with diamond core drills. Size of holes shall be suitable for pipe, conduit, sleeve, equipment or mechanical seals to be installed.
- B. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.
- C. Slurry or tailings resulting from coring operations shall be removed from the area following drilling.

### 3.04 PATCHING:

- A. Prepare surfaces to receive cementitious repair mortar in accordance with manufacturer's instructions.
- B. Mix the cementitious repair mortar material components in accordance with the manufacturer's instructions. Concrete surfaces should be surface saturated dry (SSD) with no standing water prior to mortar application.
- C. Work a wet scrub coat of the mortar per the manufacturer's recommendations into the pores and voids in the substrate and over the substrate prior to mortar application by trowel.
- D. Apply the cementitious repair mortar using a steel trowel to work the material into the surface. Fill voids from deepest to shallowest areas as the application work proceeds. Strictly follow the manufacturer's application requirements.

- E. Once the repair areas are filled with repair mortar, strike off the mortar level with the surrounding concrete substrate. Do not leave a broom finish. Finish with a steel trowel until closed up at the surface and flat.
- F. Cure the repair mortar in strict accordance with the manufacturer's instructions.

3.05 CLEANING:

- A. Perform periodic and final cleaning as specified in Section 011004, and:
  - 1. Clean Owner-occupied areas daily.
  - 2. Clean spillage, overspray, and heavy collection of dust in Owner-occupied areas immediately.
- B. At completion of alterations work in each area, provide final cleaning and return space to condition suitable for use by Owner.
- C. Remove debris from site each day. Removed material, except that listed or marked by Engineer for retention, becomes property of Contractor.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 017400

### CONTRACT CLOSEOUT

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor shall furnish all labor materials, equipment, and services necessary and incidental for contract closeout tasks, as shown on the Drawings and specified herein with respect to:
1. Final cleaning of sanitary sewer pipe and manholes.
  2. Acceptance Testing.
  3. ~~Post-Construction CCTV Inspection~~ (NOT REQUIRED FOR FORCEMAIN CONSTRUCTION)
  4. As-Built Contract Drawings
  5. Cleaning of surfaces.

#### PART 2 - PRODUCTS (NOT USED)

#### PART 3 - EXECUTION

##### 3.1 FINAL CLEANING OF SANITARY SEWER PIPE AND MANHOLES

- A. The Contractor shall remove accumulated sediment, construction debris and other material from the sewer system.

##### 3.2 ACCEPTANCE TESTING

- A. The Contractor shall provide all labor, equipment and materials for Acceptance Testing of the Work, as specified in Section 333001.

##### 3.3 POST-CONSTRUCTION TV INSPECTION

- A. The Contractor may be required to provide a closed-circuit televised (CCTV) recording of all Work as part of the Contract, in accordance with Section 021007. CCTV inspection may include laser profiling to confirm acceptable ovality of the pipe constructed. If required, all documentation shall be provided for review and shall be accepted prior to Conditional Acceptance.

### 3.4 AS-BUILT CONTRACT DRAWINGS

- A. The Contractor shall maintain a set of Contract Drawings upon which the Work accomplished under this Contract is accurately depicted.
- B. Work constructed as shown on the Contract Drawings shall remain as drawn.
- C. All changes in size/diameter, elevation, depth/height, width/length, stations of point repairs and lateral connections, and all other design data/information shall be revised with notes that clearly indicate changes in design. These changes shall be made to all views (plan, profile, section, etc.) on the Contract Drawings.
  - 1. New data/information shall be noted legibly in “red.”
  - 2. Old data/information shall be cross-hatched to show deletion.
- D. At a minimum, as-built information shall also include:
  - 1. Pipe Repair/Replacement Projects
    - a. Material (including SDR, Class, or other designation)
    - b. Turf trail width (if applicable)
    - c. Rim Elevation (inches above/below grade)
    - d. Grade Adjustment
  - 2. Pipe Lining Projects
    - a. Nominal Host Pipe Diameter
    - b. Host Pipe Material (including SDR, Class, or other designation)
    - c. Lining material (Felt or Fiberglass)
    - d. Manufacturer’s Production Reference Number
    - e. Liner Thickness
    - f. Installation Date
  - 3. The format in which this as-built information is provided shall be discussed at the Pre-Construction meeting.
- E. The Contractor shall provide one (1) mylar and one (1) paper set of as-built drawings.
- F. All as-built drawings and information must be signed and sealed by a professional Land Surveyor or Engineer registered in the State of Delaware and delivered to New Castle County prior to issuance of Conditional Acceptance.

### 3.5 CLEANING OF SURFACES

- A. During its progress, the Work and the adjacent areas affected thereby shall be kept clean of all rubbish and surplus materials. Unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible. Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this contract, or elsewhere during the course of the Contractor’s operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, etc., shall, upon completion of the work, be left clean and neat.



- B. On or before the completion of the Work, the Contractor shall, unless otherwise directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.
  
- C. Upon completion of the Work, the Contractor shall remove from the sites of the subsurface explorations all of his plant, machinery, tools, equipment, temporary work, and surplus materials; shall, unless otherwise directed or permitted in writing, remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a satisfactory condition. The Contractor shall thoroughly clean all materials and equipment installed by him and his subcontractors, and on completion of the work shall deliver it undamaged and in fresh and new-appearing condition.

**END OF SECTION 017400**

## SECTION 01 78 23

### OPERATION AND MAINTENANCE DATA

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section includes procedural requirements for providing, compiling and submitting operation and maintenance data required for this project.

##### 1.02 SUMMARY:

- A. This section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. General contents of data.
  - 2. Specific data for each equipment and system.
  - 3. Manual for materials and finishes.
  - 4. Assembly.

##### 1.03 DEFINITIONS:

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

##### 1.04 SUBMITTALS:

- A. O&M Manual Content: Operations and maintenance manual submittal requirements are specified in individual Specification Sections for the Products for which they must be supplied. Submit reviewed manual content formatted and organized by this Section and as defined in Section 01 33 00, Table 01 33 00-1.
  - 1. Engineer and Owner will comment on whether content of operations and maintenance submittals are acceptable.
  - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Initial O&M Manual: Submit draft copy of each manual as defined in Section 01 33 00, Table 01 33 00-1. Engineer and Owner will comment on whether general scope and content of manual are acceptable.

- C. Pre-Final Manual Submittal: Submit [2] copies of each manual in final form prior to requesting inspection for Substantial Completion and as defined in Section 01 33 00, Table 01 33 00-1. Engineer and Owner will return one copy with comments.
  - 1. The contractor to correct or revise each manual to comply with Engineer and Owner comments.
- D. Submit [10] copies of each corrected manual as a final manual within 15 days of receipt of Engineer and Owner comments and prior to commencing startup, commissioning, and/or training.
- E. Prepare data in the form of an O&M instructional manual.
- F. Binders: Commercial quality, 8-1/2 x 11-inch three-hole post type binders with hardback, 3-inch maximum binder size. When multiple binders are used, correlate data into related consistent groupings. Three ring binders are not acceptable.
- G. Arrange contents by Specification Section numbers and sequence of Table of Contents of this Project Manual.
- H. Provide tabbed fly leaf for each separate product and system, with printed description of product and major component parts of equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.
- I. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- J. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages and insert into clear plastic envelopes that can be secured into the three-hole post binders.

1.05 FORMAT (ELECTRONIC DOCUMENTATION):

- A. The Contractor must provide Operation and Maintenance Manual information specific to the configuration of the project in electronic form. Documents should be formatted like a web site complete with index page and Table of Contents. The electronic format must be such that the Owner is able to load the files onto a server to provide online access via any standard web browser. The Contractor shall make use of HTML (for text based documents) and PDF (for CAD type drawings) file formats. The complete document shall be provided on a CD.
- B. The electronic O&M data must be organized in a logical manner to aid operation in troubleshooting and information retrieval.

1.06 QUALITY ASSURANCE:

- A. Preparation of data shall be performed by personnel:
  - 1. Trained and experienced in O&M of described equipment.

2. Familiar with requirements of this section.
3. Skilled as technical writers to the extent required to communicate the essential data to the Reader.
4. Skilled as drafters competent to prepare any required drawings.

## PART 2 - PRODUCTS

(Not Used)

## PART 3 - EXECUTION

### 3.01 GENERAL CONTENTS OF DATA:

- A. Each individual manual shall contain equipment data pertaining to not more than one Specification section number as indicated in the Contract Documents.
  1. Completed Form 01 78 23-1, Contractor's Submittal Form. An electronic copy of Form 01 78 23-1 will be provided to the Contractor
- B. Title Sheet: First page in data listing following:
  1. Title: "OPERATION AND MAINTENANCE INSTRUCTIONS".
  2. Title of Project: As shown on Contract Documents.
  3. Name(s) of applicable building(s) or structure(s) in which equipment is located.
  4. Name of equipment as described in Contract Documents.
  5. Contractor's name, address, and telephone number.
  6. Subcontractor's name, address, and telephone number if equipment is provided by Subcontractor.
  7. Contractor's or Subcontractor's purchase order number, manufacturer's shop order number or other such numbers required for parts and service ordering.
  8. Manufacturer's name, address, and telephone number.
  9. Name, address, and telephone number for local source of supply for parts and service.
- C. Equipment List: Immediately following title sheet containing the following:

1. Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum each tabbed divider. Each page shall be numbered.
2. Tabbed Dividers: Insert tabbed section dividers between each major section
  - a. Provide title of section on each tab.
  - b. Provide table of contents for each tabbed section, arranged in systematic order.
3. Equipment Data Sheets: Provide catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).
4. Text:
  - a. Include only those sheets applicable to Project.
  - b. Each sheet shall:
    - (1) Identify specific equipment or part installed.
    - (2) Identify text applicable to equipment or part installed.
    - (3) Do not include inapplicable information or neatly strike it out.
5. Drawings:
  - a. Supplement text with drawings to clearly illustrate following:
    - (1) Equipment and components.
    - (2) Relations of component parts of equipment and systems.
    - (3) Control and flow diagrams.
  - b. Actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable, unless they accurately illustrate actual installation for this contract.
6. Specially written information, as required to supplement text for particular installation.
  - a. Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.

- b. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.
- c. Provide glossary of any special terms used by the manufacturer if applicable.
- d. Organize in consistent format under separate headings for different O&M procedures.
- e. Provide logical sequence of instructions in order of O&M action required for each procedure.

3.02 SPECIFIC DATA FOR EACH ITEM OF EQUIPMENT AND/OR SYSTEM:

A. For each item of equipment and system include:

- 1. Completed Equipment Data Form typewritten on copy of Form 01 78 23-2 to Section 01 78 23. An electronic copy of Form 01 78 23-2 will be provided to the contractor.
- 2. Description of equipment and component parts:
  - a. Function
  - b. Normal operating characteristics
  - c. Limiting conditions.
  - d. Performance curves
  - e. Engineering data
  - f. Test as applicable.
  - g. Complete nomenclature and model number of replaceable parts including keyed labeled exploded diagram.
  - h. Complete nameplate data.
  - i. Owners tag (or asset) numbers for equipment as indicated on the Contract Drawings.
- 3. Operating Procedures:
  - a. Startup and break-in.
  - b. Normal operating instructions.
  - c. Regulation and control

- d. Stopping and shutdown,
  - e. Emergency instructions.
  - f. Summer and winter operating instructions, as applicable.
  - g. Special operating instructions.
4. Maintenance Procedures:
- a. Routine maintenance operations.
  - b. Guide to troubleshooting.
  - c. Disassembly, repair, and reassembly instructions.
  - d. Alignment, adjusting, and checking instructions.
5. Servicing and Lubrication Schedule:
- a. List of lubricants required and quantity to be applied.
  - b. Schedule of lubrication.
  - c. Schedule for other routine maintenance.
6. Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.
7. Description of sequence of operation of controls.
8. Assembly drawings and diagrams required for maintenance.
9. Manufacturer's parts list and illustrations
- a. Predicted life of parts subject to wear.
  - b. Items recommended to be stocked by the Owner as spare parts and quantities of same.
10. Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics.
11. Bill of material.
12. Other data as required under applicable Specification sections.

- B. Each electric and electronic system, as applicable to equipment such as switchgear, motor control centers, panel boards, switchboards, starters, breakers, and relays shall include:
1. Description of System and Component Parts:
    - a. Function
    - b. Normal operating characteristics
    - c. Limiting conditions.
    - d. Performance curves
    - e. Engineering data
    - f. Rating tables
    - g. Tests, as applicable.
    - h. Complete nomenclature and model number of replaceable parts.
    - i. Complete nameplate data.
    - j. Owner's Tag (asset) numbers for equipment as indicated on the Contract Drawings.
  2. Circuit Directories of Panel Boards:
    - a. Electrical service.
    - b. Controls.
    - c. Communications.
  3. Complete instrumentation
    - a. Loop diagrams
    - b. Tabulated listing of components in each control circuit or loop.
  4. Operating Procedures:
    - a. Routine and normal operating instructions.
    - b. Sequences required.
    - c. Special operating instructions.



5. Maintenance Procedures:
    - a. Routine maintenance operations.
    - b. Guide to troubleshooting.
    - c. Disassembly, repair, and reassembly instructions.
    - d. Adjustment and checking instructions.
  6. Manufacturer's printed instructions regarding safety precautions for both:
    - a. Protection of personnel operating equipment and systems.
    - b. Prevention of damage to equipment and systems.
  7. List of original all of the manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by the Owner.
  8. Other data as required under pertinent sections of Specifications.
- C. Prepare and include additional data when need for such data becomes apparent during instruction of Owner's personnel. Differences between the equipment O&M manual and the manufacturers training session shall result in the training and/or O&M Manual being corrected.

### 3.03 MANUAL FOR MATERIALS AND FINISHES:

- A. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements: As specified in individual product specification sections.
- E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

### 3.04 ASSEMBLY:

- A. Assemble in [10] sets.

- B. Remove bindings of individual manuals.
- C. Insert index tabs labeled with the respective piece of equipment to separate individual manuals.
- D. Provide a Table of Contents at the front of each volume showing the equipment items in the order in which they appear in the volume. Each equipment items shall include the functional name, applicable specifications section, and the plan listing, if any.
- E. The preventive maintenance schedule shall be bound in the front of each section immediately following the index tab sheet. The schedule shall be identified with respect to the piece of equipment it is referring to.
- F. Sheet Size: 8-1/2 x 11 sheets.
- G. Drawings may be on 11 x 17-inch sheets folded to 8-1/2 x 11 inches.
- H. Engrave on covers and end of binder, title OPERATIONS AND MAINTENANCE INSTRUCTIONS, name of Project, Owner's project number, date of Contract, and volume number with subject matter of contents, and Engineer's name.

FORM 01 78 23-1 Page 1 of 5  
 CONTRACTOR SUBMITTAL FORM

TO: (Engineer) (Address) (City, State, Zip) (Attn:)		DATE:	
		SPECIFICATION SECTION TITLE:	
		SECTION NO.:	
		MANUFACTURER/ VENDOR:	
FROM: (Contractor) (Address) (City, State, Zip)		NO. OF COPIES SUBMITTED TO [ENGINEER][CM]:	
		SIGNATURE OF CONTRACTOR:	

GENTLEMEN:

We have checked the O&M manual submittal dated \_\_\_\_\_, 20\_\_, and have found it to be in accordance with the requirements of Specification Section 01 78 23 as noted below.

FORMAT

Size: 8-1/2 x 11 or 11 x 17

Paper: 20-lb minimum

Text: Printed data/neatly typed

Drawings: Standard size bound in text; in text-size labeled envelopes

Tabbed Section Dividers

Cover Label: Title

Project name

Building/structure ID

Equipment name

Specification section

Binders: 3-ring

FORM 01 78 23-1 Page 2 of 5  
 CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.01 GENERAL CONTENTS			
			A. Section number - one specification only
			B. Title Page
			1. Title
			2. Project title
			3. Building/structure ID
			4. Equipment name
			5. Contractor ID
			6. Subcontractor ID
			7. Purchase order data
			8. Manufacturer ID
			9. Service/parts supplier ID
			C. Product List
			D. Table of Contents
			E. Tabbed Sections
			F. Pertinent data sheets
			1. Annotated as needed
			G. Text
			1. Pertinent to project
			2. Annotated
			H. Drawings
			1. Supplement text
			a. Illustrate product and components
			b. Relations of equipment systems
			c. Control and flow diagrams
			2. Actual drawing of project equipment

FORM 01 78 23-1 Page 3 of 5  
 CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.01 GENERAL CONTENTS			
			I. Special Information
			1. Interrelationships of equipment and components
			2. Instructions and procedures provided
			3. Instructions organized in consistent format
			4. Instructions in logical sequence
			5. Glossary
			J. Warranty, Bond, Service Contract
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			A. For each item of equipment
			1. Complete Form 2 to Section 01 78 23
			2. Description of Unit and Components
			a. Equipment functions
			b. Normal operating characteristics
			c. Limiting conditions
			d. Performance curves
			e. Engineering data
			f. Test data
			g. Replaceable parts list (with numbers)
			h. Nameplate data
			i. P&ID numbers
			3. Operating Procedures
			a. Startup, break-in
			b. Routine/normal operation
			c. Regulation and control
			d. Stopping and shutdown
			e. Emergency

FORM 01 78 23-1 Page 4 of 5  
 CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			3. Operating Procedures (continued)
			f. Seasonal operation
			g. Special instructions
			4. Maintenance Procedures
			a. Routine/normal instructions
			b. Troubleshooting guide
			c. Disassembly/repair/assembly
			d. Alignment, adjusting and checking instructions
			5. Servicing and Lubrication
			a. List of lubricants
			b. Lubrication schedule
			c. Maintenance schedule
			6. Safety Precautions/Features
			7. Sequence of Operation of Controls
			8. Assembly Drawings
			9. Parts List and Illustrations
			a. Predicted life
			b. Spare parts list
			10. Control Diagrams/Schematics
			11. Bill of Materials
			12. Other Data as Required

FORM 01 78 23-1 Page 5 of 5  
 CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			B. Each electrical and electronic system
			1. Description
			a. Equipment functions
			b. Normal operating characteristics
			c. Performance curves
			d. Engineering data
			e. Test data
			f. Replaceable parts list (with numbers)
			g. Nameplate data
			h. P&ID numbers
			2. Circuit and Panel Board Directories
			a. Electrical
			b. Controls
			c. Communications
			3. Instrumentation
			a. Loop Diagrams
			b. Components list each circuit/loop
			4. Operation Procedures
			a. Routine/normal operating instructions
			b. Sequences required
			c. Special operating instruction
			5. Maintenance Procedures
			a. Routine/normal instructions
			b. Troubleshooting guide
			c. Disassembly/reassembly
			d. Adjusting and checking
			6. Safety Precautions/Features
			7. Spare Parts List
			8. Additional Data

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EQUIPMENT DATA FORM

PROJECT NAME			
CONTRACT NO.			
CONTRACTOR			
EQUIPMENT NO.		ASSET NO.*	
DESCRIPTION		MAINT. NO.*	
LOCATION			
MANUFACTURER			
PURCHASED FROM			
VENDOR ORDER NO.		PURCHASE \$	
DATE OF PURCHASE			
LOCAL SUPPLIER			
ADDRESS			
PHONE NO.			
MODEL NO.			
NO. OF UNITS		SERIAL NOS.	
*By Owner			



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EQUIPMENT DATA FORM

NAMEPLATE DATA			
ELECTRIC MOTOR		PUMP/HVAC UNIT	
MANUFACTURER		MANUFACTURER	
TYPE	[ ] AC [ ] DC	TYPE	
HORSEPOWER		SIZE	
RPM		CAPACITY	
VOLTAGE		PRESSURE	
AMPERAGE		ROTATION	
PHASE		IMPELLER SIZE	
FRAME		IMPELLER MATERIAL	
DRIVE/REDUCER		OTHER (I&C)	
MANUFACTURER		MANUFACTURER	
TYPE	[ ] GEAR	TYPE	
	[ ] V-BELT		
	[ ] CHAIN	SIZE	
	[ ] VARIDRIVE		
SERVICE FACTOR		CAPACITY	
RATIO		RANGE	



LUBRICANT/RECOMMENDED SPARE PARTS LIST				
EQUIPMENT NO.			ASSET NO.*	
DESCRIPTION			MAINT. NO.*	
LUBRICANT LIST				
REFERENCE SYMBOL	LUBRICANT TYPE (MILITARY STANDARD)	RECOMMENDED LUBRICANT AND MANUFACTURER		
List symbols in "Maintenance Operation" (Page 3).	List general lubricant type.	List specific lubricant name, viscosity, and manufacturer.		
RECOMMENDED SPARE PARTS LIST				
PART NO. **	DESCRIPTION	UNIT	QUANTITY	UNIT COST
ADDITIONAL DATA AND REMARKS				
* By Owner ** Identify parts provided by this contract with two asterisks. Note: Attach additional sheets if necessary; identify each sheet at top with equipment number and description.				

END OF SECTION

## **DIVISION 02 – EXISTING CONDITIONS**

## SECTION 02 01 20

### PROTECTING EXISTING UNDERGROUND UTILITIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Protecting existing underground utilities as indicated and in compliance with Contract Documents.
  - 1. Removing and plugging abandoned lines.
  - 2. Compaction.
  - 3. Alternative support methods.
  - 4. Protecting thrust blocks.

##### 1.02 DEFINITIONS:

- A. Concrete: Refer to Section 03 30 00.

##### 1.03 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 013400.
  - 1. Record drawings to include record survey coordinates and elevations.
  - 2. Proposed locations for test pits.

##### 1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.

##### 1.05 PROJECT/SITE CONDITIONS:

- A. Pipelines will be indicated on the drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing utilities.

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Except as indicated, or as specifically authorized by the Engineer, where existing utilities to remain must be removed, reconstruct utilities with new material of the same size, type, and quality as that removed.

## PART 3 - EXECUTION

### 3.01 EXAMINATION:

- A. Comply with the requirements in Section 011005.
- C. Notify utility owners and Engineer at least 72 hours before digging operations are scheduled to begin.
- D. Test Pits: Excavate test pits to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

### 3.02 PREPARATION:

- A. Where utilities are parallel to or cross work, but do not conflict with work, notify the utility owner at least 48 hours in advance of construction at the crossing. Coordinate the construction schedule with the utility owner.

### 3.03 PROCEDURES:

- A. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise indicated or specified.
- B. Damage to Utilities to Remain: If existing utilities to remain are damaged, immediately notify utility owner, and repair to owner's satisfaction.

### 3.04 COMPACTION:

- A. Protecting Existing Utilities:
  - 1. Backfill and compact under and around utilities. Compaction shall conform to Section 31 23 00 and 31 23 33.
  - 2. Where compaction cannot adequately be performed around utility due to the presence of encroaching existing utilities, utilize concrete.

3.05 PROTECTION OF THRUST BLOCKS:

- A. Protect thrust blocks on existing waterlines or sewer force mains in place or shore to resist the thrust by a means accepted by the Engineer, and reconstruct. If the thrust blocks are exposed or rendered to be ineffective in the opinion of the Engineer, reconstruct them to bear against firm unexcavated or backfill material.
  - 1. Provide firm support by backfilling affected portion of the trench for a distance of 2 feet on each side of the thrust block to be reconstructed from the pipe bedding to the pavement subgrade with either:
    - a. Controlled low strength fill, or
    - b. Native material compacted to a relative compaction of 95 percent. See Section 31 23 33 for compaction requirements.
  - 2. Excavate the backfill material for construction of the thrust block.
  - 3. Test compaction of the backfill material before pouring any concrete thrust block. Concrete shall conform to Section 03 30 00.

3.06 CLOSEOUT ACTIVITIES:

- A. Provide in accordance with Section 017400.

END OF SECTION

## **SECTION 021001**

### **TEST PITS**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Contractor shall furnish all labor, materials, equipment, transportation, disposal, and incidentals as shown, specified or required for test pit excavation.
- B. Test pits shall be used to locate and determine depth, material, size, etc., of underground structures and utilities, or as directed by the Engineer.

##### 1.2 INFORMATION PROVIDED IN THE CONTRACT

- A. The Drawings depict the approximate location of underground structures and utilities. The Contractor shall be responsible to determine the actual location, depth, size, material, etc., of underground structures and utilities prior to site clearing and grubbing or excavation operations.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### 3.1 GENERAL

- A. The Contractor shall notify MISS Utility of Delmarva to obtain field mark out of utilities in the area where the Work is located before test pit excavation.
- B. The Contractor shall use methods and means as appropriate for excavating the test pit.
- C. Once an underground structure or utility is uncovered, the Contractor shall note all pertinent information.
  - 1. If the Contractor discovers an underground structure or utility location, depth, size, material, etc., that is different than what is depicted on the Drawings, and that difference requires revising the Contract or Drawings, the Contractor shall contact the Engineer prior to starting the Work.
  - 2. If no change in the Contract or Drawings is required, the Contractor shall note the proper location, depth, material, size, etc., on the as-built drawings.
- D. The Contractor shall backfill and restore the area disturbed, using the appropriate materials, to the existing conditions.

**END OF SECTION 021001**



## SECTION 021003

### PRECONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor shall furnish all labor, equipment and material necessary to record by video pre-existing conditions along the alignment, within the permanent and temporary construction easements, staging areas, and in the immediate vicinity of the Work.

##### 1.2 SUBMITTALS

- A. Provide the following information with each recording:
  1. Name of Project.
  2. Name and contact information for video photographer.
  3. Date video was taken.
  4. Description of vantage point, indicating location, direction (by compass point), and relevant address.

##### 1.3 QUALITY ASSURANCE

- A. The video photographer shall have experience as a photographer of construction projects.

#### PART 2 - PRODUCTS

##### 2.1 PHOTOGRAPHIC MEDIA

- A. All photographic documentation shall be provided on a DVD, external hard drive or suitable memory storage device acceptable to the Engineer.

#### PART 3 - EXECUTION

##### 3.1 CONSTRUCTION VIDEO

- A. Following issuance of "Notice to Proceed" and flagging of the Limits of Disturbance, but prior to mobilization or start of construction, the entire project area shall be videotaped to provide a visual record of preconstruction conditions. The Contractor is responsible for providing clear and distinct video documentation sufficient to evaluate the physical condition of all features within the Limits of Disturbance which shall include, but not be limited to; road surfaces, driveways, curbs, sidewalks, walls fences, trees, shrubs, lawns, flower beds, mailboxes, signs, pools, buildings and other structures.

- B. Particular attention shall be given to documenting pre-construction defects, such as cracks in walls or pavement, broken or diseased tree limbs or shrub branches, or any other defect that could become a potential damage claim.
- C. The Contractor shall submit digital recordings exactly as originally recorded by the digital camera, without alteration, manipulation, editing, or modifications using image or sound editing software.
- D. Include date and time in file name for each video recording as well as voice narration to identify images on the recording, this will include as a minimum the closest property address, distance to nearest intersection, identification of upstream and downstream manholes or construction stationing, and the compass orientation of the camera.
- E. A copy of the video recording shall be furnished to the Engineer before the Work begins.

**END OF SECTION 021003**

## **DIVISION 03 – CONCRETE**

SECTION 03 01 30  
CONCRETE REPAIR

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide materials labor, equipment, and services necessary to repair concrete as specified.
- B. Complete concrete repair operations in accordance with these specifications and the various system manufacturers' instructions regarding surface preparation, application, inspection and requirements for safety.
- C. Complete crack repair work in accordance with these specifications and crack repair material manufacturer's instructions.
- D. Complete joint repair work in accordance with these specifications and the joint repair material manufacturer's instructions.
- E. The areas of concrete repair shall be determined by the Contractor and the Engineer and shall include any location where acidic attack of the concrete surfaces has reached a depth of ½" or deeper and at any air voids, bug holes or poorly consolidated concrete areas where the specified filler/surfacer materials cannot be used for filling or surfacing of the concrete.
- F. If repair work is required for an area indicated to receive protective lining or coating, provide such repair in accordance with the requirements of this specification and the related lining or coating specifications.
- G. The repair work specified herein is intended to cover the requirements for repair of concrete only, to a maximum depth of approximately 4-inch. If after blasting and cleaning, an area is discovered that requires a repair greater than 4-inch deep, or an area is discovered that requires repair or replacement of reinforcing steel notify the Engineer so that details may be provided to the Contractor to complete the repair.

1.02 REFERENCES:

- A. National Association of Corrosion Engineers (NACE):
  - 1. 6D-173: "A Manual for Painter Safety"
  - 2. 6F-163: "Surface Preparation of Steel or Concrete Tank Interiors"
  - 3. TPC2: "Coatings and Linings for Immersion Service"
- B. American Concrete Institute (ACI):

1. [503.4](#): Standard Specification for Repairing Concrete with Epoxy Mortars

C. ASTM International (ASTM ):

1. [C33](#): Standard Specifications for Concrete Aggregates
2. [C150](#): Standard Specification for Portland Cement
3. [C321](#): Standard Test Method for Bond Strength of Chemical-Resistant Mortars
4. [C882](#): Test Method for Bond Strength of Epoxy Resin Systems
5. [D570](#): Test Method for Water Absorption of Plastics
6. [D638](#): Test Method for Tensile Properties of Plastics
7. [D695](#): Test Method for Compressive Properties of Rigid Plastics
8. [D790](#): Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
9. [D4262](#): L.R. Standard Test Method for pH of Chemically Cleaned or Acid Etched Concrete Surfaces
10. E329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
11. [E337](#): L.R. Standard Practice Test Method for Measuring Humidity with a Psychrometer.

1.03 MEASUREMENT:

- A. Crack Repair: The quantities in linear feet to be measured for payment shall be the actual length of cracks repaired by the methods and materials specified under.
  1. Epoxy crack repair.
  2. Flexible polyurethane crack repair.
  3. Rigid polyurethane crack repair.
- B. Spall Repair Depth 4-inch or less: The quantities in square feet to be measured for payment shall be the actual square footage of spalled concrete repaired by the method and materials specified under spall repair.
- C. Spall Repair Depth Greater Than 4-inch: The quantities in cubic feet to be measured for payment shall be the actual cubic footage of spalled concrete repaired by the method and materials specified under spall repair.

- D. Crystalline Waterproofing Crack and Joint Repair: The quantities in linear feet to be measured for payment shall be the actual length of joints repaired by the methods and materials specified under crystalline waterproofing crack and joint repair.
- E. Pipe Penetrations: The quantities in linear feet to be measured for payment shall be the actual circumference repaired by the methods and materials specified under pipe penetrations.
- F. Waterproofing Treatment: The quantities in square feet to be measured for payment shall be the actual square footage of concrete surface to which the coating shall be applied specified under waterproofing treatment.

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00.
  - 1. Procedures proposed for the accomplishment of repair work. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations to be coordinated with other works in progress.
  - 2. Manufacturer's recommendations and product data sheets for all repair materials including performance criteria, surface preparation, ambient condition requirements and applications, curing requirements, volatile organic compound (VOC) data, and safety requirements.
  - 3. Material Safety Data Sheets (MSDS) for any materials brought on-site including all repair system materials, solvents and abrasive blast media.
  - 4. Qualifications of foreman and epoxy gun operators and demonstration of meeting the minimum requirements specified.
  - 5. Design Mixes: Provide concrete and cement mortar in conformance with Section 03 30 00 and as specified herein.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Furnish the names of all subcontractors proposed for use for this work including necessary evidence and/or experience records to ascertain their qualifications in the application of epoxy, polyurethane, polymer-modified and cement-based compounds.
- C. Include in accepted applicator qualifications:
  - 1. A minimum of five years experience in applying epoxy, polyurethane and polymer-modified and cement-based compounds, and crystalline waterproofing repair systems similar to those specified in this Section.

2. A letter from the manufacturer of the specified materials, on the manufacturer's letterhead, signed by an officer of the company, stating that the subcontractor/applicator has been trained in the proper techniques for the preparation of the surface, and proper methods for mixing, placing, curing, and caring of the manufacturer's products. This letter shall further state that the subcontractor/applicator is on the manufacturer's approved list of contractors.
- D. Adhere strictly to the manufacturer's printed recommendations supplied with the product regarding temperature at time of application for all work. Do not use epoxy materials when either the temperature of the concrete to be repaired or the ambient temperature is below 50 degrees F 24 hours before, during, or for a period of 48 hours after the completion of the repair. Do not use crystalline waterproofing materials when either the temperature of the concrete to be repaired or the ambient temperature is below 40 degrees F 24 hours before, during, or for a period of 48 hours after the completion of the repair. Temporary heat may be used to meet the specified requirements.
  - E. Use new materials and use within the shelf life limitations set forth by the manufacturer. Clearly mark the shelf life limitations of each container.
  - F. The Contractor is ultimately responsible for the concrete repair work. Inspections by the Engineer or others do not limit the Contractor's responsibility.
  - G. Make all parts of the work accessible for inspections by the Engineer. Correct any conditions not in conformance with the specifications at no additional cost to the Owner.
  - H. Provide a Representative on site at all times when work is ongoing to represent the Contractor and to have authority to receive and execute all instructions given by the Engineer.
  - I. Allow changes in the specified repair work methods only with the permission of the Engineer.
  - J. Provide technical field support or training services required by the accepted material manufacturers at no additional cost to the Owner.
  - K. Provide materials from a single manufacturer for all components of a single repair.
- 1.06 SERVICES OF MANUFACTURERS REPRESENTATIVES:
- A. Provide the services of a qualified manufacturer's technical representative to instruct the Contractor's personnel in the mixing, proper use and application of the epoxy, polyurethane, polymer-modified, crystalline repair systems and cement-based compounds.
  - B. Provide written certification from the manufacturers' representative that materials have been mixed and applied properly and surfaces to receive these products have been prepared properly, all in conformance with manufacturer's requirements.

- C. Provide on-site time required for the manufacturer's representative to achieve a successful installation at no additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements in section 011006.
- B. Provide shelter to store materials in area or areas designated by the Owner solely for this purpose. Confine mixing, thinning, clean-up and associated operations and storage of repair mortar materials debris before authorized disposal, to these areas.
- C. Mix all specified materials in the sheltered mixing operation and materials from direct sunlight and inclement weather. Protect facilities from staining and damage.
- D. Do not dispose of waste materials on-site.
- E. Store waste temporarily in closed, nonflammable containers until final disposal. Keep no rubbish in Contractor's area longer than 24 hours.
- F. Deliver all materials to the job site in new, unopened containers. Each container shall bear the manufacturer's name and label. Labels on all material containers shall contain the following information:
  - 1. Name of product.
  - 2. Federal Specification Number if applicable.
  - 3. Manufacturer's batch number.
  - 4. Manufacturer's name.
  - 5. Generic type of material.
  - 6. Hazardous material identification label.
  - 7. Shelf life date.
- G. Clearly mark all containers indicating any safety hazards associated with the use of or exposure to the materials.
- H. Handle and store materials to prevent damage or loss of label. Protection of materials is the Contractor's responsibility.

1.08 PROJECT/SITE CONDITIONS:

- A. Environmental Requirements:
  - 1. Comply with the repair material manufacturer's recommendations as to environmental conditions under which materials can be applied and cured.



2. Do not apply materials when dust is being generated.
- B. Protection:
1. Cover or otherwise protect finish work or other surfaces not being repaired.
- C. Ventilation:
1. Provide ventilation to meet product requirements prior to, during, and after application.

## PART 2 - PRODUCTS

### 2.01 WATER:

- A. Use water free from injurious amounts of ice, oil, acid, alkali, salt, organic matter, or other deleterious substances and conforms to requirements of ASTM C1602.
- B. Water shall not contain more than 500 mg of chlorides or more than 500 mg of sulfates.
- C. Heat or cool water to obtain concrete repair product temperatures in accordance with manufacture's printed recommendations, and in accordance with ACI 305.1 and ACI 306.1.

### 2.02 AGGREGATE:

- A. All aggregates shall conform to ASTM C33 and section 03 30 00.

### 2.03 EPOXY BONDING AGENT:

- A. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives, depending on the application. The class of epoxy bonding agent shall be suitable for all ambient and substrate temperatures.

B. Products:

1. Sika Corporation; Sikdur 32 Hi-Mod
2. Euclid Chemical Company; Duralcrete
3. BASF Corporation; MasterEmaco ADH 326
4. Or acceptable equivalent product.

### 2.04 ANTI-CORROSION COATING:

- A. Anti-corrosion coating shall be a three-component, solvent free, and moisture tolerant epoxy-modified cementitious material.

B. Products:

1. Sika Corporation; Sika Armatec 110
2. Sto Corporation; CR 246
3. Euclid Chemical Company; Duralprep A.C.
4. Or acceptable equivalent product.

2.05 EPOXY CRACK REPAIR BINDER:

A. Epoxy crack repair binder shall be a two-component, 100 percent solids, high-modulus, low viscosity epoxy adhesive suitable for crack grouting by injection or gravity feed.

B. Products:

1. Sika Corporation; Sikadur 52
2. Euclid Chemical Company; Duralcrete LV
3. BASF Corporation; MasterInject 1380
4. Or acceptable equivalent product.

2.06 RIGID POLYURETHANE CRACK REPAIR MATERIAL:

A. Rigid polyurethane crack repair material shall be a one-component, water-activated polyurethane hydrophobic injection grout capable of 700 percent expansion. Polyurethane grout shall form a tough rigid foam seal that is impenetrable to water.

B. Products:

1. Euclid Chemical Company; Dural Aqua-Dam LV
2. Prime Resins; Prime Flex 920
3. Sika Corporation; Sikafix HH LV
4. Or acceptable equivalent product.

2.07 EPOXY REPAIR MORTAR:

A. Epoxy Repair Mortar shall be two-component, 100 percent solids, and 100 percent reactive epoxy resin system.

B. Spall repair mortar for use in horizontal applications.

1. Products:

- a. BASF Corporation; MasterEmaco ADH 327
  - b. Sika Corporation; Sikadur 22 Lo-Mod
  - c. Euclid Chemical Company; Euco #4565 Mortar
  - d. Or acceptable equivalent product.
- C. Spall repair mortar for use in vertical and overhead applications.
- 1. Products:
    - a. Sika Corporation; Sikadur 23 Lo-Mod Gel
    - b. BASF Corporation; MasterEmaco ADH 327
    - c. Or acceptable equivalent product.
- 2.08 SPALL REPAIRS USING NON-SHRINK CEMENTITIOUS MORTAR:
- A. Products:
- 1. BASF Corporation; MasterEmaco S 488CI
  - 2. Sika Corporation; Sika Repair 224
  - 3. Sauereisen, Inc.; Restokrete Underlayment No. F-120
  - 4. Or acceptable equivalent product.
- 2.09 SPALL REPAIRS USING POLYMER MODIFIED CEMENTITIOUS MORTAR:
- A. Repair spalls repair not requiring formwork using a two-component, polymer-modified cementitious mortar having a minimum 28-day compressive strength of 6,000 psi.
- B. Spall repair mortar for use in horizontal applications.
- 1. Products:
    - a. Sika Corporation; Sikatop 122 Plus
    - b. Euclid Chemical Company; Duraltop Flowable Mortar
    - c. BASF Corporation; MasterEmaco T302
    - d. Or acceptable equivalent product.
- C. Spall repair mortar for use in vertical applications.
- 1. Products:

- a. Sika Corporation; Sikatop 123 Plus
- b. Euclid Chemical Company; Duraltop Gel
- c. BASF Corporation; MasterEmaco N 423RS
- d. Or acceptable equivalent product.

#### 2.10 SPALL REPAIRS REQUIRING FORMWORK:

- A. Repair spalls repair requiring formwork using a two-component, polymer-modified cementitious mortar/pea gravel mixture and shall have a minimum 28-day compressive strength of 5,000 psi. Mix each unit of mortar with Saturated Surface Dry (SSD) pea gravel to form the repair material following the manufacturer's recommendations.
- B. Products:
  1. Sika Corporation; Sikatop 111 Plus
  2. Euclid Chemical Company; Duraltop Flowable Mortar
  3. BASF Corporation; MasterEmaco N 1500HCR Self Consolidated-Extended
  4. Or acceptable equivalent product.

### PART 3 - EXECUTION

#### 3.01 GENERAL REQUIREMENTS:

- A. Perform exterior work during dry weather and appropriate temperature conditions in accordance with the manufacturer's recommendations. Protect unfinished work during inclement weather with tarpulins or heavy gage polyethylene sheeting.
- B. Perform work in spaces within structures at temperature and conditions suitable for proper curing in accordance with the manufacturer's recommendations.
- C. Coordinate concrete rehabilitation work with other work being performed.
- D. Remove scaling, broken, loose and disintegrating materials by use of hand tools or power driven saws, down to solid unyielding material.
- E. Clean surfaces thoroughly of efflorescence, oils, grease and other objectionable material in area to be repaired in accordance with the manufacturer's recommendations.

#### 3.02 EPOXY BONDING AGENT:

- A. Use epoxy bonding agent to adhere fresh mortar to existing concrete. Roughen existing concrete surfaces prior to application of bonding agent. Concrete surface shall be clean

and sound, free of all foreign particles and laitance. Place repair material while bonding agent is still tacky or per the written instructions of the manufacturer. Reapply bonding agent if bonding agent cures prior to placement of repair material.

- B. Conform to all the requirements of ACI 503.4, and as specified herein.

### 3.03 ANTI-CORROSION COATING:

- A. Sandblast, clean and coat reinforcing steel that is cut or exposed during alteration and/or repair operations with an anti-corrosive coating.
- B. Cover all exposed parts of the steel with the coating and apply according to manufacturer's recommendations.

### 3.04 EPOXY CRACK REPAIR:

- A. Cracks on horizontal surfaces: When permitted by the Engineer repair existing cracks by gravity feeding an epoxy crack repair binder into the prepared crack.

1. Rout concrete surface at the crack to form a minimum 1/4-inch wide by 1/4-inch deep V-notch and clean to remove all loose and foreign particles. Fill crack with clean, dry sand and pour epoxy crack repair binder into V-notch, completely filling crack.
2. As binder penetrates into crack, apply additional binder to the V-notch.

- B. Cracks on vertical or horizontal surfaces: Repair cracks by pressure injecting an epoxy crack repair binder into the prepared crack. Seal cracked surfaces and install injection ports per manufacturer's recommendations.

1. Do not damage reinforcement steel when drilling holes for injection ports. If rebar is encountered during drilling, abandon the hole and relocate. Patch the abandoned hole immediately with epoxy mortar flush with the surface of the existing concrete.
2. Inject crack with epoxy crack repair binder once the surface sealing material has cured as directed by the manufacturer.
3. Remove injection ports upon satisfactory completion of crack injection and patch with epoxy mortar.

### 3.05 RIGID AND FLEXIBLE POLYURETHANE CRACK REPAIR:

- A. Repair leaking cracks by pressure injecting with a waterproof hydrophobic injection grout as directed by the Structural Engineer of Record. Seal crack surfaces and install injection ports per manufacturer's recommendations.

- B. Do not damage rebar when drilling holes for injection ports. If rebar is encountered during drilling, abandon the hole and patch immediately with epoxy mortar flush with the surface of the existing concrete.
- C. Inject crack with hydrophobic injection grout as directed once the surface sealing material has cured, as directed by the manufacturer.

3.06 SPALL REPAIR:

- A. Saw cut the perimeter of the repair area to a minimum depth of 1/4-inch below the surface of the concrete. Chip all loose concrete in the repair area to remove loose and degraded concrete to a minimum of 1/4-inch or until a sound substrate is reached. Clean the area to be repaired and restore to the original dimensions with spall repair patching material according to the manufacturer's recommendations.
- B. Make final finished surface of patches flat, level and even with the existing concrete surface. Do not feather repair mortar to meet existing concrete surface.
- C. Finish final patches on horizontal surfaces consistent with the finish on the existing structure.

3.07 CURING:

- A. Cure repair materials in accordance with manufacturer's printed instructions.

3.08 CLEANING:

- A. Mechanically remove excess material from walls, floors, etc. after material has cured.
- B. Clean excess materials caused by work under this Section from existing surfaces by the use of power sanders. Vacuum surfaces to receive final cleaning and finishing specified under other sections of the specifications. Sand cracks flush to adjacent surfaces.
- C. Remove misplaced sealants using methods and materials recommended by the manufacturers. Leave finished work and work area in a neat and clean condition.

3.09 LEAKAGE TESTING

- A. Provide leakage testing in accordance with Section 03 05 10.
- B. Leak test all cells in the single test. Do not test cells individually.

3.10 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400

END OF SECTION

## SECTION 03 05 10

### LEAKAGE TESTING OF CONTAINMENT STRUCTURES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section describes the method of testing concrete containment structures for leakage. All containment structures shall be leak tested unless specifically exempted by the Engineer.

##### 1.02 REFERENCES:

- A. American Concrete Institute (ACI):
  - 1. [350.1](#): Tightness Testing of Environmental Engineering Concrete Structures and Commentary.

#### PART 2 - PRODUCTS

##### 2.01 MATERIALS:

- A. Provide piping and equipment to test concrete structures for leakage as described herein.

#### PART 3 - EXECUTION

##### 3.01 GENERAL:

- A. Hydrostatically test reinforced concrete structures which will contain fluids to determine that they conform to leakage criteria specified herein and are free of detectable leaks. Do not hydrostatically test walls that are to be restrained or laterally supported by slabs until slab concrete has obtained the specified compressive strength.
- B. Prior to testing, clean exposed surfaces by thoroughly hosing and removing surface laitance and loose matter from walls and slabs. Remove wash water and debris from the structures by means other than washing through plant piping. All potential leakage points shall be identified and repaired prior to filling the tank with water for the tightness test. Methods for repairing concrete shall be as described in Section 03 01 30.
- C. No backfilling, floor finish, concrete or mortar fill, wall insulation, gas proofing or protective coatings shall be applied to or installed in any new containment structures until they have been subjected to loading for settlement and tested for leakage. Testing shall not be done until the concrete has reached its specified design strength.

### 3.02 PRELOADING TEST:

- A. For the Preloading Test the Contractor shall maintain the liquid level in the structures at the design maximum water level for 72-hours. If the characteristics of settlement of the structure so require, the loading shall continue for a longer period to permit the necessary consolidation of the foundation material, in which case the Contractor shall be entitled to no extra compensation, but a commensurate extension of time for completion of the whole work under this contract shall be allowed.

### 3.03 LEAK TEST PROCEDURE:

- A. Leakage testing shall meet the provisions of ACI 350.1 – Tightness Testing of Environmental Engineering Concrete Structures. The test criterion shall be HST-050 (0.050 percent per day) as defined by ACI 350.1
- B. During the test period, the excavation around the structure shall be kept dewatered by the Contractor. Dewatering shall maintain the groundwater level to below the top of the base slab. The Contractor shall temporarily seal all bottom openings and wall openings below maximum water level in the structures, furnish and fill the structures to the design maximum water level with clean water. The Contractor shall make his own arrangements for handling the water for testing and its transfer from one structure to another and its final disposal.
- C. Filling rate shall not exceed a 4 feet per hour or as permitted by the Engineer. Filling shall be at a uniform rate with continuous monitoring.
- D. During the leakage test period, the Engineer will inspect the structure for leakage or change in volume. If moist spots become visible, indicating the existence of minor leaks, or if the water level indicates hidden leakage, the Contractor shall furnish all materials and do all work necessary to locate the leaks and make the structure watertight to the complete satisfaction of the Engineer. No additional compensation will be allowed for such work.
- E. If, in the opinion of the Engineer, during the course of the test weather conditions are such that it becomes difficult to accurately monitor the water level in the tank, the test shall be stopped, and started over again when weather permits, at no additional cost to the Owner.
- F. On conclusion of the test, the Contractor shall pump or drain the water from the structure and dispose of it without damage to structures or surrounding facilities.
- G. The structure will be considered as passing the water tightness test when no wet spots are observed on the exterior surfaces of the containment structure during the water tightness test period and when the measured loss is less than the maximum specified



3.04 REPAIR METHODS

- A. Methods for repairing concrete not passing the leakage test shall be as described in Section 03 01 30.

3.05 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400

END OF SECTION

SECTION 03 10 00  
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide design and furnish materials for fabricating, erecting and removing formwork, false work and shoring for cast-in-place concrete as shown on the contract drawings and specified herein for a complete installation. The use of stay-in-place forms is expressly prohibited.
- B. Use formwork to cast all cast-in-place concrete structures.
- C. Provide and remove all formwork for architectural, civil, mechanical, and electrical work as shown on the drawings or specified under specified under those disciplines.

1.02 REFERENCES:

- A. American Concrete Institute (ACI):
  - 1. [117/117R](#): Standard Tolerances for Concrete Construction and Materials.
  - 2. [309.2R](#): Identification and Control of Visible Effects of Consolidation on Formed Concrete Surfaces.
  - 3. [318/318R](#): Building Code Requirements for Structural Concrete and Commentary.
  - 4. [347](#): Guide to Formwork for Concrete.
  - 5. [350/350R](#): Code Requirements for Environmental Concrete Structures and Commentary.
- B. Engineered Wood Association (APA)
- C. National Institute of Product Standards and Technology
  - 1. Voluntary Product Standard PS 1 Structural Plywood

1.03 DESIGN REQUIREMENTS:

- A. Design formwork in conformance with methodology of ACI 347R for anticipated loads, lateral pressures, depth of concrete placement and rate of concrete placement. Design shall consider any special requirements due to the use of self consolidating, plasticized and/or retarded set concrete. All forms and shoring shall be designed at the contractor's expense.

1.04 QUALIFICATIONS:

- A. Formwork Designer: Formwork, false work, and shoring design shall be by an engineer licensed in the state where the Project is located.

1.05 SUBMITTALS:

- A. Submit product data for form ties, spreaders, chamfer strips, rustication strips, form liners, form coatings, and bond breakers.
- B. Submit following shop drawings in accordance with 01 33 00.
  - 1. Layout of panel joints and tie hole pattern for architectural formwork.
  - 2. Form Ties: Submit data sheets for form ties proposed for use.
  - 3. Form Ties-Tapered Through-Bolts: Proposed method of sealing and patching form tie holes.

1.06 QUALITY ASSURANCE:

- A. Comply with requirements in section 01 43 00 and as specified.
- B. Design of Formwork:
  - 1. The Contractor shall assume responsibility for the design, engineering and construction of formwork. Forms shall be designed to produce concrete members identical in shape, lines and dimensions to members shown on the Contract Documents.
  - 2. When high range water reducer (superplasticizer) is used in concrete mix or when self consolidated concrete is specified, forms shall be designed for full hydrostatic pressure per ACI 347.
  - 3. The formwork shall be designed for the loads and lateral pressures in accordance with ACI 347 and wind loads as specified by the local building code.
  - 4. Construction and contraction joints, openings, offsets, keyways, recesses, moldings, chamfers, blocking, screeds, bulkheads, waterstops, anchorages, inserts, and other features shall be provided.
  - 5. Formwork shall be designed to be readily removable without impact, shock, or damage to 'green' concrete surfaces and adjacent materials.
  - 6. The maximum panel deflection shall be  $L/360$  of the span between structural members.
- C. Unless otherwise specified herein, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits as given in ACI 117.

- D. Materials, fabrications and workmanship found defective shall be promptly removed and replaced and new acceptable work shall be provided in accordance with Contract requirements at no additional cost to the owner.

1.07 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements in section 011006.
- B. Materials shall be delivered to the site in an undamaged condition and at such intervals as will avoid delay in the work.
- C. Material shall be stored and protected in a clean, properly drained location. Material shall be kept off the ground under a weather-tight covering permitting good air circulation. Formwork materials shall be stored on dry wood sleepers, pallets, platforms or other appropriate supports which have slope for positive drainage. Materials shall be protected from distortion, excessive stresses, corrosion and other damage. Materials shall not be stored on the structure in a manner that might cause distortion or damage to the supporting structure.

PART 2 - PRODUCTS

2.01 LUMBER:

- A. Lumber used in form construction shall be Douglas fir, No. 2 grade, S4S, Standard Grading and Dressing Rules No. 16, West Coast Lumber Inspection Bureau; or Southern Yellow Pine, No. 2, S4S, Standard Grade Rules Southern Pine Inspection Bureau. Boards shall be 6 inches or more in width.

2.02 PLYWOOD:

- A. Only grade-marked plywood conforming to APA shall be provided.
- B. Plywood used in form construction shall be Grade B-B, Class 1 plyform, mill-oiled, and sanded on both sides in conformance with U.S. Product Standard PS 1 Structural Plywood.
- C. Thickness shall be sized to maintain alignment and surface smoothness, but not less than 5/8-inch thick.

2.03 STEEL FORMS:

- A. Commercial grade sheets not less than 16 gage shall be provided.
- B. Stock material that is free from warps, bends, kinks, cracks, and rust or other matter that could stain the concrete shall be provided.

## 2.04 FORM MATERIAL LOCATIONS:

- A. Wall Forms and Underside of Slabs and Beams:
  - 1. Materials: Plywood, hard plastic finished plywood or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
- B. Column Forms:
  - 1. Rectangular Columns: As specified for walls.
- C. All Other Forms: Materials as specified for wall forms.
- D. Rustication Grooves and Chamfer Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

## 2.05 FORM TIES:

- A. Locate form ties on exposed surfaces in a uniform pattern. Place form ties so they remain embedded in the concrete except for a removable portion at each end. Form ties shall have conical or spherical type inserts with a maximum diameter of 1 inch. Construct form ties so that no metal is within 1-1/2 inch of the concrete surface when the forms, inserts, and tie ends are removed. Do not use wire ties. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.
- B. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 1-1/2 inch and sufficient dimensions to permit patching of the tie hole.
- C. Tapered form ties shall be tapered through-bolts or through-bolts that utilize a removable tapered sleeve.
- D. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
  - 1. Integral steel water stop 0.103 inch thick and 0.625 inch in diameter tightly and continuously welded to tie.
  - 2. Neoprene water stop 3/16-inch thick and 15/16 inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.
- E. Elastic Vinyl Plug:
  - 1. Design and size of plug shall allow insertion with tool to enable plug to elongate and return to original length and diameter upon removal forming watertight seal.
  - 2. Manufacturer:

- a. Dayton Superior; A58 Sure Plug.
  - b. Or acceptable equivalent product.
- F. Mechanical EPDM Rubber Plug:
  - 1. Mechanical plug for taper tie
  - 2. Manufacturers:
    - a. Sika Greenstreak, St. Louis, MO; X-Plug
    - b. Or acceptable equivalent product.
  - 3. Friction fit plugs shall not be allowed.
- 2.06 BOND BREAKER:
  - A. Bond breaker shall be a V.O.C.-compliant nonstaining type that will provide positive bond prevention.
  - B. Manufacturers:
    - 1. Edoco Burke; Clean Lift 90 W.B.
    - 2. Nox-Crete, Inc.; Silcoseal 97EC.
    - 3. Or acceptable equivalent product.
- 2.07 FORM CAULKING:
  - A. Form caulking shall be a one-component, gun-grade silicone sealant that is capable of producing flush, watertight and non-absorbent surfaces and joints. Sealant shall be compatible with the type of forming material and concrete ingredients used.
  - B. Products:
    - 1. Series 1200 Construction Caulking; GE Silicones.
    - 2. Dow Corning 999-A; Dow Corning Co.
    - 3. Sikasil WS-295; Sika Corporation.
    - 4. Or acceptable equivalent product.

2.08 CHAMFER STRIPS:

- A. Provide 3/4 inch by 3/4-inch chamfer strips milled from clear, straight-grain pine, surfaced each side or extruded vinyl type with or without nailing flange unless otherwise shown on the Contract Documents.

2.09 FORM RELEASE AGENT:

- A. Form release agent shall not bond with, stain, or adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces. Form release agent shall be a ready-to-use water-based material formulated to reduce or eliminate surface imperfections and containing no mineral oil or organic solvents.
- B. Manufacturers and Products:
  - 1. BASF; MBT, Rheofinish 211.
  - 2. Cresset Chemical Company; Crete-Lease 20-VOC.
  - 3. Unitex Chemicals; Farm Fresh.
  - 4. Symons Corporation: Magic Kote
  - 5. Or acceptable equivalent product.

PART 3 - EXECUTION

3.01 FORM TOLERANCES:

- A. Comply with the requirements of ACI 117 for tolerances for formed surfaces except as specified in Table 03 10 00-1.

<b>Table 03 10 00-1</b>	
Vertical alignment (plumbness)	1/4-inch in any 10 feet and 1-inch maximum for entire length
Variation in the lines and surfaces of foundation mats, base slabs and walls	1/4-inch in any 10 feet and 1-inch max. for entire length
Variation from the level or from the grades indicated on the drawings	1/4-inch in any 10 feet
Variation of the linear building lines from established position in plan	1/2-inch in any 20 feet and 1-inch maximum for entire length
Variation of distance between walls	1/4-inch in any 10 feet and 1-inch maximum for entire length and height
Variation in the sizes and locations of sleeves, floor openings and wall openings	Minus 1/4-inch Plus 1/2-inch

Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 1/4-inch Plus 1/2-inch
Offset between adjacent panels of formwork facing material	1/2-inch (ACI 117 Class C finish).
Offset between adjacent panels of formwork facing material for exposed surfaces where appearance is of importance	1/8-inch (ACI 117 Class A finish).

- B. Tolerances are not cumulative
- C. Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.
- D. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejection of the concrete work. Rejected work shall be repaired or replaced at no additional cost to the Owner.

### 3.02 PREPARATION:

- A. Clean form surfaces to be in contact with concrete of foreign material prior to installation. Tape, gasket, plug, and/or caulk joints, gaps, and apertures in forms so that the joint will remain watertight and withstand placing pressures without bulging outward or creating surface irregularities.
- B. Coat form surfaces in contact with concrete with a form release agent prior to form installation.
- C. Keep form coatings off steel reinforcement, items to be embedded, and previously placed concrete.
- D. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.
- E. Form liners for architectural concrete finish shall be installed in accordance with the manufacturer's recommendations.

### 3.03 ERECTION AND INSTALLATION:

- A. Forms shall be constructed in accordance with ACI 347 to required dimensions, plumb, straight and mortar tight. Forms shall be substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subject. Unless otherwise indicated on the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits in ACI 117 and herein specified.



- B. Provide means for holding adjacent edges and ends of form panels tight and in accurate alignment to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete.
- C. Provide one cleanout and inspection opening 12 inches wide by 18 inches high every 7 feet at the bottom of each lift of forms.
- D. Provide exterior corners of concrete members with chamfers as specified.
- E. Provide means for removing forms without injury to the surface of finished concrete.
- F. Do not embed any form-tying device or part thereof other than metal in the concrete.
- G. Locate large end of taper tie on the "wet" side of the wall.
- H. Use only form or form-tying methods that do not cause spalling of the concrete upon form stripping or tie removal.
- I. Form surfaces of concrete members except where placement of the concrete against the ground is shown in the drawings or as indicated below. The dimensions of concrete members shown in the drawings apply to formed surfaces, except where otherwise indicated. Add 2 inches of concrete where concrete is placed against trimmed undisturbed ground in lieu of forms. Placement of concrete against the ground shall be limited to footings and other nonexposed concrete and only where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing.
- J. Provide openings with continuous keyways and water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with additional reinforcement as shown in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.
- K. Set anchor bolts and other embedded items accurately before placing concrete and hold securely in position until the concrete is placed and set. Check special castings, channels, or other metal parts that are to be embedded in the concrete prior to and again after placing concrete. Check nailing blocks, plugs, and strips necessary for the attachment of trim, finish, and similar work prior to placing concrete.

#### 3.04 PROTECTION:

- A. During installation, the forms shall not be used as a storage platform nor as a working platform until the forms have been permanently fastened in position.

#### 3.05 PIPES AND WALL CASTINGS CAST IN CONCRETE:

- A. Install wall castings, wall flanges, and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall castings or anchors to the reinforcing steel.

- B. Pipes or wall castings located below operating water level shall have water stop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast unless permitted, authorized or directed by the Engineer. Pipes fitted with thrust rings shall be cast in place.

3.06 REMOVAL OF FORMS:

- A. Forms shall be removed in accordance with ACI 347 recommendations without damage to concrete and in a manner to ensure complete safety to the structure. Forms, form ties and bracing shall not be removed without specific permission of the Contractor's Registered Professional Engineer.
- B. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed; during which the air surrounding the concrete is above 50 degrees F.

<b>Table 03 10 00-2</b>	
Sides of footings and encasements; Walls; Vertical sides of slabs, beams, girders; Columns; Similar members not supporting loads.	24 hours
Bottom forms of slabs, beams, and girders; and shoring for slabs, beams, and girders with immediate reshoring.	Until concrete strength reaches 70 percent specified 28-day strength
Bottom forms of slabs, beams, and girders; and shoring for slabs, beams, and girders without reshoring	Until concrete strength reaches specified 28-day design strength

- C. Removal times will be increased if the concrete temperature following placement is permitted to drop below 50 degrees F.
- D. Do not remove supports and reshore.

3.07 PATCHING OF TAPERED TIE HOLES:

- A. Clear tie hole of all loose debris with a taper tie void brush and flush debris from tie hole with air or water.
- B. Install plug from larger tie hole end in accordance with manufacturer's instructions using an insertion tool as recommended by the manufacturer.
- C. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 03 15 00

### CONCRETE JOINTS AND ACCESSORIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section describes materials, testing, and installation of concrete joints and accessories as specified and as shown on contract drawings.

##### 1.02 REFERENCES:

- A. ASTM International (ASTM):

1. [A276](#): Standard Specification for Stainless Steel Bars and Shapes.
2. [C920](#): Specification for Elastomeric Joint Sealants
3. [C1193](#): Guide for Use of Joint Sealants
4. [D1752](#): Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

- B. Environmental Protection Agency (EPA):

1. [40 CFR 59](#): National Volatile Organic Compound Emission Standards for Consumer and Commercial Products.

- C. Corps of Engineers:

1. CRD-C 572: Specifications for Polyvinylchloride Waterstop.

- D. Federal Specifications:

1. TT-S-00230C: Sealing Compound: Elastomeric Type, Single Component

##### 1.03 SUBMITTALS:

- A. Submit following shop drawings in accordance with 01 33 00.

1. Manufacturer's printed data and application instructions for specified materials and locations where materials are to be used.
2. Submit one sample of each type of water stop.
3. Submit layouts for joints.

4. Certification that materials used within the joint system are compatible with each other.

1.04 QUALITY ASSURANCE:

- A. Comply with requirements in section 01 43 00 and as specified.
- B. Do not add, relocate or omit joints without written permission from the Engineer.
- C. Reject material exceeding expiration date for use.
- D. Clean concrete surfaces to receive expansion joint compound in accordance with the printed instructions of the joint compound manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements in section 011006.
- B. Transport, handle and deliver materials to the job site in the manufacturer's sealed bags, unopened containers or banded pallets.
- C. Store materials off the ground on a platform or skids and protect with covers from snow, rain and ground splatter.
- D. Store expansion joint compounds in a dry location where they cannot freeze.
- E. Store plastic products under cover in a dry location, out of direct sunlight.

1.06 MANUFACTURER'S SERVICES:

- A. Prior to joint preparation for joints receiving sealant materials, require joint manufacturer's technical representative to demonstrate, on site, joint preparation, priming, and sealant materials application for the Contractor's personnel performing joint work.

## PART 2 - PRODUCTS

2.01 ELASTOMERIC JOINT SEALANT:

- A. Federal Specification TT-S-00230C Type 1, Class A, single component, cold applied, pourable, polyurethane.
  1. Products:
    - a. Euclid Chemical Corp; Eucolastic 1
    - b. Mameco ; Vulkem 45

- c. Or accepted equivalent product.

2.02 JOINT SEALANT FOR CONCRETE STRUCTURES:

- A. Joint sealant shall be a multipart, gray, nonstaining, nonsagging, gun grade polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall comply with ASTM C920, Type M, Grade P, Class 25 for horizontal joints and Grade NS, Class 25 for vertical joints and be recommended by the manufacturer for continuous immersion in water. Troweling of sealants into joints will not be permitted. Sealant shall meet requirements in Table 03 15 10-1.

<b>TABLE 03 15 10-1</b>	
<b>Characteristic or Parameter</b>	<b>Technical Requirements</b>
Pot life	1 to 3 hours
Hardness	35 Shore A, +/- 5
Elongation	650 percent, ASTM D412
Tensile strength	200 psi, ASTM D412
Peel strength on concrete	No adhesion loss at 25 pounds
Temperature service range	40 to 167 degrees F
Immersion in water	Continuous

- B. Products:
  - 1. Tremco; Vulkem 227 or Vulkem 245 (for Type M, Grade P, Class 25)
  - 2. Sika Corporation; Sikaflex-2CNS (for Grade NS, Class 25), Sikaflex-2CSL
  - 3. Or accepted equivalent product.
- C. For applications on walls and surfaces inclined more than 30 degrees from the horizontal, use multi-component chemical resistant polysulfide sealant conforming to ASTM C920, Type M, Grade NS, Class 25.
  - 1. Sonneborn ; Sonolastic Two-part
  - 2. Tamms; Hornflex-L
  - 3. DuPont; Cormax PSC
  - 4. Or accepted equivalent product.

2.03 EPOXY JOINT SEALANT:

- A. 100 percent solids per ASTM D1259, two-part epoxy with an instantaneous Shore D hardness of 50 to 65 per ASTM D2240.

1. Metzger-McGuire Co.; MM80 or Edge Pro50
2. Euclid Chemical Corp. ; Euco700
3. Or accepted equivalent product.

2.04 BACKING ROD FOR EXPANSION JOINTS:

- A. Provide an extruded closed-cell polyethylene foam rod. The rod shall be 1/4-inch larger in diameter than the joint width. Where possible, provide full-length sections for the joint; minimize splices.
  1. Industrial Systems Department; Minicel backer rod
  2. Hercules, Inc.; Plastic Products Group
  3. Or accepted equivalent product.

2.05 BOND BREAKER TAPE:

- A. Provide an adhesive-backed glazed butyl or polyethylene tape that will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.06 PREMOLDED JOINT FILLER FOR PAVEMENTS AND SLABS:

- A. Joint filler shall be preformed, nonextruded type constructed of closed-cell neoprene conforming to ASTM D1752, Type I
- B. Bituminous-type preformed expansion joint filler conforming to ASTM D994.

2.07 VOC LIMITS FOR SEALANTS, AND SEALANT PRIMERS:

- A. VOC limits for sealants, and sealant primers to comply with content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24), or applicable state and local codes containing more stringent requirements.

2.08 BOND BREAKER FOR JOINT COMPOUNDS:

- A. Provide polyethylene tape.

PART 3 - EXECUTION

3.01 JOINTS:

- A. Make joints only at locations shown on the contract drawings or as permitted by the Engineer. Any addition or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written permission.

- B. Relocate additional joints where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. If a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footing or floor slabs.
- C. Cast slabs and beams monolithically without horizontal joints unless specifically indicated on the drawings.
- D. Do not use horizontal joints within foundation mats, base slabs, footings, pile caps, slabs on grade or elevated beams and slabs.
- E. Provide joints in concrete fills and toppings at the same location as the joints in the supporting concrete.
- F. Provide waterstops in all wall and slab joints in liquid containment structures and at locations shown on the contract Drawings. Do not provide metal waterstops unless permitted by Engineer.
- G. Construction Joints
  - 1. Provide flat ribbed waterstops at construction joints where shown on contract drawings and specified herein.
  - 2. Where joint key ways are shown on contract drawings form keyways by beveled strips or boards placed at right angles to the formed face. Except where otherwise shown on contract drawings or specified, keyways shall be at least 1-1/2 inches in depth over at least 25 percent of the width of the section.
  - 3. After the placement has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire surface of the joint of surface laitance, loose concrete, foreign material, and expose clean aggregate by sandblasting or waterblasting the surface of construction joints before placing the new concrete. Cover horizontal construction joints with mortar. Spread uniformly and work thoroughly into irregularities of the surface. The water-cement ratio of the mortar in place shall not exceed that of the concrete to be placed, and the consistency of the mortar shall be suitable for placing and working.
  - 4. In case of emergency, place additional construction joints. (An interval of 45 minutes between two consecutive batches of concrete shall constitute cause for an emergency construction joint.)
- H. Control Joints:
  - 1. Do not use of control joints in liquid containment structures.
  - 2. Locate control joints as shown on the Contract Drawings.



3. Form control joints with control joint inserts or sawcuts.
4. For sawcutting:
  - a. Using early entry saws, saw joints in slabs before the formation of uncontrolled cracking (i.e., cracking that occurs at locations other than construction, control, or contraction joints) and as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing.
  - b. Fill saw cut to full depth with elastomeric joint sealant for joints not exposed to vehicular traffic. Fill joints to full depth with epoxy joint sealant for joints exposed to vehicular traffic.
5. Unless noted otherwise on the Contract Drawings, total reduction in concrete member thickness shall be at least 1/4 the member thickness.

#### 3.02 INSTALLATION OF JOINT SEALANTS:

- A. Immediately before installing the joint sealant, clean the joint cavity by sandblasting or power wire brushing. Install bond breaker tape per manufacturer's instructions.
- B. Apply masking tape along the edges of the exposed surface of the exposed joints.
- C. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the recommendations of the sealant manufacturer.
- D. After the joints have been prepared as described above, apply the joint sealant. Apply the primer, if required, and joint sealant only with the equipment and methods recommended by the joint sealant manufacturer.
- E. Trowel the joints smooth with a tuck pointing tool wiped with a solvent recommended by the sealant manufacturer.
- F. After the sealant has been applied, remove the masking tape and any sealant spillage.
- G. Sealants used in water retaining structures shall achieve final cure at least seven days before the structure is filled with water.

#### 3.03 LEAKAGE TESTING:

- A. Test hydraulic structures in accordance with Section 03 05 10.

#### 3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 03 15 13

### NON-EXPANDING WATERSTOPS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide polyvinyl chloride (PVC) waterstops in construction between dry areas and sources of liquid, between dry areas and the ground, and between sources of liquid and the ground as indicated on the drawings and specified herein.

1. Waterstops shall form a continuous watertight diaphragm to prevent leakage.
2. Provide 6" ribbed waterstops in construction joints.

##### 1.02 REFERENCES:

- A. ASTM International (ASTM):

1. [D412](#): Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
2. [D570](#): Standard Test Method for Water Absorption of Plastics
3. [D624](#): Standard Test method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
4. [D638](#): Standard Test Method for Tensile Properties of Plastics
5. [D746](#): Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
6. [D747](#): Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
7. [D792](#): Standard Test Methods for Density and Specific Gravity of Plastics by Displacement.
8. [D1171](#): Standard Test Method for Rubber Deterioration – Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
9. [D1259](#): Standard Test Methods for Nonvolatile Content of Resin Solutions.
10. [D2240](#): Standard Test Method for Rubber Property – Durometer Hardness

- B. Corps of Engineers:

1. CRD-C 572: Specifications for Polyvinylchloride Waterstop.

1.03 SUBMITTALS:

A. Submit following shop drawings in accordance with 01 33 00.

1. Manufacturer's printed data and application instructions for specified materials and locations where materials are to be used.

1.04 QUALITY ASSURANCE:

A. Comply with requirements in section 01 43 00 and as specified.

B. Reject waterstops containing scrap or reclaimed material or pigment.

C. Position waterstops in construction as indicated.

D. Use factory made and tested crosses, tees and ells at corners and intersections.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements in section 011006.

B. Transport, handle and deliver materials to the job site in the manufacturer's sealed bags, unopened containers or banded pallets.

C. Store materials off the ground on a platform or skids and protect with covers from snow, rain and ground splatter.

D. Store plastic products under cover in a dry location, out of direct sunlight.

PART 2 - PRODUCTS

2.01 PVC WATERSTOP:

A. Provide polyvinyl chloride waterstops manufactured from virgin polyvinyl chloride plastic compound conforming to Corps of Engineers Specification CRD-C572.

B. Provide waterstops of type, shape and size indicated with looped galvanized steel wire or grommets spaced at 12 inches on center along both edges.

C. Provide factory-made crosses, tees and ells fabricated by the waterstop manufacturer using thermostatically controlled electric heat source.

D. Provide waterstops resistant to chemical action with Portland cement, alkalis, acids, and not affected by mildew or fungi. It shall show no effect when immersed for 10 days in a 10 percent solution of sulfuric or hydrochloric acid, saturated lime solution or salt water.

Water stops shall be such that any cross section will be dense, homogeneous, and free from porosity and other imperfections. They shall be symmetrical in shape.

E. The material shall meet the requirements in Table 03 15 10-1.

<b>TABLE 03 15 10-1</b>		
<b>Property</b>	<b>Test Method</b>	<b>Limit</b>
Water Absorption	ASTM D 570	5% maximum
Tear Resistance	ASTM D 624	250 #/inch minimum
Ultimate Elongation	ASTM D 638	300% minimum
Tensile Strength	ASTM D 638	1750 psi minimum
Low Temperature Brittleness	ASTM D 746	No Failure at - 35°F
Stiffness in Flexure	ASTM D 747	600 psi minimum
Ozone Resistance	ASTM D 1149	No Failure
Volatile Loss	ASTM D 1203	0.50% maximum
Hardness, Shore A	ASTM D 2240	65 to 80
Tensile strength after accelerated extraction	CRD C 572	1500 psi minimum
Elongation after accelerated extraction	CRD C 572	280% minimum
Effect of Alkalis after 7 days - Weight Change	CRD C 572	-0.10% to +0.25%
Effect of Alkalis after 7 days - Hardness Change	CRD C 572	+5 maximum

F. PVC waterstops for construction joints: Flat ribbed type, 6 inches wide with a minimum thickness of 3/8-inches.

1. Products:

- a. Greenstreak: Model 679
- b. Vinylex; Model R638
- c. BoMetals, Inc.; Model TFR-638
- d. Or accepted equivalent product.

## PART 3 - EXECUTION

### 3.01 FABRICATION:

- A. Make all splices on a bench following manufacturer's printed instructions and splicing procedures.
- B. Use miter guide and portable power saw to cut spliced ends.
- C. Maintain continuity of characteristic features of waterstop cross section including ribs through splice.
- D. Remove looped steel wire along both edges of waterstop adjacent to saw cut prior to splicing.
- E. Make splices by heat sealing adjacent surfaces using a thermostatically controlled electric heat source in conformance with manufacturer's printed instructions.
- F. Reform waterstop at splices using a remolding iron having a pattern matching the waterstop.
- G. If splice shows any separation or lack of fusion, reject the splice, re-cut back at least one inch from rejected splice each side, re-weld.
- H. Replace or repair damaged or punctured waterstops in conformance with manufacturer's printed instructions at no additional cost to the Owner.
- I. Clean waterstops of curing compound, foreign materials and protrusions of hardened concrete and mortar.
- J. Provide waterstops with an integral fastening system consisting of grommets or pre-punched holes.

### 3.02 INSTALLATION:

- A. Place waterstop to form a continuous watertight diaphragm in joints.
- B. Center waterstops in joints unless otherwise indicated.
- C. Install waterstops in continuous lengths to minimize field splices.
- D. Maintain 1-in. minimum clearance between waterstop and reinforcement and embedded items.
- E. Use factory-made crosses, tees and ells at all corners and intersections.
- F. Do not fold waterstops against bulkhead forms.

- G. Secure waterstops in position with tie wire from loops to adjacent reinforcement on both sides every 12 in. along each edge.
  - H. Consolidate concrete during placement in vicinity of waterstop without damaging or dislodging waterstop.
  - I. Protect exposed waterstop from damage.
  - J. Terminate vertical waterstops three inches below top of concrete walls in open tanks, at the underside of elevated framed slabs that are above maximum process liquid levels and above finish grade in exterior foundation walls.
  - K. Do not use split waterstops.
- 3.03 CONTRACT CLOSEOUT:
- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 03 15 16

### EXPANDING WATERSTOPS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section describes materials, testing, and installation of concrete joints and accessories as specified and as shown on contract drawings.

##### 1.02 REFERENCES:

- A. ASTM International (ASTM):
  1. [D638](#): Test Method for Tensile Properties of Plastic.
  2. D1149: Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
  3. D1203: Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods.
  4. [D2240](#): Standard Test Method for Rubber Property – Durometer Hardness

##### 1.03 SUBMITTALS:

- A. Submit following shop drawings in accordance with 01 33 00.
  1. Manufacturer's printed data and application instructions for specified materials and locations where materials are to be used.

##### 1.04 QUALITY ASSURANCE:

- A. Comply with requirements in section 01 43 00 and as specified.
- B. Reject and replace waterstops which have become wet or exhibit swelling prior to concrete placement.
- C. Position waterstops in joints as indicated.
- D. Provide waterstops in maximum practical lengths to minimize joints.
- E. Use adhesives manufactured by or recommended by the waterstop manufacturer for attachment of the waterstop to concrete.
- F. Waterstops shall be positioned to provide a minimum of 3" concrete cover.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements in section 011006.
- B. Transport, handle and deliver materials to the job site in the manufacturer's sealed bags, unopened containers or banded pallets.
- C. Store materials off the ground on a platform or skids and protect with covers from snow, rain and ground splatter.
- D. Store hydrophilic waterstops under cover in a dry location, out of direct sunlight.
- E. Waterstop shall be maintained in a dry condition until concrete placement.

PART 2 - PRODUCTS

2.01 HYDROPHILIC GASKET WATERSTOP:

- A. Provide a bentonite free rubber waterstop. Waterstop shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast. Provide minimum concrete cover as recommended by the waterstop manufacturer.
- B. Provide hydrophilic rubber gasket waterstops fabricated of non-vulcanized rubber, chloroprene rubber, urethane polymers, vinylester polymers or combinations of these materials.
- C. Provide waterstop as recommended by manufacturer for specific installation.
- D. Provide hydrophilic gasket waterstops which meet the criteria in Table 03 15 16-1.

<b>Table 03 15 16-1</b>		
<b>Property</b>	<b>Test Method</b>	<b>Limit</b>
Ultimate Elongation	ASTM D 638	70% minimum
Tensile Strength	ASTM D 638	25 psi minimum
Ozone Resistance	ASTM D 1149	No Failure
Volatile Loss	ASTM D 1203	0.50% maximum
Hardness, Shore A	ASTM D 2240	20 to 60

- E. Provide hydrophilic rubber gasket waterstops as manufactured by:
  - 1. Duroseal Gasket Waterstop manufactured by BBZ USA;
  - 2. Adeka Ultraseal MC-2010M manufactured by Adeka North America;



3. Swellseal 8 manufactured by de neef Construction Chemicals, Inc.;
4. Or accepted equivalent product.

2.02 HYDROPHILIC PASTE WATERSTOPS:

- A. Provide hydrophilic rubber paste waterstops of urethane paste, thixotropic vinyl monomer or similar materials.
- B. Hydrophilic rubber paste shall be compatible with gasket waterstop material.
- C. Hydrophilic paste shall be 100% solids.
- D. Provide hydrophilic paste waterstops which meet or exceed the criteria in Table 03 15 16-2.

<b>Table 03 15 16-2</b>		
<b>Property</b>	<b>Test Method</b>	<b>Limit</b>
Ultimate Elongation	ASTM D 638	50% minimum
Tensile Strength	ASTM D 638	25 psi minimum
Ozone Resistance	ASTM D 1149	No Failure
Volatile Loss	ASTM D 1203	0.50% maximum
Hardness, Shore A	ASTM D 2240	20 to 60

- E. Provide hydrophilic rubber paste as manufactured by:
  1. Duroseal Paste manufactured by BBZ USA;
  2. Adeka Ultraseal P-201 manufactured by Adeka North America;
  3. de neef; Swellseal WA
  4. Or acceptable equivalent product.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Provide hydrophilic rubber gasket and paste waterstops where specifically indicated.
- B. Center waterstops in joints unless otherwise indicated.
- C. Consolidate concrete during placement in vicinity of waterstop without damaging or dislodging waterstop.

- D. Clean joint surface of dirt, dust, debris and laitence immediately before applying waterstop and remove standing water.
- E. Protect waterstops from moisture until concrete is placed. Waterstops which exhibit swelling prior to concrete placement shall be removed and replaced at the contractor's expense.

### 3.02 HYDROPHILIC GASKET WATERSTOPS:

- A. Install hydrophilic gasket waterstops in continuous lengths to minimize joints. Provide waterstop in one continuous length insofar as practicable. Butt ends at joints of waterstop or overlap a minimum of 2" per manufacturer's instructions.
- B. Seal joints in hydrophilic gasket waterstops with a hydrophilic rubber paste compound as recommended by the manufacturer.
- C. Do not bend hydrophilic gasket waterstop. Cut square and butt joints at corners.
- D. Waterstop shall be in continuous contact with the concrete surface.
- E. Attach hydrophilic gasket waterstop to concrete surface by one of the following methods:
  - 1. Fix hydrophilic gasket waterstop to concrete surface with continuous bead of hydrophilic rubber paste or adhesive. Paste or adhesive shall be provided by or as recommended by the waterstop manufacturer.
  - 2. Fix hydrophilic gasket waterstop to concrete surface with masonry or concrete nails or power activated fasteners at a maximum 12 inch spacing.
- F. Provide one fastener one inch from the top and a second fastener four inches from the top of vertical hydrophilic gasket waterstops regardless of which fastening method is used.
- G. Do not compress or otherwise deform hydrophilic gasket waterstop when fastening to concrete.
- H. Do not wrap hydrophilic gasket waterstops around pipes less than the minimum diameter recommended in the manufacturer's printed instructions.

### 3.03 HYDROPHILIC PASTE WATERSTOPS:

- A. Clean dirt and debris from area to receive hydrophilic paste waterstop.
- B. Bead of hydrophilic paste waterstop shall be a minimum of 1/4 by 1/2 inches.
- C. Apply hydrophilic paste waterstop such that there is no break in the bead.

- D. Place hydrophilic paste waterstop bead continuously around pipe near the center of the wall where used for sealing pipe penetrations. Allow hydrophilic paste waterstop to cure for 24 hours before placing concrete.
- E. Install hydrophilic paste waterstops in accordance with the manufacturer's printed instructions.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 03 21 00  
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide concrete reinforcement as indicated and specified:
  - 1. Section Includes:
    - a. Reinforcement bars.
    - b. Welded wire reinforcement.
    - c. Reinforcement accessories.
- B. Provide concrete reinforcement for architectural, civil, mechanical, and electrical work as shown on the drawings or specified under those disciplines.

1.02 REFERENCES:

- A. ASTM International (ASTM):
  - 1. [A184](#): Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
  - 2. [A615](#): Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 3. [A616](#): Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
  - 4. [A617](#): Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.
  - 5. [A706](#): Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
  - 6. ASTM A1064/A1064M - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- B. American Concrete Institute (ACI):
  - 1. [301](#): Standard Specification for Structural Concrete.
  - 2. [315](#): Details and Detailing of Concrete Reinforcement.

3. [318](#): Building Code Requirements for Structural Concrete.
4. [350](#): Building Code Requirements for Environmental Engineering Concrete Structures

C. Concrete Reinforcing Steel Institute (CRSI):

1. Manual of Standard Practice.
2. Placing Reinforcing Bars.

D. American Welding Society (AWS):

1. [D1.4](#): Structural Welding Code, Reinforcement Steel.

E. Where reference is made to one of the above standards, the version in effect at the time of bid opening shall apply.

1.03 SUBMITTALS:

A. Unless otherwise acceptable to the Engineer, each submittal shall include reinforcement only for a single structure or part thereof. Shop drawings depicting multiple structures on the same sheet are not acceptable.

B. Shop Drawings:

1. Submit bar lists and placing drawings for all reinforced concrete and masonry structures in accordance with Section 01 33 00.
2. Detail reinforcement in conformance with ACI 315.
3. Clearly indicate bar sizes, spacing, locations, quantities and total weight of reinforcement steel and wire reinforcement, bending schedules, and supporting and spacing devices. Show joints, with applicable joint reinforcement and waterstops.
4. Coordinate bar splicing and placement with Contractor's concrete placing schedule and joint locations. Do not add or delete joints without permission from the Engineer.
5. Show wall reinforcement in elevation. Show entire elevation of wall from top to bottom and end to end. Do not show partial elevations. Show all dowels, joints and pockets in walls.
6. Show slab reinforcement in plan view. Show all dowels, joints, openings and recesses in slabs.
7. Show location and size of all penetrations greater than 12-inches in diameter or least dimension of the opening with the corresponding added reinforcement around the penetrations.

8. Clearly show marking for each reinforcement item.
  9. Indicate locations of reinforcement bar cut-offs, splices and development lengths.
- C. Submit Certificates: Submit AWS qualification certificates for welders employed on the Work for the appropriate electrode and class of material. Testing shall be conducted and witnessed by an independent testing laboratory prior to welding reinforcement in work. Maintain qualification and certification records at the job site, readily available for examination of test results.
  - D. Submit certified copies of mill test reports of reinforcement analysis dated within the last three months for each shipment of reinforcement with specific lots in shipments identified.
  - E. Chemical composition of reinforcement steel: Ladle analysis indicating percentage of carbon, phosphorous, manganese and sulfur present in steel.
  - F. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit Manufacturer's literature that contains instructions and recommendations for installation for each type of coupler used; certified test reports that verify the load capacity of each type and size of coupler used; and Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.
- 1.04 QUALITY ASSURANCE:
- A. Comply with requirements in Section 01 43 00 and as specified.
  - B. Do not fabricate reinforcement until shop and placement drawings have been reviewed and accepted by the Engineer.
  - C. Perform concrete reinforcement work in accordance with CRSI Manual of Practice and ACI 315.
  - D. An independent testing agency accepted by Engineer shall visually inspect and test reinforcing steel welds in accordance with AWS D1.4/D1.4M.
  - E. An independent testing agency accepted by Engineer shall inspect each mechanical coupler and verify each component is installed in accordance with Manufacturer's instructions and ICC Evaluation Services Report or equivalent code agency report.
- 1.05 QUALIFICATIONS:
- A. Welders: AWS qualified within previous 12 months.
- 1.06 INSPECTION AND TESTING:
- A. In no case shall any reinforcement steel be covered with concrete until the installation of the reinforcement has been observed by the Engineer and the Engineer's authorization to

proceed with the concreting has been obtained. The Engineer shall be given a minimum of 48 hours prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished observations of the reinforcement steel.

- B. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement. Notify Engineer of commencement and duration of shop fabrication, in sufficient time to allow for proper inspection.

#### 1.07 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements in Section 011006.
- B. Keep reinforcement steel free from mill scale, rust, dirt, grease or other foreign matter.
- C. Ship and store reinforcement steel with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placing drawings.
- D. Store reinforcement steel off the ground, protected from moisture and kept free from dirt, oil or other injurious contaminants.

### PART 2 - PRODUCTS

#### 2.01 REINFORCEMENT STEEL:

- A. Reinforcement Steel: ASTM A615/A615M, 60 ksi yield grade; deformed billet steel bars.
- B. Reinforcement Steel to be Welded: ASTM A706/A706M, 60 ksi yield strength; deformed low-alloy steel bars.
- C. Reinforcement Steel Plain Bar and Rod Mats: ASTM A704/A704M, ASTM A1064, Grade 60; steel bars or rods, unfinished.
- D. Reinforcement shall be clean and free from loose mill scale, dirt, grease, oil, form release agent, dried concrete or any material reducing bond with concrete.
- E. Welded Wire Reinforcement:
  - 1. Provide welded wire reinforcement conforming to ASTM A1064 in flat sheets.
  - 2. Provide deformed welded wire reinforcement conforming to ASTM A1064 in flat sheets.
  - 3. Provide support bars and reinforcement bar supports as specified herein to obtain the concrete cover indicated.

## 2.02 ACCESSORY MATERIALS:

- A. Tie Wire: Minimum 16 gage annealed type.
- B. Chairs, Bolsters, Bar Supports, and Spacers: sized and shaped for strength and support of reinforcement during concrete placement including load bearing pad on bottom of base slabs and slabs on grade to prevent puncturing the vapor retarder.
- C. Special Chairs, Bolsters, Bar Supports, and Spacers Adjacent to Weather Exposed Concrete Surfaces: plastic coated steel, stainless steel or plastic type; size and shape as required.
- D. Provide 3-inch by 3-inch plain precast concrete blocks, precast concrete doweled blocks or concrete brick for support of bottom reinforcement in foundation mats, base slabs, footings, pile caps, grade beams and slabs on grade. Provide block thickness to produce concrete cover of reinforcement as indicated.
- E. Mechanical Couplers
  - 1. Reinforcement Tension Bar Splicers:
    - a. Cadweld or Lenton rebar splicers by Erico Products, Inc. and Dayton Barsplice, Inc.
    - b. DB-SAE splicer system by Richmond Screw Anchor Company, Inc., C2D rebar flange coupler by Williams Form Engineering Corporation and Lenton Form Saver by Erico Products, Inc.
    - c. Develop minimum 125 percent of yield capacity of bars spliced in tension when tested as assembly in accordance with ASTM A370 and A615.
- F. Reinforcement Compression Bar Splicers:
  - 1. Manufacturers: G-Loc splicers by Gateway Building Products Division
  - 2. Speed-Sleeve by Erico Products, Inc.
- G. Provide epoxy for grouting reinforcement bars specifically formulated for such application for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements in Section 03 60 00 Grout.

## 2.03 FABRICATION:

- A. Fabricate concrete reinforcement in accordance with CRSI Manual of Standard Practice, ACI 315 and ASTM A184/A184M.
- B. Weld reinforcement in accordance with AWS D1.4 only when permitted by the Engineer.



- C. Locate reinforcement splices not indicated on Drawings, at point of minimum stress.
- D. Cold bend bars. Do not straighten or rebend bars.
- E. Do not heat reinforcement steel to bend or straighten.
- F. Bend bars around a revolving collar having a diameter of not less than that recommended by ACI 318.
- G. Cut bar ends that are to be butt spliced, or threaded by saw cutting. Terminate such ends in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Place reinforcement a minimum of 2 inches clear of any metal pipe or fittings.
- B. Do not displace or damage vapor retarder.
- C. Position dowels accurately. Rigidly support, align and securely tie dowels normal to the concrete surface before concrete placement. Setting dowels into wet concrete is prohibited.
- D. Position wall dowels projecting from base slabs on grade with templates or guides held in place above the concrete placement line. Position the templates to obtain the required clearance between the dowels and the face of the walls.
- E. Bars additional to those indicated that may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at no additional cost to the Owner.
- F. Do not extend continuous reinforcement or other fixed metal items through expansion joints. Provide 2 inches clearance from each face of expansion joint.
- G. Provide additional reinforcement bars to support top reinforcement in slabs. Do not shift reinforcement bars from positions in upper layers to positions in lower layers as a substitute for additional support bars.
- H. Support reinforcement steel in accordance with CRSI "Placing Reinforcement Bars" with maximum spacing of 4'-0".
- I. Tie reinforcement steel at intersections in accordance with CRSI "Placing Reinforcement Bars":

1. Maximum tie spacing for footings, walls and columns: every third intersection or 3 feet.
  2. Maximum spacing for slabs and other work: every fourth intersection or 3 feet.
  3. Tie a minimum of 25 percent of all intersecting bars in foundation mats, base slabs, footings, pile caps, slabs on grade and elevated slabs.
  4. Secure all dowels in place before placing concrete.
  5. Tie wires shall be bent away from the forms and from finished concrete surfaces in order to provide the required concrete coverage.
- J. Locate reinforcement to avoid interference with items drilled in later, such as concrete anchors.
- K. Extend welded wire reinforcement to within 2 inches of edges of slab or section. Lap sheets at least 12 inches or two wire spaces, whichever is greater, at ends and edges and wire tightly together. Stagger end laps.
- L. Unless shown otherwise on Drawings, place welded wire reinforcement in slabs on grade between the upper third point and mid-point of slab. Placing welded wire reinforcement on the subgrade and pulling it up during concrete placement is not permitted.
- M. Support welded wire reinforcement placed over the ground on wired concrete blocks spaced not more than 3 feet on centers in any direction.
- N. Support welded wire reinforcement placed over horizontal forms on slab bolsters spaced not more than 30 inches on center.
- O. Mechanical coupler systems may be substituted for dowels at Contractor's option when permitted by Engineer.
- P. Provide additional reinforcement bars to support ties and stirrups in beams where top reinforcement is not continuous.
- Q. Securely support and tie reinforcement steel to prevent movement during concrete placement.
- R. Unless otherwise shown on the Drawings or permitted by the Engineer, do not bend reinforcement bars that project from in-place concrete.
- S. Do not weld reinforcement steel bars (including tack welded) either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written permission has been obtained from the Engineer. Immediately remove bars that have been welded, including tack welds, without such permission from the work. Comply with AWS D1.4 when welding of reinforcement is or called for.

- T. Reinforcement steel interfering with the location of other reinforcement steel, conduits or embedded items may be moved up to 3 inches. Make greater displacement of bars to avoid interference only with the permission of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior permission from the Engineer.
- U. Setting bars and welded wire reinforcement on layers of fresh concrete as the work progresses or adjusting reinforcement during the placement of concrete is prohibited.
- V. Provide and place safety caps on all exposed ends of vertical reinforcement that pose a danger to injury or life safety.

### 3.02 REINFORCEMENT AROUND OPENINGS AND PENETRATIONS:

- A. Accommodate placement of formed openings and penetrations.
- B. Unless specific additional reinforcement around openings and penetrations is shown on the Drawings, provide additional reinforcement steel on each side of opening or penetration equivalent to one half of the cross-sectional area of the reinforcement steel interrupted by an opening or penetration. The bars shall have sufficient length to be fully developed at each end beyond the opening or penetration.
- C. Refer to details on Drawings for additional diagonal bars around openings or penetrations and bar extension length on each side of openings or penetrations.

### 3.03 SPLICING OF REINFORCEMENT:

- A. Splices may be used to provide continuity due to bar length limitations. Do not splice reinforcement that is detailed to be continuous in the Drawings.
- B. Provide tension lap splices at all laps in compliance with ACI 318. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Use Class B splices at all other locations.
- C. Except as otherwise indicated on the Drawings, stagger splices in circumferential reinforcement in circular walls using Class B tension splices. Do not splice adjacent bars within the required lap length.
- D. Make splices for reinforcement in tension tie members, with a full mechanical or full welded splice and staggered at least 30 inches.
- E. Make splices in column spiral reinforcement, when necessary, by a lap of 1-1/2 turns.
- F. Reinforcement shall be continuous through construction joints.
- G. Reinforcement may be spliced at construction joints provided that entire lap is placed within only one concrete placement.

### 3.04 ACCESSORIES:

- A. Provide accessories such as chairs, chair bars and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B. Use precast concrete blocks where the reinforcement steel is to be supported over soil.
- C. Provide stainless steel bar supports or steel chairs with plastic tips where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity or liquid (including bottom of slabs over liquid containing areas) unless otherwise noted on contract documents.
- D. Do not use metal chairs, ferrous clips, nails, etc. that extend to the surfaces of the concrete. Do not use stones, brick or wood block supports.
- E. Do not use alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcement steel fastened to the bottom and top mats unless permitted by the Engineer.
- F. Mechanical Couplers:
  - 1. Couplers that are located at a joint face can be a type that can be set either flush or recessed from the face as indicated.
  - 2. Seal couplers during concrete placement to completely eliminate concrete or cement paste from entering.
  - 3. Recess couplers intended for future connections a minimum of 1/2 inch from the concrete surface. After the concrete is placed, plug the coupler with plastic plugs that have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.
  - 4. Unless indicated otherwise, provide mechanical coupler spacing and size to match the spacing and size of the reinforcement indicated for the adjacent section.

### 3.05 FIELD QUALITY CONTROL:

- A. Remove reinforcement with kinks or bends not shown on shop or placement drawings. Remove such reinforcement from job site and replace with new fabricated steel. Do not field bend of reinforcement unless reinforcement is indicated or specified to be field bent.
- B. Protect reinforcement from rusting, deforming, bending, kinking and other injury. Clean in-place reinforcement that has rusted, or been splattered with concrete using sand or water blasting prior to incorporation into the Work.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 03 30 00

### CAST-IN-PLACE CONCRETE

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide all labor, materials, equipment and incidentals necessary to furnish and install cast-in-place concrete as specified and as shown on contract drawings.
- B. Provide cast-in-place concrete for architectural, civil, mechanical, and electrical work as shown on the drawings or specified under specified under those disciplines.

##### 1.02 REFERENCES:

###### A. American Concrete Institute (ACI):

- 1. [ACI 211.1](#): Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- 2. [ACI 301](#): Specifications for Structural Concrete
- 3. [ACI 304R](#): Guide for Measuring, Mixing, Transporting and Placing Concrete
- 4. ACI 304.2R: Placing Concrete by Pumping Methods
- 5. [ACI 305.1](#): Specification for Hot Weather Concreting
- 6. [ACI 306.1](#): Standard Specification for Cold Weather Concreting
- 7. [ACI 308.1](#): Specification for Curing Concrete
- 8. [ACI 318](#): Building Code Requirements for Structural Concrete
- 9. [ACI 350](#): Code Requirements For Environmental Engineering Concrete Structures

###### B. ASTM International (ASTM) Publications:

- 1. [A 123](#): Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- 2. [A 153](#): Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- 3. [C 31](#): Standard Practice for Making and Curing Concrete Test Specimens in the Field

4. [C 33](#): Standard Specification for Concrete Aggregates
5. [C 39](#): Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
6. [C 40](#): Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
7. [C 42](#): Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
8. [C 87](#): Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
9. [C 88](#): Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
10. [C 94](#): Standard Specification for Ready-Mixed Concrete
11. [C 109](#): Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or (50-mm) Cube Specimens)
12. [C 123](#): Standard Test Method for Lightweight Particles in Aggregate
13. [C 136](#): Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
14. [C 138](#): Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
15. [C 143](#): Standard Test Method for Slump of Hydraulic Cement Concrete
16. [C 150](#): Standard Specification for Portland Cement
17. [C 157](#): Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete
18. [C 171](#): Standard Specification for Sheet Materials for Curing Concrete
19. [C 172](#): Standard Practice for Sampling Freshly Mixed Concrete
20. [C 192](#): Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
21. [C 231](#): Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. [C 260](#): Standard Specification for Air-Entraining Admixtures for Concrete
23. [C 295](#): Standard Guide for Petrographic Examination of Aggregates for Concrete

24. [C 309](#): Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
25. C 311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as in Portland Cement Concrete
26. [C 494](#): Standard Specification for Chemical Admixtures for Concrete
27. [C 595](#): Standard Specification for Blended Hydraulic Cements
28. [C 618](#): Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
29. C 881: Standard Test Method for Epoxy Resin Base Bonding Systems for Concrete
30. [C 882](#): Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear
31. [C 989](#): Standard Specification for Slag Cement for Use in Concrete and Mortars
32. [C 1017](#): Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
33. [C 1064](#): Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
34. [C 1107](#): Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
35. [C 1116](#): Standard Specification for Fiber Reinforced Concrete
36. [C 1240](#): Standard Specification for Silica Fume Used in Cementitious Mixtures
37. C 1260: Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
38. C 1293: Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
39. C 1567: Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
40. C 1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
41. [D 75](#): Standard Practice for Sampling Aggregates



42. [E 154](#): Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
43. [E 329](#): Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

C. American Association of State Highway and Transportation Officials (AASHTO):

[M182](#): Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

1.03 SUBMITTALS:

A. Section 01 33 00 - Submittals: Requirements for submittals.

B. Product Data:

1. Manufacturer's specifications and instructions for all admixtures, and curing materials. Manufacturer's certification of compatibility of all admixtures.

C. Shop Drawings:

1. Provide certification that cement used complies with ASTM C150 and these specifications.
2. Provide certification that aggregates comply with ASTM C33. Submit gradation analysis with concrete mix designs.
3. Provide certification of compliance with these specifications from the manufacturer of the concrete admixtures.
4. Prepare mix designs in accordance with ACI 318, except as modified herein.
  - a. Submit concrete mix designs, laboratory 7-day and 28-day compressive test results and laboratory shrinkage test results for review and approval by the Engineer.
  - b. Alternatively, submit test reports of 7- and 28-day compressive tests and shrinkage test results of the proposed mix where that same mix has been used on two previous projects in the past twelve months.
  - c. Do not use any concrete mixes in the work that have not been approved by the Engineer.
5. Plant Qualification: Submit certification from the National Ready Mixed Concrete Association indicating compliance with the specified qualification requirements.

D. Test and Evaluation Reports

1. Provide results of drying shrinkage tests from trial concrete mixes by the Contractor's testing laboratory firm.

E. Manufacturers' Instructions

1. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's certifications as to suitability of product to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.

F. Field Quality Control Submittals

1. Provide delivery tickets for ready-mix concrete or weigh masters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant and record of placements. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate and liquid admixtures.
2. Batch tickets shall include the following information:
  - a. Load number, truck number and driver's name
  - b. Strength of concrete (compression strength)
  - c. Amount of concrete (cu. yds.)
  - d. Time truck was charged with cement
  - e. Type, brand and amount of cement
  - f. Type, brand and amount of admixtures
  - g. Amount of water withheld at the plant (if any)
  - h. Information necessary to calculate total mixing water
  - i. Maximum size of aggregate
  - j. Weights of fine and coarse aggregates
  - k. Signature of ready-mix representative
  - l. Concrete temperature at batching plant
  - m. Type and amount of fly ash, other pozzolan or slag cement.

#### 1.04 SHRINKAGE TESTS:

- A. The testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein. Shrinkage limitations apply only to concrete for liquid containing structures.
- B. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows:
  - 1. Remove specimens from molds at an age of 23 hours +/- 1 hour after trial batching, place immediately in water at 70 degrees F +/- 3 degrees F for at least 30 minutes, measure within 30 minutes thereafter to determine original length, and then submerge in saturated lime water at 73 degrees F +/- 3 degrees F.
  - 2. At age seven days, take measurements to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).
  - 3. Immediately place specimens in a humidity-controlled room maintained at 73 degrees F +/- 3 degrees F and 50 percent +/- 4 percent relative humidity for the remainder of the test.
  - 4. Report measurements to determine shrinkage expressed as percentage of the base length separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
- C. Compute the drying shrinkage deformation of each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age.
  - 1. Compute the average drying shrinkage deformation of the specimens to the nearest 0.0001 inch at each test age.
  - 2. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch, disregard the results obtained from that specimen.
  - 3. Report results of the shrinkage test to the nearest 0.001 percent of shrinkage.
- D. Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project.
- E. Acceptance of Test Results: The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.028 percent or 0.032 percent, respectively.
  - 1. Use only mix designs for construction that have first met the trial batch shrinkage and compression requirements.

2. If the trial batch specimens do not meet both the strength and shrinkage requirements, revise the mix designs and/or materials and retest.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00.
- B. Concrete not meeting the minimum specified 28-day design strength shall be cause for rejection and removal from the work.
- C. Perform concrete work in conformance with ACI 301 unless otherwise specified.
- D. Do not use calcium chloride or admixtures containing calcium chloride.
- E. Do not place concrete until design mix, material tests and trial concrete batch mix compression and shrinkage test results are approved by the Engineer. Approvals shall be obtained at least 30 days prior to the need for use on the job site.
- F. The Contractor shall employ an independent testing laboratory, acceptable to the Engineer, to develop concrete mix designs and testing.
- G. The Contractor shall employ an independent testing laboratory, acceptable to the Engineer, to test the conformity of materials proposed for use in the concrete mixes to the project specifications and to design and test concrete mixes proposed for use. Concrete testing shall be performed by an ACI Concrete Field Technician, Grade I or equivalent. The Contractor shall allow free access to obtain test samples.
- H. The Owner shall employ an independent testing laboratory, acceptable to the Engineer, to test conformity of materials placed into the work during construction. Concrete testing shall be performed by an ACI Concrete Field Technician, Grade I or equivalent. The Contractor shall allow free access to obtain test samples.
- I. Methods of Sampling and Testing:
  1. Fresh Concrete Sampling: ASTM C 172
  2. Specimen Preparation: ASTM C 31
  3. Compressive Strength: ASTM C 39
  4. Air Content: ASTM C 231
  5. Slump: ASTM C 143
  6. Temperature: ASTM C 1064
  7. Unit Weight: ASTM C 138
  8. Obtaining Drilled Cores: ASTM C 42

9. Drying Shrinkage: ASTM C 157

- J. Acceptance of Structure: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance and strength as indicated or specified.
- K. Hot weather concrete to conform to ACI 305 and as specified herein.
- L. Cold weather concrete to conform to ACI 306 and as specified herein.
- M. Reject concrete delivered to job site that exceeds the time limit specified.
- N. Reject concrete delivered to job site that exceeds the concrete temperature limitations specified.
- O. Do not place concrete in water or on frozen or uncompacted ground.

1.06 WORKABILITY:

- A. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the materials to segregate or free water to collect on the surface.

1.07 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in conformance with Section 011006 and as specified herein.
- B. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water- cementitious materials ratio, slump, air entrainment, temperature and homogeneity.
- C. Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

1.08 SITE CONDITIONS:

- A. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C 31 and as specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Cement:
  - 1. Portland cement, ASTM C150, Type II; or blended hydraulic cement, ASTM C595, Type IP (MS).

2. Type IP (MS) shall not be used for concrete to come in contact with potable water.
3. Use only one brand of cement in any individual structure. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.
4. Maximum tricalcium aluminate shall not exceed 8 percent. The maximum percent alkalis shall not exceed 0.6 percent.

B. Fly Ash:

1. Provide fly ash conforming to the following requirements:
  - a. Class F fly ash conforming to ASTM C 618 for chemical and physical properties.
  - b. Supplemental requirements in percent:
    - (1) Maximum carbon content: 3%
    - (2) Maximum sulfur trioxide (SO<sub>3</sub>) content: 4%
    - (3) Maximum loss on ignition: 3%
    - (4) Maximum water requirement (as a percent of control): 100%
    - (5) Fineness, maximum retained on No. 325 sieve: 25%

C. Slag Cement:

1. Slag cement, when used, shall meet the requirements of ASTM C989, Grade 100 or better.

D. Silica Fume:

1. Silica fume, when used, shall meet the requirements of ASTM C1240.
  - a. Products:
    - (1) Master Builders Solutions; MasterLife SF 100.
    - (2) Sika Corporation; Sikacrete 950DP
    - (3) Euclid Chemical Company; Eucoshot MSA
    - (4) Or accepted equivalent product.

E. Fine Aggregates:

1. Clean, sharp, natural sand conforming to requirements of ASTM C33 with a fineness modulus between 2.50 and 3.0.
2. Confirm aggregates intended for use in concrete do not contain pyrrhotite or other deleterious materials by petrographic testing.
3. Test conformity of aggregate and confirm that aggregates intended for use in concrete are potentially non-reactive when tested in conformance with ASTM C1260, ASTM C1293 or ASTM C1567.
4. Coarse aggregates shall be supplied to an ANSI accredited lab, accompanied by the appropriate chains-of-custody and tested for regulated metals and gross alpha radionuclides. Testing shall be conducted by an ANSI accredited product certification body for Drinking Water Quality.

F. Coarse Aggregate:

1. Well graded crushed stone, natural rock conforming to requirements of ASTM C33.
2. Limit deleterious substances in accordance with ASTM C33, Table 3, Severe Weathering Regions, limit clay lumps not to exceed 5.0 percent by weight, and limit loss when tested for soundness using magnesium sulfate to 12 percent.
3. Test conformity of aggregate and confirm that aggregates intended for use in concrete are potentially non-reactive when tested in conformance with ASTM C1260, ASTM C1293 or ASTM C1567.
4. Confirm aggregates intended for use in concrete do not contain pyrrhotite or other deleterious materials by petrographic testing.
5. Coarse aggregates shall be supplied to an ANSI accredited lab, accompanied by the appropriate chains-of-custody and tested for regulated metals and gross alpha radionuclides. Testing shall be conducted by an ANSI accredited product certification body for Drinking Water Quality.

G. Water and Ice:

1. Use water and ice free from injurious amounts of oil, acid, alkali, salt, organic matter or other deleterious substances and conforms to requirements of ASTM C1602.
2. Water shall not contain more than 500 mg/L of chlorides or more than 500 mg/L of sulfate.

3. Heat or cool water to obtain concrete temperatures specified, and in conformance with ACI 305.1 and ACI 306.1.
- H. Color Additive for Exterior Electrical Duct Encasement:
1. For exterior electrical duct concrete encasements, use a color additive for identification purposes.
- I. Concrete Admixtures:
1. Maintain compressive strength and maximum water-cementitious materials ratios specified in Table 03 30 00-1 when using admixtures. Include all admixtures in solution form in the water-cementitious materials ratio calculations. Do not use any admixture that contains intentionally-added chlorides or other corrosive elements. Admixtures shall be used in compliance with the manufacturer's printed instructions. The manufacturer shall certify the compatibility of multiple admixtures used in the same mix. Do not use admixtures in greater dosages than recommended by manufacturer.
  2. Air Entrainment:
    - a. Air-entraining admixture shall conform to ASTM C260.
    - b. Products:
      - (1) Master Builders Solutions – MasterAir AE Series
      - (2) Sika Corporation, AER.
      - (3) WR Grace & Co.; Darex II-AEA
      - (4) Or accepted equivalent product.
    - c. Adjust the admixture content to accommodate fly ash or other pozzolan requirements, and other admixtures when used, in order to obtain the specified air content.
  3. Water Reducing:
    - a. Water-reducing admixture shall conform to ASTM C494, Type A and be compatible with the air-entraining admixture.
    - b. Products:
      - (1) Master Builders Solutions; MasterPozzolith Series or MasterPolyHeed Series
      - (2) Sika Corporation, Plastocrete 161



- (3) WR Grace & Co.; Daracem 65
  - (4) Euclid Chemical Company; Eucon NW
  - (5) Or accepted equivalent product.
4. Water Reducing and Retarding:
- a. Water-reducing and retarding admixture shall conform to ASTM C494, Type D and compatible with the air-entraining admixture.
  - b. Products:
    - (1) Master Builders Solutions; MasterSet R Series or MasterSet DELVO VO Series
    - (2) Sika Corporation; Plastiment
    - (3) WR Grace & Co.; WRDA 64
    - (4) Or accepted equivalent product.
5. Accelerating:
- a. Accelerating admixture shall conform to ASTM C494, Type C or E.
  - b. Products:
    - (1) Master Builders Solutions; MasterSet AC 534 or MasterSet FP 20
    - (2) WR Grace & Co.; Lubricon NCA or Polarset
    - (3) Euclid Chemical Company: Accelguard NCA
    - (4) Or accepted equivalent product.
6. High-Range Water-Reducing Admixture (Superplasticizer):
- a. High-Range water-reducing admixture shall conform to ASTM C494, Type F or ASTM C1017, Type I.
  - b. Products:
    - (1) Master Builders Solutions; MasterRheobuild 1000 or MasterGlenium Series
    - (2) WR Grace & Co.; Daracem 100
    - (3) Euclid Chemical company; Eucon SPC

- (4) Or accepted equivalent product.
- 7. Workability-Retaining Admixture:
  - a. Workability-enhancing admixture shall conform to ASTM C 494, Type S.
  - b. Products:
    - (1) Master Builders Solutions; MasterSure Z 60
    - (2) WR Grace & Co.; Adva XT2
    - (3) Or accepted equivalent product.
- 8. Shrinkage Reducing Admixture:
  - a. Shrinkage-reducing admixture is permitted to be used in the mix to meet shrinkage limitations provided that specified strength are met and there is no reduction in sulfate resistance and no increase in permeability. Quantity of shrinkage-reducing admixture used in the mix shall be added to the quantity of water for purposes of determining the water/cementitious materials ratio.
  - b. Products:
    - (1) Master Buildings Solutions; MasterLIFE SRA 20
    - (2) WR Grace & Co.; Eclipse 4500
    - (3) Euclid Chemical company; Eucon SRA
    - (4) Or accepted equivalent product.
- J. Fiber Reinforcement:
  - 1. Fiber reinforcing shall conform to ASTM C 1116, Type III.
  - 2. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement
  - 3. Dosage Rate: Volume of fibers shall be a minimum of 3 pounds per cubic yard.
  - 4. Physical Characteristics:
    - a. Specific gravity: 0.91
    - b. Tensile strength: 40,000 to 110,000 psi
    - c. Minimum Fiber length: 1/2 inch

5. Fibrous concrete reinforcement materials provided in this section shall produce concrete conforming to the requirements for strength of concrete specified.
  - a. Products:
    - (1) Master Builders Solutions; MasterFiber MAC Series
    - (2) WR Grace & Co.; STRUX 90/40
    - (3) Propex Operating Company, LLC; Enduro 600
    - (4) Or accepted equivalent product.
- K. Epoxy Bonding Agent:
  1. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives, depending on the application. The class of epoxy bonding agent shall be suitable for all ambient and substrate temperatures.
  2. Products:
    - a. Sika Corp.; Sikadur 32 Hi-Mod
    - b. Euclid Chemical Company; Duralcrete
    - c. Master Builders Solutions; MasterEmaco ADH 326
    - d. Or accepted equivalent product
- L. Vapor Retarder: 10 mil polyethylene sheet conforming to ASTM E 154
- M. Curing Compound:
  1. Liquid form, which will form impervious membrane over, exposed surface of concrete when applied to fresh concrete by means of spray gun. Compound shall not inhibit future bond of floor covering or concrete floor treatment. Use Type I-D compound with red fugitive dye, Class B, having 18 percent minimum solids conforming to ASTM C 309.
  2. Products:
    - a. Master Builders Solutions; MasterKure CC 1315
    - b. Euclid Chemical Company; Super Diamond Clear VOX
    - c. W. R. Meadows, Inc.; VOCOMP-30
    - d. Dayton Superior Corp; Safe Cure and Seal 30% J23UV

- e. Or accepted equivalent product.
  - N. Burlap Mats:
    - 1. Conform to AASHTO M182.
  - O. Sisal-Kraft Paper and Polyethylene Sheets for Curing:
    - 1. Conform to ASTM C171.
- 2.02 MIXES:
- A. Conform to ASTM C94, except as modified by these specifications.
  - B. Air content as determined by ASTM C231:
    - 5 ± 1 1/2 percent for concrete using 1-1/2 inch maximum aggregate size.
    - 6 ± 1 1/2 percent for concrete using 3/4 inch maximum aggregate size.
  - C. Provide minimum cementitious material content as follows in Table 03 30 00-1:

<b>Table 03 30 00-1</b>		
<b>Nominal Maximum Aggregate Size (in.)</b>	<b>Coarse Aggregate (ASTM C 33) Size No.</b>	<b>Minimum Cementitious Materials (lb/yd<sup>3</sup>)</b>
1 - 1/2	467	515
1	57	535
3/4	67	560
1/2	7	580
3/8	8	600

- D. Provide concrete with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318 and ACI 350. The resulting mix shall not conflict with limiting values specified in Table 03 30 00-2.

<b>Table 03 30 00-2</b>		
<b>Type of Work</b>	<b>28-Day Minimum Compressive Strength (in psi)</b>	<b>Maximum Water/Cement Ratio</b>
Concrete for liquid containing structures	5,000	0.40
Precast concrete	5,000	0.40
Concrete (fiber reinforced) fill	5,000	0.40
Pavement	3,000	0.54
Mud mats and concrete under foundations	1,500	0.76
Concrete not otherwise specified	5,000	0.40

E. Measure slump in accordance with ASTM C143:

1. Proportion and produce the concrete to have a maximum slump of 4 inches. A tolerance of up to 1 inch above the indicated maximum is allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated.
2. Mixes containing water reducers shall have a maximum slump of 6 inches after the addition of a mid-range water reducer and maximum slump of 8 inches after the addition of a high range water reducer.

F. Pozzolan Content:

1. Fly ash shall not exceed 20 percent of the total cementitious content.
2. Slag cement will be permitted as a substitute for fly ash at no additional cost to the Owner, in the event that Class F Fly Ash is not available. The slag substitution shall be in the same proportions and percentages of the total cementitious material as shown for fly ash.
3. Use silica fume concrete where indicated on the drawings. Silica fume not to exceed 10 percent of the total weight of the silica fume plus cement.

G. Aggregate Size:

1. The maximum aggregate size shall be:
  - a. 1-½ inches for walls greater than 18 inches in thickness, grade beams, footings, foundation mats, and base slabs.
  - b. 3/8 inches for floor fill in clarifiers, in congested areas where approved by the engineer, for fireproofing around structural steel beams and columns and to fill cored holes.
  - c. 3/4 inches for all other concrete.
2. Combined aggregate grading shall be as specified in Table 03 30 00-3:

<b>Table 03 30 00-3</b>				
Maximum Aggregate Size	1-1/2"	1"	3/4"	3/8"
Aggregate Grade per ASTM C33	467	57	67	8

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Contractor shall examine the substrate and the conditions under which work is to be performed and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions are corrected in a manner acceptable to the engineer.

3.02 MIXING AND TRANSPORTING CONCRETE:

- A. General: Conform to concreting procedures set forth in ASTM C 94, ACI 304R and as specified herein.
  - 1. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.
  - 2. Discharge concrete into forms within 1-1/2 hours after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of water, whichever occurs first.
  - 3. Do not add water at the jobsite unless permitted by the engineer. If it is necessary to add water to obtain the specified slump, add water per ASTM C 94, but do not exceed the amount of water that has been held back at the plant. Added water shall be incorporated by additional mixing of at least 35 revolutions. Quality control sampling shall be done after the water has been added and the batch thoroughly mixed.
  - 4. Do not add water to concrete containing high range water reducing admixture.
  - 5. Keep a record showing time and place of each placement of concrete, together with transit-mix delivery slips certifying the contents of the placement.

Discharge of concrete shall be completed within the limits set out in Table 03 30 00-4.

<b>Table 03 30 00-4</b>	
<b>MAXIMUM TIME TO CONCRETE DISCHARGE</b>	
<b>Concrete Temperature</b>	<b>Limit</b>
Over 90 Degree F	Remove concrete from jobsite and discard concrete
86 to 90 Degree F	45 minutes
81 to 85 Degree F	60 minutes

70 to 80 Degree F	75 minutes
Below 70 Degree F	90 minutes

B. Conveying: Convey concrete from agitator or mixer truck to place of final deposit in forms by one of the following methods:

1. Buckets or hoppers with discharge gates having a clear opening equal to not less than one-third the maximum interior horizontal area or five times the maximum aggregate size being used, whichever is greater, and side slopes of not less than 60 degrees to horizontal.
2. Buggies or wheelbarrows equipped with pneumatic tires.
3. Round bottom, metal or metal-lined chutes with inclined slope of between two to three feet horizontally to one foot vertically and of sufficient capacity to avoid overflow.
4. Circular drop pipes with a top diameter of at least eight times the maximum aggregate size, but not less than 6 inch, or tapered to not less than six times maximum aggregate size.

### 3.03 CONCRETE ACCEPTANCE:

- A. The Contractor shall accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. The signature of a Contractor's authorized representative on the delivery batch ticket shall indicate concrete acceptance.
- B. The Contractor shall reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier will furnish copies of the signed batch ticket to the Contractor and Engineer.
- C. The testing agency shall perform field tests at the point of agitator or mixer truck discharge. Accept or reject concrete on the basis of conformity with slump, air content and temperature specified.
- D. The testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete which exceeds the maximum barrel revolution of 300, the limits in Table 03 30 00-3 or concrete that has water content exceeding the specified water-cement ratio.
- E. The Contractor shall reject concrete not conforming to specification before discharging into the forms.

### 3.04 PREPARATION AND COORDINATION:

- A. Contractor shall notify the Engineer or the Engineer's Representative of readiness to place concrete in any portion of the work a minimum of 48 hours prior to concrete

placement. Failure to provide this notification will be cause for delay in placing until inspections can be completed and arrangements for testing established.

- B. All reinforcement, installation of waterstop, positioning of embedded items, and condition of formwork shall be inspected by the Engineer or the Engineer's representative prior to concrete placement.
- C. Coordinate the sequence of placement to assure that construction joints will occur only where indicated on the drawings.
- D. Schedule sufficient equipment for continuous concrete placement. Provide for backup equipment and procedures to be implemented in case of an interruption in placement.
- E. Compact the subbase and/or bedding. The subbase and/or bedding shall be uniformly moist at the time of concrete placement. Spraying water on the subbase and/or bedding may be necessary prior to placement of concrete. Concrete shall not be placed on standing water, mud, and foreign matter.
- F. Provide mud slabs to obtain a dry and stable working platform for placement of slabs on grade and foundation mats as indicated on the drawings or as may be required.
- G. Install a granular base beneath slabs on ground where shown on contract drawings, Place granular material on a compacted subgrade and compact the granular base.
- H. Place vapor retarder under structural slabs and buildings and where shown on contract drawings. Install material with 6 inch lap at joints and seal joints with tape as recommended by the vapor retarder manufacturer. Tape material cut for slab penetrations to the pipe, conduit or other items passing through the slab. Use tape recommended by the vapor retarder manufacturer.
- I. Install vapor retarder without punctures or tears and protect against punctures and breaks.
- J. Where concrete is required to be placed and bonded to existing concrete, coat the contact surfaces with epoxy bonding agent. The method of preparation and application of the bonding agent shall conform to the manufacturer's recommendations.

### 3.05 JOINTS AND EMBEDDED ITEMS:

- A. Provide construction as specified in Section 03 15 00:
  - 1. Clean all construction joints to remove loose concrete and laitance before placing adjoining concrete. Do not damage exposed concrete edges, key grooves, waterstops or reinforcement.
  - 2. Intentionally roughen surfaces of set concrete to receive new concrete to 1/4" amplitude in a manner to expose bonded aggregate uniformly at joints.



3. Do not place concrete against construction joints for at least 72 hours after initial concrete set.

B. Embedded Items:

1. Secure castings, inserts, conduits and other metalwork encased in concrete to prevent them from being displaced or deformed during concrete work. Use templates to secure items in place.
2. Clean embedded items of oil and all foreign matter.
3. Install inserts, anchors, sleeves and other items into formwork where indicated or specified under other sections of these specifications.
4. Build dovetail anchor slots into new concrete against which facing brick, concrete masonry units, tile, stone or any type ashlar is to be installed. Provide vertically at 16-in. centers where facing brick, etc., passes by concrete. Provide one continuous anchor slot where facing brick, etc., abuts the concrete work.
5. Aluminum embedded in concrete shall be coated to prevent galvanic corrosion with a zinc chromate primer and one of the following products:
  - a. Bitumastic Super Service Black by Koppers Co., Inc.
  - b. Tarmastic 100 by Porter Coatings Division, Porter Paint Co.
  - c. 450 Heavy Tnemecol by Tnemec Company.
  - d. Or accepted equivalent product.
6. Check location and support of piping, electrical conduits and other embedded items before depositing concrete. Correct locations as required and secure in place.
7. Complete required tests on embedded piping before starting concrete placement.

C. Embedded Pipes And Conduit:

1. Embedded pipes and conduit in concrete shall conform to the requirements and limitations of ACI 318, ACI 350 and these specifications and shall be as approved by the engineer.
2. Conduits, pipes, and sleeves of any material not harmful to concrete and within the limitations specified herein shall be permitted to be embedded in concrete with the approval of the Engineer.
3. Conduits and pipes of aluminum shall not be embedded in concrete.

4. Pipes passing through walls of a liquid-containing structure shall include an integral waterstop.
5. Conduits, pipes, and sleeves passing through a slab, wall, or beam shall not impair significantly the strength of the construction.
6. Conduits and pipes, with their fittings, embedded within a column shall not displace more than 4 percent of the area of cross section.
7. Except when drawings for conduits and pipes are approved by the structural engineer, conduits and pipes embedded within a slab, wall, or beam (other than those merely passing through) shall satisfy the following:
  - a. Conduits and pipes shall not be larger in outside dimension than  $\frac{1}{3}$  the overall thickness of the slab, wall, or beam in which they are embedded.
  - b. Conduits and pipes shall not be spaced closer than 3 times the outside diameters on center.
  - c. Conduits and pipes shall be placed within the middle third of the element and between reinforcement layers. Do not install runs of piping or conduit between formwork and reinforcement.
  - d. Avoid crossing pipes and conduit in concrete.
8. Pipes and fittings shall be designed to resist the effects of the material, pressure, and temperature to which they will be subjected.
9. No liquid, gas, or vapor, except water not exceeding 90 F or 50 psi pressure, shall be placed in the pipes until the concrete has attained its design strength.
10. Reinforcement with an area not less than 0.002 times area of concrete section shall be provided perpendicular to piping or conduit at a maximum spacing of 12 inches.
11. Piping and conduit shall be so fabricated and installed that cutting, bending, or displacement of reinforcement from its proper location will not be required.
12. Close ends of conduits, piping and sleeves embedded in concrete with caps or plugs prior to concrete placement.

### 3.06 CONCRETE PLACEMENT:

- A. Placement shall conform to ACI 304R as modified by these specifications.
- B. Intentionally roughen surfaces of set concrete to receive new concrete to  $\frac{1}{4}$ " amplitude in a manner to expose bonded aggregate uniformly at joints.

- C. Do not place adjacent sections of walls and slabs until seven days after placement of the previously placed concrete.
- D. Do not place concrete until all free water has been removed from the forms, clear of the work. Do not permit free or storm water to flow over surfaces of concrete so as to injure the quality or surface finish.
- E. Do not place concrete during inclement weather. Protect concrete placed from inclement weather. Keep sufficient protective covering ready at all times for this purpose.
- F. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing. Do not deposit concrete in large quantities in one place to be worked along the forms with a vibrator.
- G. Deposit concrete continuously and in level layers 1 to 2 feet thick. Avoid inclined layers and cold joints. Place concrete at lower portion of slope first on sloping surfaces.
- H. Do not deposit partially hardened concrete in forms. Retempering of partially hardened concrete is not permitted. Remove all partially hardened concrete from site at no additional compensation.
- I. Do not allow concrete to fall freely in forms to cause segregation (separation of coarse aggregate from mortar). Limit maximum free fall of concrete to 4 feet. Do not move concrete horizontally more than four feet from point of discharge. Space points of deposit not more than eight feet apart.
- J. At least two hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise shown on contract drawings.
- K. Consolidate concrete using mechanical vibrators operated within the mass of concrete and/or on the forms conforming to procedures set forth in ACI 309R and as specified herein.
- L. Conduct vibration to produce concrete of uniform texture and appearance, free of honeycombing, streaking, cold joints or visible lift lines.
- M. Conduct vibration in a systematic manner with regularly maintained vibrators. Furnish sufficient backup units at job site. Use vibrators having minimum frequency of 8,000 vibrations per minute and of sufficient amplitude to consolidate concrete. Use not less than one vibrator with crew for each 35 to 40 cubic yards of concrete placed per hour.
- N. Insert and withdraw vibrator vertically at a uniform spacing over the entire area of placement. Space distances between insertions such that spheres of influence of each insertion overlap.

- O. Use additional vibration with pencil vibrators on vertical surfaces and on all exposed concrete to bring full surface of mortar against the forms so as to eliminate air voids, bug holes and other surface defects. Employ the following additional procedures for vibrating concrete as necessary to maintain proper consolidation of concrete:
1. Reduce distance between internal vibration insertions and increase time for each insertion.
  2. Insert vibrator as close to face of form as possible without contacting form or reinforcement.
  3. Thoroughly vibrate area immediately adjacent to waterstops without damaging the waterstop.
  4. Use spading as a supplement to vibration where particularly difficult conditions exist.

P. Pumping Concrete:

1. Conform to the recommendations of ACI 304.2R except as modified herein.
2. Use equipment and procedures and schedule deliveries to maintain steady flow of concrete at the discharge end of pipe.
3. Maintain concrete properties of slump, air content and temperature. Make adjustments in concrete proportions as necessary to provide concrete properties in accordance with the approved concrete design mix and as specified herein.
4. Use pipe with inside diameter of at least three times the maximum coarse aggregate size, but not less than 4 inches.
5. Do not use aluminum pipes for delivery of concrete to the forms.
6. Take samples at the point of agitator or mixer truck discharge.
7. Furnish labor and assistance as required by the testing laboratory in obtaining and handling test specimens.

3.07 CURING AND PROTECTION:

A. General:

1. Protect concrete from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.
2. Comply with curing procedures set forth in ACI 301, ACI 308.1 and as specified herein.

3. Perform hot weather concreting in conformance with ACI 305.1 and as specified herein when the ambient atmospheric temperature is 80 degrees F or above.
4. Perform cold weather concreting in conformance with ACI 306.1 and as specified herein when the ambient atmospheric temperature is 40 degrees F or below.
5. Concrete required to be moist cured shall remain moist for the entire duration of the cure. Repeated wetting and drying cycles of the curing process will not be allowed.

B. Curing Duration:

1. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from unformed concrete surfaces. Initial curing starts as soon as concrete achieves final set. Forms left tightly in place are considered as part of the curing system, provided that wooden forms are kept continuously moist. Keep continuously moist for not less than 72 hours.
2. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.
3. Avoid rapid drying at the end of the final curing period

C. Curing Requirements:

1. Unformed Surfaces: Cover and cure entire surface of newly placed concrete immediately after completing finishing operations and water film has evaporated from surface or as soon as marring of concrete will not occur. Protect finished slabs from direct rays of the sun to prevent checking, crazing and plastic shrinkage.
2. Formed Surfaces: Minimize moisture loss for formed surfaces exposed to heating by the sun by keeping forms wet until safely removed. Keep surface continuously wet by warm water spray or warm water saturated fabric immediately following form removal.
3. Liquid containing and below grade structures: Moist cure by the application of water to maintain the surface in a continually wet condition. Use water that is free of impurities that could etch or discolor exposed concrete surfaces.
4. Other concrete: Moist cure by moisture-retaining cover curing, or by the use of curing compound.

D. Curing Methods:

1. Water Curing: Use water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing by any of the following methods:
  - a. Keeping the surface of the concrete continuously wet by ponding or immersion.
  - b. Continuous water-fog spray or sprinkling.
  - c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface, as necessary.
2. Sealing Materials:
  - a. Use common sealing materials such as plastic film or waterproofing (kraft) paper when permitted by the Engineer.
  - b. Lap adjacent sheets a minimum of 12 inches. Seal edges with waterproof tape or adhesive. Use sheets of sufficient length to cover sides of concrete member.
  - c. Place sheet materials only on moist concrete surfaces. Wet concrete surface with fine water spray if the surface appears dry before placing sheet material.
  - d. The presence of moisture on concrete surfaces at all times during the prescribed curing period is proof of acceptable curing using sheet material.
3. Membrane Curing Compound:
  - a. Apply membrane-curing compound uniformly over concrete surface by means of roller or spray at a rate recommended by the curing compound manufacturer, but not less than 1 gallon per 150 sq. ft. of surface area. Agitate curing material in supply container immediately before transfer to distributor and thoroughly agitate it during application for uniform consistency and dispersion of pigment
  - b. Do not use curing compounds on construction and expansion joints or on surfaces to receive liquid hardener, dustproofer/sealer, concrete paint, tile, concrete fills and toppings or other applications requiring positive bond.
  - c. Reapply membrane-curing compound to concrete surfaces that have been subjected to wetting within 3 hours after curing compound has been applied by method for initial application.

- E. Protection from environmental conditions: Maintain the concrete temperature above 50 degrees F continuously throughout the curing period. Make arrangements before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the curing period.
  - 1. When the atmospheric temperature is 80 degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering.
  - 2. Protect the concrete continuously for the entire curing period.
  - 3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes.
  - 4. Avoid temperature changes in concrete that exceed 5 degrees F in any one hour and 50 degrees F in any 24-hour period.
- F. Protection from physical injury: Protect concrete from physical disturbances such as shock and vibration during curing period. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures and rain or running water. Do not load concrete in such a manner as to overstress concrete.
- G. Protection from Deicing Agents: Do not apply deicing chemicals to concrete.

### 3.08 FIELD QUALITY CONTROL:

#### A. Hot Weather Requirements

- 1. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 305.1 and the following.
- 2. When the weather is such that the temperature of the concrete as placed would exceed 90 degrees F, use ice or other means of cooling the concrete during mixing and transportation so that the temperature of the concrete as placed will not exceed 90 degrees F.
- 3. Take precautions when placing concrete during hot, dry weather to eliminate early setting of concrete. This includes protection of reinforcing from direct sunlight to prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.
- 4. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

B. Cold Weather Requirements

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306.1 and the following.
2. When the temperature of the surrounding atmosphere is 40 degrees F or is likely to fall below this temperature, use heated mixing water not to exceed 140 degrees F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.
3. When placed in the forms during cold weather, maintain concrete temperature at not less than 55 degrees F. All materials shall be free from ice, snow, and frozen lumps before entering the mixer.
4. Maintain the air and the forms in contact with the concrete at temperatures above 40 degrees F for the first five days after placing, and above 35 degrees F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature.
5. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

C. Backfill Against Walls

1. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.
2. Do not backfill the walls of structures that will be laterally restrained or supported by suspended slabs or slabs on grade until the slab is placed and the concrete has reached the specified compressive strength.

D. Concrete Testing

1. Concrete Quality Test Specimen:
  - a. Perform sampling and curing of test specimen in accordance with ASTM C31.
  - b. Testing agency personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content and temperature.
  - c. For each 50 cu. yd. of each mix design of concrete but not less than once a day nor less than once for each 5,000 sq. ft. of surface area of foundation mats, base slabs, footings, pile caps, slabs on grade, grade beams, walls, or elevated slabs, the testing agency will cast a minimum of:



- (1) One set of four (4) 6"x12" test specimens or
  - (2) One set of seven (7) 4"x8" test specimens
- d. Once a cylinder size has been selected, the size and number of specimens representing a strength test for each concrete mix shall remain constant.
- e. For 6"x12" test cylinders:
  - (1) The testing agency will compression test one (1) of each set of four 6"x12" specimens at 7 days.
  - (2) Test two (2) of the remaining cylinders at 28 days for concrete strength acceptance.
  - (3) The fourth cylinder shall be held for testing at 56 days only if the 28 day cylinder strengths are deficient. The fourth cylinder of each set shall be discarded if the 28 day strengths meet or exceed the specified minimum strength.
- f. For 4"x8" test cylinders:
  - (1) The testing agency will compression test two (2) of each set of seven 4"x8" specimens at 7 days.
  - (2) Test three (3) of the remaining cylinders at 28 days for concrete strength acceptance.
  - (3) The last two cylinders shall be held for testing at 56 days only if the 28 day cylinder strengths are deficient. The 6<sup>th</sup> and 7<sup>th</sup> cylinders of each set shall be discarded if the 28 day strengths meet or exceed the specified minimum strength.
2. The laboratory firm shall immediately notify the Contractor and the Engineer if the seven day strength is deficient.
3. The acceptance test result is the average of the strengths of the two specimens tested at 28 days.
4. The laboratory firm shall submit compression test results to both the Contractor and the Engineer. Concrete acceptance shall be based on the requirements of ACI 318 and ACI 350.
5. Field cured cylinders conforming to ASTM C31 will be required to determine field compressive strength of concrete. Laboratory cured cylinders for concrete quality testing shall not be used for determining field compressive strength.

E. Concrete Coring:

1. When the concrete quality test specimen compression tests fail to be in compliance with the Contract Documents or when the Engineer detects deficiencies in the concrete, the Contractor will take concrete cores at least 4 inches in diameter from the structure in conformance with ASTM C 42 at locations determined by the Engineer.
2. Obtain at least three representative cores from each member or area of concrete that is considered potentially deficient.
3. Obtain additional cores to replace cores that show evidence of having been damaged subsequent to or during removal from the structure.
4. Testing agency shall compression test the cores taken from the structure in conformance with ASTM C 39 and submit test strength test results of cores specified above to the Contractor and to the Engineer.
5. All costs associated with coring and testing of cores will be borne by the Contractor at no additional cost to the Owner.

3.09 REPAIRS:

- A. Provide in accordance with Section 03 01 30.

3.10 CONCRETE FINISHES:

- A. Do not use curing compound where epoxy, urethane, mortar bed, grout, additional concrete or other toppings or adhesive will be applied.
- B. Do not sprinkle with dry cement or add water when finishing concrete surfaces.
- C. Finish concrete surfaces in accordance with the following schedule:

<b>Table 03 30 00-5</b>	
<b>Finish Designation</b>	<b>Area Applied</b>
F-1	Beams, columns, and exterior walls not exposed to liquids or view.
F-2	Walls, beams, and columns exposed to liquids EXCEPTION: surfaces that are to be coated.
F-3	Walls, beams, and columns exposed to view and to 1 foot below liquid level or finished grade. Underside of formed floors or slabs. EXCEPTION: surfaces that are to be coated.
F-4	Exterior and interior surfaces to be coated.
S-1	Slabs and floors to be covered with concrete or grout.
S-2	Slabs and floors not liquid containing and interior stairs.
S-3	Slab surfaces on which mechanical equipment moves. Slab surfaces to receive sealer or hardener shall be prepared in accordance with product manufacturer's requirements.
S-4	Slabs and floors exposed to view, which are liquid containing, or are to receive crystalline waterproofing.
S-5	Slabs and floors at slopes greater than 10% and exterior stairs.
E-1	Exposed edges.
E-2	Top of walls, beams, and similar unformed surfaces.

1. Finish F-1: Repair defective concrete, fill depressions deeper than 1/2-inch, and fill tie holes.
2. Finish F-2: Repair defective concrete, remove fins, fill depressions 1/4-inch or deeper, and fill tie holes.
3. Finish F-3: In addition to Finish F-2, fill depressions and airholes with mortar. Dampen surfaces and then spread a slurry consisting of one part cement and one and one-half parts sand by damp loose volume, over the surface with clean burlap pads or sponge rubber floats. Remove any surplus by scraping and then rubbing with clean burlap.
4. Finish F-4: Repair defective concrete, remove fins, fill depressions 1/16-inch or deeper, fill tie holes, remove mortar spatter, and remove bulges higher than 1/16-inch.
5. Finish S-1: Screed to grade without special finish unless otherwise shown on contract documents. Roughen and/or apply bonding agent where shown on contract drawings.
6. Finish S-2: Smooth steel trowel finish.

7. Finish S-3: Steel trowel finish free from trowel marks and all irregularities.
  8. Finish S-4: Steel trowel finish without local depressions or high points. For liquid containing slabs apply a light hair-broom finish. Do not use stiff bristle brooms or brushes. Leave hair-broom lines parallel to the direction of slab drainage.
  9. Finish S-5: Steel trowel finish without local depressions or high points. Apply a stiff bristle broom finish. Leave broom lines parallel to the direction of slope drainage.
  10. Finish E-1: Provide 3/4 inch chamfer on external corners of exposed concrete walls, beams columns, equipment pads and exposed edges of construction joints. Do not chamfer columns flush with concrete block walls.
  11. Finish E-2: Strike smooth and float to an F-3 or F-4 finish.
- D. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures and rain or running water.
- 3.11 FINISHING OF FORMED SURFACES:
- A. Cure surfaces until finishing and repairing are completed.
  - B. Perform finish work in accordance with the schedule in Table 03 30 00-5 as soon as possible after forms are removed.
  - C. Conform to the requirements specified in Section 03 10 00 for tolerances for formed surfaces.
- 3.12 FINISHING OF UNFORMED SURFACES:
- A. Perform finish work in accordance with the schedule in Table 03 30 00-5.
  - B. Provide S-3 steel-trowel finish to all top, horizontal, and inclined surfaces not otherwise specified or indicated. This includes concrete fills and toppings and floors. Provide hand steel-trowel finish to all surfaces such as weirs or walls over which liquids will flow.
  - C. Provide S-5 broom finish to exterior walkways, exterior stairs, entrance platforms and loading docks.
- 3.13 CONTRACT CLOSEOUT:
- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 03 35 00

CONCRETE FLOOR TREATMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide concrete floor treatment as indicated and specified.

1.02 REFERENCES:

- A. ASTM International (ASTM):

- 1. D4263: Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:

- 1. Submit manufacturer's product data.
- 2. Submit manufacturer's surface preparation and application instructions.
- 3. VOC Content Submittal:
  - a. Product data for interior concrete floor treatment including printed statement of VOC content.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.

PART 2 – PRODUCTS

2.01 LIQUID HARDENER (LQH):

- A. Manufacturers:

- 1. Lapidolith manufactured by BASF Construction Chemicals, LLC.

2. Harbeton manufactured by Nox-Crete, Inc.
  3. Sure Hard Densifier J17 manufactured by Dayton Superior Corporation.
  4. Or approved equal.
- B. Provide a magnesium fluorosilicate based hardener, noncombustible, low odor, clear solution.
- C. VOC Content: 100 g/L or less.

### PART 3 - EXECUTION

#### 3.01 SURFACE PREPARATION:

A. General:

1. Prepare concrete surfaces in accordance with manufacturer's printed instructions. Concrete shall be cured for a minimum of 28 days prior to application of floor treatment.
2. Acid etching will not be allowed.
3. Concrete surfaces shall be free of dirt, oil, wax, sealers, grease, rust stains, curing and parting compounds and other foreign matter.

#### 3.02 APPLICATION:

A. Liquid Hardener (LQH):

1. Mix and apply two coats, liquid hardener solution in accordance with recommendations of manufacturer, with particular attention to age and condition of new concrete, and the number of applications and curing times required for the particular product used.

#### 3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 03 48 18

### PRECAST REINFORCED CONCRETE VAULTS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section includes materials, design, and installation of factory-built precast reinforced concrete underground vaults and chambers as indicated and in compliance with Contract Documents.

##### 1.02 REFERENCES:

- A. American Association of State Highway and Transportation Officials (AASHTO):
  - 1. HB: Standard Specifications for Highway Bridges.
  - 2. M198: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- B. American Concrete Institute (ACI):
  - 1. 318: Building Code Requirements for Structural Concrete and Commentary
- C. ASTM International (ASTM):
  - 1. A48: Standard Specification for Gray Iron Castings.
  - 2. A615: Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods.
  - 3. C31: Practice for Making and Curing Concrete Test Specimens in the Field
  - 4. C33: Specification for Concrete Aggregates
  - 5. C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - 6. C143: Test method for Slump of Hydraulic Cement Concrete
  - 7. C150: Specification for Portland Cement
  - 8. C172: Practice for Sampling Freshly Mixed Concrete
  - 9. C192: Practice for Making and Curing Concrete Test Specimens in the Laboratory

10. C231: Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
11. C260: Specification for Air-Entraining Admixtures for Concrete
12. C494: Specification for Chemical Admixtures for Concrete
13. C857: Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
14. C858: Specification for Underground Precast Utility Chambers
15. C1064: Test Method for Temperature of Freshly Mixed Portland Cement Concrete
16. D75: Practice for Sampling Aggregates
17. D4101: Standard Specification for Polypropylene Injection and Extrusion Materials

1.03 SUBMITTALS:

- A. Shop Drawings: Submit the following in accordance with Section 013400.
  1. Completely detailed shop drawings for precast concrete vaults. Indicate all dimensions, details, reinforcing steel, inserts, connections, openings and lifting devices. Mark each component for identification. Show mark on erection plan and place legibly on unit at time of manufacture.
- B. Drawings of modifications or changes in features or details, which are necessitated by design requirements. Make such modifications without additional compensation.
- C. Do not fabricate precast concrete vaults before shop drawings are accepted by the Engineer.
- D. Certification, signed and sealed by a Professional Structural Engineer registered in the State where the vaults will be installed and employed by the vault manufacturer and stating:
  1. Elements and connections are designed to withstand required loads and forces
  2. Structure is not affected by buoyant forces.
  3. Codes and specifications to which structural design conforms.



1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.
- B. Vault design and construction comply with the specified design load conditions, ASTM C858 and as specified herein.
- C. Qualification of Manufacturer: The precast concrete manufacturer shall have a proven record and satisfactory 10-year experience in the design and manufacture of the structural units specified.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. Store vaults on clean blocking, off the ground and protected from rain and ground splatter.

PART 2 - PRODUCTS

2.01 PRECAST REINFORCED CONCRETE VAULTS:

- A. Manufacturers:
  - 1. Oldcastle Precast, Inc.
  - 2. Shea Concrete Products Inc.
- B. Materials:
  - 1. Minimum concrete compressive strength of 5,000 psi at 28 days conforming to Section 03 30 00.
  - 2. Portland Cement: ASTM C150, Type II.
  - 3. Coarse Aggregate and sand conforming to Section 03 30 00.
  - 4. Steel reinforcement conforming to ASTM A615, Grade 60.
  - 5. Water: Potable.
  - 6. Provide air entraining and water reducing concrete admixtures as specified in Section 03 30 00.
  - 7. Butyl rubber-based sealants conforming to AASHTO M198, Type B but with no bitumen content.
  - 8. Non-Shrink Grout:

- a. BASF Chemical Company; Masterflow 713 Plus
  - b. The Euclid Chemical Co.; Euco NS Grout
  - c. Sika Corporation; SikaGrout 212
- C. Design Criteria. Use design loads according to ASTM C857 or as indicated below, whichever produces the more severe conditions:
1. Design precast reinforced concrete vault to withstand earth and groundwater loads. Assume groundwater elevation to be at the top of the vault. Provide design based on an equivalent fluid pressure equal to a minimum of 95 pounds per cubic foot.
  2. Design precast reinforced concrete vault to withstand internal hydrostatic and seismic loading. Assume internal fluid level to be at the top of the vault. Provide design based upon an equivalent fluid pressure of 65 pounds per cubic foot.
  3. Design precast reinforced concrete vault to withstand vehicle loading with an impact factor as prescribed in ASTM C857 but a minimum of 250 psf surcharge. Account for vehicle positions both above and alongside vault including directly on each manhole cover.
  4. Design precast reinforced concrete vault ceiling to withstand additional concentrated loads from lifting hooks located directly above each valve, meter or other equipment. Provide lifting hook capable of supporting the load, but not less than 2,500 pounds each hook.
  5. Design and install vaults to withstand hydrostatic uplift caused by a groundwater elevation at grade level or equal to the top of the vault, whichever produces the most severe condition. Use only the weight of the vault and hold-down slab to resist hydrostatic uplift with a minimum safety factor of 1.25. Do not include side friction of soil on walls.
  6. Walls and floor slab: minimum of 8 inches in thickness. Cast lower wall section and floor slab together in one placement.
  7. Precast reinforced concrete vault roof: minimum of 8 inches in thickness.
  8. Design vault to withstand the load condition where the vault roof is removed while the structure is backfilled to grade and subject to live and dead loads.
  9. Provide precast reinforced concrete vault as indicated on the drawings. Provide a watertight vault enclosure including sumps and entrance tubes as indicated.

10. Fabricate precast reinforced concrete vault in sections for as required for installation.
11. Provide pipe sleeves with water stops, rubber pipe boots or other devices at pipe penetrations as indicated.
12. Provide reinforced concrete vertical entrance tube with inside dimensions as indicated.

2.02 MANHOLE FRAMES AND COVERS:

- A. Conform to requirements of ASTM A48.
- B. Manufacturers:
  1. Neenah Foundry
  2. Campbell Foundry
- C. Castings to be free from scale, lumps, blisters and sandholes.
- D. Machine contact surfaces to prevent rocking.
- E. Thoroughly clean and hammer inspect.
- F. Capable of withstanding AASHTO H-20 loading unless otherwise indicated or specified.

2.03 BITUMINOUS WATERPROOFING MATERIAL:

- A. Manufacturers:
  1. Tnemec Company, Inc.; Series 46-465 H.B. Tnemecol
  2. PPG Industries; Amercoat 78HB.
  3. Carboline; Bitumastic 300M
- B. Apply waterproofing to outside of walls, floor, and ceiling.

2.04 ENTRANCE HATCHES:

- B. Provide access hatches per Section 05 53 00.
- A. Manufacturers:
  1. Bilco Co.
  2. Halliday

3. Babcock-Davis Associates, Inc.
- C. Provide aluminum hatches of the type and size indicated and as follows:
1. Fabricate hatch and frame with 1/4-inch extruded aluminum frame and 1/4-inch (6 mm) diamond checkered aluminum plate covers.
  2. Reinforce cover, with aluminum bars and angles welded to underside of covers, to withstand AASHTO H-20 wheel loading.
  3. Provide hatch with hinges, hold-open safety-lock bars and flush lift handles, factory assembled, and shipped complete for installation.
  4. Provide stainless steel hardware throughout. Hinge covers to frames with heavy duty stainless steel concealed hinges and stainless steel pins. Attach hinges to covers and frames with countersunk/flathead stainless steel machine screws. Fit covers flush to frame.
  5. Provide slam latch, flush mounted grip handle, and removable plug and key wrench.
  6. Fabricate gutter type hatches with 1-1/2-inch drainage coupling in one corner of the channel frame.
  7. Provide frost proof inner hatch.
  8. Provide ladder-up safety post.
  9. Provide drain PVC drain piping to location required by the Contract Drawings or as recommended by the Engineer.

2.05 LIFTING HOOKS:

- A. Provide lifting hooks in the ceiling above pumps, valves and meters.

2.06 ACCESS LADDERS:

- A. Provide aluminum per Section 05 51 20.

1. Ladders conforming to OSHA Standards 29 CFR Chapter 1926.1053.

- B. Provide aluminum access ladders as follows:

1. Fabricate from 1-1/2-inch IPS, Schedule 80 aluminum pipe upright and 1 inch solid round aluminum rod rungs, mortised and welded to uprights. Ground welds smooth. Close, seal and ground smooth top of uprights.
2. Space aluminum rungs 12 inches on centers.

3. Securely fasten ladder to entrance tube and precast reinforced concrete vaults with aluminum brackets and 1/2-inch diameter stainless steel expansion bolts.
4. Ladders conforming to OSHA Standards 29 CFR Chapter 1926.1053.

2.07 MANHOLE STEPS:

A. Plastic Coated Steel Steps:

1. Provide steps 13 inches minimum width projecting 5 inches minimum from the wall surface. Steps to be driven into preformed holes.
2. Provide steps with copolymer polypropylene coating conforming to ASTM D4101 and 1/2-inch diameter steel reinforcing rod conforming to ASTM A615.
3. Test steps to resist a pull out load of 1,500 pounds (750 pounds per leg) without loosening or being damaged.
4. Manufacturers:
  - a. American Step Company, Inc., Griffin, GA.
  - b. Parson Environmental Products, Inc., Reading, PA.
  - c. Bowco Industries, Inc., Canby, OR.

PART 3 - EXECUTION

3.01 PROTECTION:

- A. Protect aluminum from contact with dissimilar metals, concrete, masonry or mortar.
- B. Before coating application, clean contact surfaces, remove dirt, grease, oil, foreign substances.

3.02 FINISHES:

- A. Finishes: Aluminum ladders to receive mill finish as specified or directed by the Engineer. Hatches to receive manufacturers' standard finish for aluminum.

3.03 INSTALLATION:

- A. Install precast reinforced concrete vault, and related appurtenances in accordance with manufacturer's instructions.

- B. Place precast reinforced concrete vault onto level prepared bedding as indicated. Provide uniform bearing over entire base of vault.
- C. Seal all joints inside and out with specified sealant to ensure joints are waterproof.
- D. Repair or replace damaged waterproofing.
- E. Backfill vault excavation uniformly and in such a manner so as not to damage the waterproofing.

3.04 CLOSEOUT ACTIVITIES:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 03 60 00

### GROUT

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Furnish all labor, materials, equipment, and incidentals required, and install grout complete as shown on the Drawings and as specified herein.

##### 1.02 SUMMARY:

###### A. Section Includes:

1. Material for grouting reinforcing bars, anchor bolts into existing or newly placed concrete.
2. Material for grouting under bearing plates for columns or beams.
3. Materials for grouting under equipment.
4. Materials for grouting under and around steel tanks.
5. Materials for miscellaneous grouting including but not limited to railing posts, equipment guides, bollards, precast concrete joints and supports etc.

##### 1.03 REFERENCE STANDARDS:

###### A. American Association of State Highway and Transportation Officials (AASHTO):

1. [M182](#): Burlap Cloth made from Jute or Kenaf

###### B. American Petroleum Institute (API):

1. [RP 686](#): Recommended Practice for Machinery Installation and Installation Design

###### C. ASTM International (ASTM):

1. [C33](#): Standard Specification for Concrete Aggregates
2. [C109](#): Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or (50-mm) Cube Specimens)
3. [C150](#): Standard Specification for Portland Cement

4. [C531](#): Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts, and Monolithic Surfacing
5. C579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
6. [C827](#): Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixes
7. C939 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
8. [C1107](#): Standard Specification for Packaged Dry, Hydraulic, Cement Grout (Non-shrink)
9. [D695](#): Standard Test Method for Compressive Properties of Rigid Plastics

D. U.S. Army Corps of Engineers Standard (CRD):

1. [C621](#): Corps of Engineers Specification for Non-shrink Grout

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Product Data:

1. Commercially manufactured non-shrink, non-metallic cementitious grout:
  - a. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM standards, and Material Safety Data Sheet.
2. Commercially manufactured non-shrink epoxy grout:
  - a. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM Standards and Material Safety Data Sheet.
3. Cement grout:
  - a. Include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures, and the proposed mix of the grout.
4. Concrete grout:
  - a. Include data for concrete as delineated in Section 03 30 00. This includes the mix design, constituent quantities per cubic yard, and the water/cement ratio.



5. Bonding Agent:
    - a. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to referenced ASTM standards, and Material Safety Data Sheet.
  - C. Laboratory Test Reports.
    1. Submit laboratory test data as required under Section 03 30 00 for concrete to be used as concrete grout.
  - D. Mill test reports for each shipment of cement, regardless of quantity, prior to incorporation into the work.
  - E. Manufacturer's specifications and instructions for all admixtures, curing materials, adjustable inserts and non-shrink non-metallic grout. Manufacturer's certification of compatibility of all admixtures.
- 1.05 QUALITY ASSURANCE:
- A. Qualifications
    1. Grout manufacturer to have a minimum of 5 years of experience in the production and use of the type of grout proposed for the Work.
  - B. Field Testing
    1. Field testing and inspection services required will be provided by the Owner. Provide assistance in the sampling of materials and provide any ladders, platforms, etc. for access to the Work. Comply with the applicable ASTM Standards for testing.
    2. The field testing of concrete grout will be as specified for concrete in Section 03 30 00.
    3. Take compression test specimens from the first placement of each type of grout to ensure compliance with these Specifications.
      - a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing one at seven days and two at 28 days.
      - b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B. A set of three specimens will be made for testing at seven days.

1.06 RESPONSIBILITIES:

- A. Assist the Owner in obtaining specimens for testing and furnish all materials necessary for fabricating the test specimens.
- B. The cost of laboratory tests on grout will be paid by the Owner except where test results show the grout to be defective. In such case, the Contractor shall pay for the tests, removal and replacement of defective work, and re-testing all at no cost to the Owner.

1.07 WARRANTY:

- A. Warrant the materials and products specified in this Section against defective materials and workmanship with the manufacturer's standard warranty, but for no less than one year from the date of substantial completion.
- B. Warrant the work against defects for one year from the date of substantial completion.

1.08 DELIVERY, STORAGE, AND HANDLING:

- A. Comply with the requirements in Section 011006.
- B. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers, and printed instructions.
- C. Store materials in accordance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to six months or the manufacturer's recommended storage time, whichever is less.
- D. Reject material that becomes damp, lumpy or otherwise unacceptable and immediately remove from the site and replace with acceptable material at no cost to the Owner.
- E. Deliver non-shrink cement based grouts as pre-blended, prepackaged mixes requiring only the addition of water.
- F. Deliver non-shrink epoxy grouts as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Provide materials produced by one manufacturer or supplier in order to provide standardization of appearance.

2.02 APPLICATION:

- A. Unless indicated otherwise, provide grouts as listed below:

<b>Table 03 60 00-1</b>	
<b>Type of Grout</b>	<b>Application</b>
Cement Grout	Surface repairs
Non-Shrink – Class I	Storage tanks and other non-motorized equipment.
	Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc. (Where placement time is less than 20 min.).
	Repair of holes and defects in concrete members that are not water bearing and not in contact with soil or other fill material.
Non-Shrink – Class II	Column base plates.
	Filling block-out spaces for embedded items such as railing posts, gate guide frames, etc. (where placement time exceeds 20 min.)
	Under precast concrete elements.
Non-Shrink Epoxy	Machinery subject to severe shock loads and high vibration.
Concrete Grout	Toppings and concrete/grout fill.

2.03 MATERIALS:

A. Non-shrink Class I Grout:

1. Non-shrink Class I Grout shall have a minimum 28-day compressive strength of 5,000 psi, when mixed at a fluid consistency.
2. Non-shrink Class I grout shall meet the requirements of ASTM C1107, Grade B or C, when mixed to fluid, flowable and plastic consistencies.
3. Products:
  - a. Sika Corporation; SikaGrout 212
  - b. BASF Corporation; MasterFlow 713
  - c. Euclid Chemical Company; Euco NS
  - d. Or acceptable equivalent product.

B. Non-shrink Class II Grout:

1. Non-shrink grout shall be a high precision, fluid, extended working time grout. The minimum 28-day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.

2. Grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C1107.
3. Non-shrink grouts shall meet the requirements of ASTM C1107; Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C939.
4. The grout when tested shall not bleed or segregate at maximum allowed water.
5. Products:
  - a. BASF Corporation; Masterflow 928
  - b. Euclid Chemical Co.; Hi-Flow Grout
  - c. Sika Corporation; SikaGrout 212
  - d. Or acceptable equivalent product.

C. Cement Grout:

1. Cement grouts shall be a mixture of one part Portland cement conforming to ASTM C150 types I, II, or III and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout, but not to the degree that it will allow the grout to flow.
2. Cement grout materials shall be as indicated in section 03 30 00 cast-in-place concrete.

D. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03 30 00 except as specified herein. Proportion with cement, coarse and fine aggregates, water, water reducer, and air entraining agent to produce a mix having an average strength of 4,000 psi at 28 days. Coarse aggregate size shall be 3/8-inch maximum. Keep the W/C ratio as low as practical while still retaining sufficient workability.

E. Non-shrink epoxy-based grout:

1. Provide a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in seven days when tested in conformity with ASTM D695 and have a maximum thermal expansion of  $30 \times 10^{-6}$  when tested in conformity with ASTM C531.
2. Products:

- a. BASF Corporation; MasterFlow 648
- b. Five Star Products, Inc.; HP Epoxy Grout
- c. Sika Corporation; Sikadur 42 Grout-Pak
- d. Euclid Chemical Company; High Strength Epoxy Grout
- e. Or acceptable equivalent product.

F. Dry Pack Grout:

1. Dry pack (to be packed or tamped in place) shall be mixed to a zero slump consistency.
2. When mixing the batch, add only enough water to the dry materials to produce a rather stiff mixture. Additions of water shall be made in small increments until the desired consistency is obtained.

G. Non-epoxy Bonding Compound:

1. Provide non-epoxy bonding compound that is re-wetable for up to two weeks.
2. Products:
  - a. Larsen Products Corporation; Weld-Crete
  - b. Sta-Dry Manufacturing Corporation; Link
  - c. Euclid Chemical Company; Euco Weld
  - d. Or acceptable equivalent product.

2.04 CURING MATERIALS:

- A. Curing materials for cement grout shall be as specified in Specification 03 30 00 and as recommended by the manufacturer for prepackaged grouts.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Grout shall not be placed until base concrete or masonry has attained its design strength.
- B. Prepare surfaces for curing, and protection of cement grout in accordance with Section 03 30 00 Cast-in-Place Concrete.

- C. Shade the work sites from sunlight for at least 24 hours before and 48 hours after grouting.
- D. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

### 3.02 PREPARATION:

- A. Clean concrete surfaces to receive grout free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints, and free of all loose or unsound material or foreign matter that may affect the bond or performance of the grout.
- B. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
- C. Remove all loose rust, oil or other deleterious substances from metal embedments prior to the installation of the grout.
- D. Wash concrete surfaces clean and keep them moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturate by covering the concrete with a plastic sheet or using either a soaker hose, flooding the surface or other method acceptable to the Engineer. Remove visible water from the surface upon completion of the 24-hour period prior to grouting. Use an accepted adhesive bonding agent in lieu of surface saturation when accepted by the Engineer for each specific location of grout installation.
- E. Epoxy based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- F. Construct grout forms or other leak proof containment. Forms shall be lined or coated with release agents recommended by the grout manufacturer.
- G. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other accepted means. Prevent the shims, wedges, and blocking devices from bonding to the grout by appropriate bond breaking coatings and remove them after grouting unless otherwise accepted by the Engineer.

### 3.03 GROUTING MACHINERY FOUNDATIONS:

- A. After the machinery has been set in position and placed at the proper elevation by steel wedges, the space between the bottom of the machinery base and the original placement of concrete shall be filled with a pourable non-shrink grout. Grout and grouting procedure shall be in accordance with API 686.

### 3.04 INSTALLATION:

#### A. Cement Grouts and Non-shrink Cementitious Grouts:

1. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel, or admixtures without prior approval by the grout manufacturer and the Engineer.
2. Avoid mixing by hand. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the additional water required to obtain workability. However, do not exceed the manufacturer's maximum recommended water content.
3. Place grout into the designated areas in a manner that will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner that will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (re-temper) after initial stiffening.
4. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of bearing plate unless otherwise accepted by the Engineer.
5. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer.

#### B. Non-shrink Epoxy Grouts:

1. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Mix full batches only to maintain proper proportions of resin, hardener, and aggregate. Partial mixes will be rejected and will require the suspect grout to be removed and be replaced.
2. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 degrees F or above 90 degrees F.
3. Place grout into the designated areas in a manner that will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
4. The extension of grout horizontally beyond base plate shall be less than or equal to the grout thickness.

5. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

C. Concrete Grout:

1. Provide the underlying concrete surface with a broomed finish. Protect and keep the surface clean until placement of concrete grout.
2. Remove the debris and clean the surface of all dirt and other foreign materials.
3. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16- to 1/8-inch thick cement paste.

D. Dry Pack:

1. Dry pack consistency shall be such that the grout is plastic and moldable but will not flow.
2. The use of pneumatic pressure for dry-packed grouting requires acceptance of the Engineer.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION



**DIVISION 04 – MASONRY**

## SECTION 04 20 00

### UNIT MASONRY AND ACCESSORIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide unit masonry and accessories as indicated and specified.
- B. The work under this Section includes the following, as necessary:
  - 1. Concrete masonry units (CMU), solid and hollow core units.
  - 2. Fire-rated concrete masonry units.
  - 3. CMU bond beams.
  - 4. Face brick.
  - 5. Cavity wall insulation.
  - 6. Grouting as indicated and as specified herein.
  - 7. Installing miscellaneous metal items built into masonry.
  - 8. Premolded masonry joint fillers.
  - 9. Installation of steel plates and masonry anchors.
  - 10. Door and window frames built into masonry are furnished by the Contractor in Division 8 and installed under the work of this Section.
  - 11. Masonry joint reinforcing, ties, anchors, miscellaneous reinforcing provided and installed under the work of this Section.
  - 12. Deformed steel bars for wall reinforcing and CMU lintel reinforcing are furnished by the Contractor under Division 3, installed under the work of this Section.
  - 13. Installation of beams, sills and structural items to be embedded in masonry.
  - 14. Membrane flashing (thru-wall), termination bar and sealant.

15. Installation of anchor bolts embedded in masonry.
16. Installation of metal flashing is included in this section and furnished in Section 07 60 00.
17. Installation of Air/Vapor Barrier Membrane at CMU wall.

## 1.02 REFERENCES:

### A. ASTM International (ASTM):

1. A82: Standard Specification for Steel Wire, Plain for Concrete Reinforcement.
2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. C33: Standard Specification for Concrete Aggregates.
4. C55: Standard Specification for Concrete Brick.
5. C62: Standard Specification for Building Brick (Solid Masonry Units made from Clay or Shale).
6. C67: Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile.
7. C90: Standard Specification for Loadbearing Concrete Masonry Units.
8. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] cube specimens.)
9. C126: Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
10. C140: Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units.
11. C144: Standard Specification for Aggregate for Masonry Mortar.
12. C150: Standard Specification for Portland Cement.
13. C207: Standard Specification for Hydrated Lime for Masonry Purposes.
14. C216: Standard Specification for Facing Brick (Solid Masonry Units made from Clay or Shale).

15. C270: Standard Specification for Mortar for Unit Masonry.
16. C331: Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
17. C404: Standard Specification for Aggregates for Masonry Grout.
18. C476: Standard Specification for Grout for Masonry.
19. C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
20. C979: Standard Specification for Pigments for Integrally Colored Concrete.
21. C1019: Standard Method of Sampling and Testing Grout.
22. D1056: Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
23. D1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
24. D2000: Standard Classification System for Rubber Products in Automotive Applications.
25. D2240: Test Method for Rubber Property - Durometer Hardness.

B. American Concrete Institute ACI:

1. ACI 530/ASCE 5/TMS 402: Building Code Requirements for Masonry Structures & Commentary.
2. ACI 530.1/ASCE 6/ TMS 602: Specification for Masonry Structures & Commentary.

C. International Masonry Industry All Weather Council:

1. IMIAWC: Recommended Practices and Guide Specifications for Cold Weather Masonry.

D. Brick Institute of America.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:

1. Manufacturer's product data for:
  - a. Brick units of all types
  - b. Concrete masonry units of all types
  - c. Mortar and grout
  - d. Joint reinforcement
  - e. Anchors and ties
  - f. Membrane flashing, termination bar and sealant
  - g. Weephole inserts
  - h. Cavity wall insulation
  - i. Air/vapor barrier membrane and accessories
2. Testing:
  - a. Provide efflorescence test results on actual brick and mortar to be supplied for this project, including test results of potable water for mortar conforming to the specified requirements.
  - b. Provide from testing laboratory, the chemical analysis of water-soluble alkali content (%) of cement for mortar.
3. Brick manufacturer's printed recommendations for brick cleaning agent and application procedures.
4. Samples for Approval:
  - a. Three individual samples of each type, grade, color and texture of face brick for establishing range of color and texture.
  - b. Two sample channels of colored mortar.
5. Shop drawing for structural facing tile construction indicating setting requirements, wall layout and elevations, special shapes, shape identification numbers and dimensions.
6. Drawings including plans, elevations, and details of wall reinforcement; details of reinforcing bars at corners and wall intersections, control, expansion joints and wall openings.

7. Submit information and requirements for addressing special inspection required by Section 01 45 33, including all anticipated dates and time that will allow special inspection to be accomplished.
  - a. Engineer must be notified by Masonry Subcontractor within thirty (30) days of proposed inspection periods.

#### 1.04 QUALITY ASSURANCE:

##### A. Sample Masonry Panel(s):

1. Panels shall be L-shaped or otherwise configured to represent all the wall elements. Construct sample masonry panel(s) for brick and/or concrete masonry exposed in finished work. Build panel(s) 4 ft. long x 2 ft. long x 6 ft. high by the required thickness as indicated on the drawings, with facing brick on one side, and structural facing tile and/or concrete masonry units on other side and incorporating joint reinforcement, vertical control joint, specialty shapes, insulation, air vapor/barrier membrane, accessories, weepholes and flashings, face units and backup units as indicated.
2. Construct sample panel(s) at project site location designated by the Engineer to allow acceptance by the Engineer prior to start of masonry work. Sample panel(s) shall not be built in, or as part of the structure, but shall be located where directed.
3. Construct sample panel(s) using specified materials and methods of construction, conforming to indicated shape, surface finish, color and texture range, mortar color, bond pattern, and joint finish.
4. Upon acceptance by the Engineer, sample panel(s) shall become the standard of workmanship and acceptance for represented masonry work. Do not start masonry work for which sample panel(s) are required until sample panel(s) have been accepted.
5. Protect and maintain sample panel(s) in original location and in original condition until the masonry work has been completed and approved.
6. After completion of the work, the sample panel(s), including all foundation concrete shall become the property of the Contractor and shall be removed from job site upon acceptance of represented masonry work, or when permitted by the Engineer.

B. Visual Appearance:

1. Provide brick and concrete masonry units conforming to ASTM tolerances for visual appearance at time of delivery and maintain original appearance to conform to tolerances immediately prior to construction.

C. Remove masonry work damaged as a result of failure to comply with specifications, in the opinion of the Engineer, and reconstruct as directed by the Engineer at no additional cost to the Owner.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Provide in accordance with Section 011006 and as specified.

B. Deliver masonry units in an air-dry condition.

C. Store masonry units above ground on level platforms that will permit circulation of air and prevent moisture absorption.

D. Concrete masonry units shall be covered or protected from inclement weather and shall conform to the moisture content as specified in ASTM C90, when delivered to job site.

E. Handle masonry units, either individually or in groups, to keep units whole. Handle masonry units in a manner to maintain sharp edges and undamaged faces with minimum protection as follows:

Type of Unit	Minimum Protection
Facing brick	Straw or banded cubes
Concrete masonry units	Handling

F. Do not stack masonry units more than two (2) pallets high when stacking on frozen ground. Store masonry units on wooden planks.

G. Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

H. Cementitious and other package material shall be delivered in unopened containers, plainly marked and labeled with manufacturer's names and brands. Cementitious material shall be stored in dry, weather tight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

## 1.06 SITE CONDITIONS:

### A. Protection of Masonry:

1. During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
2. Extend cover a minimum of 24-in. down both sides and hold cover securely in place.
3. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24-in. down face next to unconstructed wythe and hold in place.

### B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

### C. Stain Prevention:

1. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  - a. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
  - b. Protect sills, ledges, and projections from mortar droppings.
  - c. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - d. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

### D. Cold-Weather Requirements:

1. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  - a. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperatures is 40 deg. F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.



E. Hot-Weather Requirements:

1. Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
  - a. When ambient temperature exceeds 100 deg. F, or 90 deg. F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

F. Prevent damage due to wind and wind-blown particles.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Provide masonry units with dimensions listed in ANSI A62.3 except where otherwise specified or indicated. Provide additional masonry units to complete masonry work as indicated.
- B. For exposed alteration and restoration work, provide masonry units of same type, grade, size, and appearance as existing masonry work.
- C. Furnish special coves, corners, bullnoses, and other special shapes as indicated.
- D. Obtain masonry units from one manufacturer.

### 2.02 MORTAR AND GROUT:

A. General:

1. Provide mortar conforming to ASTM C270, Type S, composed of portland cement, hydrated lime, and sand.
2. The damp, loose volume of sand is not to exceed three times the sum of the volumes of cement and lime.
3. Proportion of lime to portland cement, by volume: 1/4 to 1/2.
4. Portland cement: ASTM C150, Type I or Type II.
5. Lime: ASTM C207, Type S
6. Sand for Mortar: ASTM C144, from single acceptable source.

7. Sand for Grout: ASTM C404.
  8. Water: Clean potable from single source and free from acids, alkalies, organic material, minerals and salts.
  9. Do not use accelerators or other admixtures in mortar or grout without written approval of Engineer.
  10. Retemper mortar only to replace water lost through evaporation and use mortar within 2 hours after mixing.
- B. Grout Mix: ASTM C476, 2,500 psi minimum compressive strength. Do not use air entraining admixtures. Provide fine or coarse grout to suit work being grouted.
- C. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
1. Manufacturers:
    - a. ACM Chemistries
    - b. BASF Corporation
    - c. GCP Applied Technologies
    - d. Or approved equal.

## 2.03 BRICK MASONRY UNITS:

- A. General:
1. Brick color and texture variation not to exceed those of samples approved by Engineer.
  2. Used or salvaged brick not permitted.
  3. Provide grade SW facing brick.
- B. Face Brick: ASTM C216, Type FBS, Grade SW. Other than chips, the face or faces shall be free of cracks or other imperfections detracting from the appearance of the designated sample when viewed from a distance of 20 ft. for types FBS.
1. Manufacturers:
    - a. Belden Brick Co.
    - b. Glen-Gery Co.

- c. Endicott Clay Products Co.
  - d. Or approved equal.
2. Size: Modular, 3 5/8-in thick by 2 1/4-in high by 7 5/8 long.
  3. Provide special shapes where indicated on the drawings.

#### 2.04 CONCRETE MASONRY UNITS:

##### A. Unit Designations:

1. Hollow load-bearing units: ASTM C90
2. Solid load-bearing units: ASTM C90

##### B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
2. Manufacturers:
  - a. ACM Chemistries
  - b. BASF Corporation
  - c. GCP Applied Technologies
  - d. Or approved equal.

##### C. General:

1. Damaged units not permitted.
2. Provide concrete masonry unit Type I, moisture-controlled units.
3. Provide units free from iron and other substances that will stain plaster, paint, corrode metal or cause popouts. Aggregates not to contain more than 1.5 mg of ferric oxide per 200 grams when tested in accordance with ASTM C331.

4. Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work indicated.

D. Hollow Load Bearing Units:

1. ASTM C90 medium weight, Grade N, Type I.
2. Sand and aggregates: ASTM C33.
3. Moisture content when laid not to exceed 35 percent of total adsorption.
4. Wet-steam cured for a minimum of 12 hours followed by covered yard storage for not less than four weeks.
5. Nominal size: 8-in. by 16 in. by heights and bed thicknesses indicated or permitted.
6. Texture: Smooth for application of paint.
7. Provide external corner units: bullnosed.
8. Prism Strength: The average strength of 3 constructed masonry prisms shall be a minimum of 1,900 psi with no individual prism less than 1,700 psi when tested in accordance with ASTM E447.

E. Solid Concrete Masonry Units:

1. Provide solid concrete masonry units conforming to fire-rated wall requirements of Hollow Load Bearing Units.
  - a. Net cross-sectional area of unit in every plane parallel to bearing surface at least 75 percent of gross cross-section area measured in sample plane.
2. Fire Rated Concrete Masonry Units: Provide concrete masonry units in fire rated assemblies and partitions which are listed by UL for the application indicated and provide construction which matches UL tested fire rated assemblies.
  - a. Prism Strength: The average strength of 3 constructed masonry prisms shall be a minimum of 1,900 psi with no individual prism less than 1,700 psi when tested in accordance with ASTM E447.

## 2.05 LINTELS:

### A. General:

1. Provide lintels to extend at least eight inches beyond each jamb of the masonry opening.
2. Provide lintels with all surfaces free of cracks, chips, and broken edges.
3. Provide lintels sized for wall thickness and masonry opening and with 3/8-in. allowance in height, width, and length for mortar joints.

### B. Block Lintels:

1. Provide block lintels fabricated from standard lintel-type concrete masonry units of same material and texture as units in adjoining work, reinforced as indicated, and filled with grout having a minimum 28 day compressive strength of 2,500 psi as specified.

## 2.06 JOINT REINFORCEMENT:

### A. Manufacturers:

1. Wire-Bond.
2. Hohmann & Barnard, Inc.
3. Or approved equal.

### B. General:

1. Prefabricated, formed of ASTM A82 cold-drawn steel.
2. Hot-dip galvanized, ASTM A153, Class B-2.
3. Provide ladder type reinforcement with smooth cross wires flush welded together on 16-in. centers.
4. Provide prefabricated special pieces for corners and intersections of walls and partitions.
5. Provide joint reinforcing width according to width and type of wall indicated on drawings.

C. Single Wythe Walls:

1. Provide 3/16-in side rods and 9-gage cross rods reinforcement.

2.07 WIRE TIES:

- A. Provide wire ties to bond facing brick to concrete masonry unit backup.
- B. Provide box wall ties of 3/16 in. diameter galvanized, ASTM A 153, Class B-2, wire, 2 in. width.

C. Manufacturers:

1. No. BWT by Hohmann & Barnard, Inc.
2. No. 253 by Heckmann Building Products, Inc.
3. Rectangular Ties by AA Wire Products Co.
4. Or approved equal.

2.08 VERTICAL REINFORCEMENT:

- A. Contractor shall furnish vertical reinforcement and dowels as specified under Section 03 21 00.

2.09 EXTERIOR WALL INSULATION:

- A. Provide in accordance with specification section 07 21 00.

2.10 AIR/VAPOR BARRIER MEMBRANE, MEMBRANE FLASHING, AND TERMINATION BARS:

- A. Membrane Thru-Wall Flashing: Provide 40 mil thick thru-wall flashing consisting of a 36 mil self-adhering rubberized asphalt membrane laminated to an 4 mil high density polyethylene film with silicone treated release sheet.

B. Air/Vapor Barrier Membrane and Membrane Flashing Products:

1. Provide in accordance with specification section 07 11 19.

C. Termination Bar and Sealant:

1. Material: Type 304 stainless steel 26 gauge.

2. Size: 1/8-in. x 1-in. x 8 ft. long with 1/4-in. holes spaced 6-in. o.c. Provide stainless steel screws suitable for masonry installation.
3. Type: Single-winged style to accept sealant.
4. Sealant shall be as recommended by membrane flashing manufacturer.

#### 2.11 METAL DRIP EDGES:

- A. Fabricate metal drip edges from 0.0156-in. thick stainless steel.
- B. Extend drip edge at least 3-in. into wall and 1/2-in. out from wall, with a hemmed outer edge bend down 30 degrees.

#### 2.12 CONTROL JOINT GASKETS:

- A. Control joint gaskets shall be factory fabricated solid section of extruded rubber material conforming to ASTM D-2000 with a durometer hardness of 80 (+ or -5) when tested in conformance with ASTM D-2240.
- B. The control joint gasket shall be provided with a solid shear section not less than 5/8-in. thick and 3/8-in. thick flanges.

#### 2.13 COMPRESSIBLE JOINT FILLER:

- A. Closed cell neoprene conforming to ASTM D1056, Class RE41.
- B. Manufacturers:
  1. #NS-Closed Cell Neoprene Sponge by Hohmann & Barnard, Inc.
  2. Or approved equal.

#### 2.14 SHOP TESTING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Do not deliver, accept or install brick units and mortar until the actual production run of brick units has been tested and passes with "no efflorescence" results as specified.
- C. Provide commercial testing laboratory approved by the Engineer to perform efflorescence testing.
  1. Provide testing laboratory with a record of at least five (5) years of efflorescence testing.

- D. Provide sample brick units and mortar mix to testing laboratory.
- E. Provide efflorescence testing of brick units by testing laboratory in accordance with ASTM C67.
  - 1. Acceptable Test Result: ASTM C67 rating of "No Efflorescence."
- F. Provide chemical analysis of water-soluble alkali content (%) of cement for mortar and adjust content in accordance with the recommendations of the Brick Institute of America to avoid efflorescence in the cured mortar joints.

#### 2.15 BRICK CLEANING AGENTS:

- A. As recommended by brick manufacturer. Muriatic acid not allowed.

### PART 3 - EXECUTION

#### 3.01 PREPARATION:

- A. Clean laitance, dust, dirt, debris, oil, grease, and other foreign substances which would affect bond of mortar, from surfaces to receive mortar.
- B. Lay out walls to establish accurate spacing of bond pattern, for uniform joint widths, and to locate openings, returns and offsets. Arrange units in manner which will result in less than two units being cut between each joint or wall opening.

#### 3.02 PROTECTION OF WORK:

- A. Protect the walls, including window sills, with non-staining waterproof coverings when work not in process.
- B. Provide minimum 24-in. overhang of protective covering on each side of wall and anchor securely.
- C. Protect facing materials from staining.

#### 3.03 INSTALLATION:

- A. Provide temporary bracing of all walls until walls have been completely erected.
- B. Lay masonry plumb and square, true to dimensions, and with full, tightly bonded joints.
- C. Horizontal joints of cavity and composite walls, which are to contain wall ties and joint reinforcement shall be level with each other.



- D. Install products, indicated to be built into wall, as masonry work progresses. Fill spaces around built-in products with mortar, rake mortar joint, and allow space for sealant.
- E. Fill backs of pressed-metal door frames solid with mortar.
- F. Make joint width equal to difference between actual and nominal dimensions of unit being installed.
- G. Tool exterior joints concave with hard glassy surface free from drying cracks. Tool interior joints flush in similar manner.
- H. Lay masonry units in a running bond.
- I. Lay vertical cored units with full beds on shells only. Fully butter vertical edges.
- J. Cut masonry units with either dry or wet masonry saws.
- K. Keep chases, wall cavities, air spaces and spaces to be grouted free from debris and mortar.
- L. Lay concrete masonry units dry.
- M. Lay masonry units in full mortar bed.
- N. When resuming masonry work, clean exposed surface of set or partially set masonry and remove loose mortar prior to laying fresh masonry.
- O. Install continuous wall reinforcement in accordance with manufacturer's printed installation instructions, and place in alternate horizontal masonry joints. Lap reinforcement not less than six inches and, at corners and intersections, connect to prefabricated reinforcement. Make splices in manner, and at those points, which will not reduce structural strength of wall. Make welded and mechanical connections to develop strength of reinforcement.
- P. Install vertical reinforcement where indicated and in poured grout studs formed by vertically aligned cells of unit masonry. Secure reinforcement at top and bottom, and at intervals not more than 192 diameters of reinforcement. Use two-cell masonry units for vertical reinforcement.
- Q. Install control joint gaskets in concrete masonry unit walls where indicated and in accordance with manufacturer's printed installation instructions.
- R. Set metalwork into masonry and build around metalwork. Metalwork furnished in accordance with requirements specified in Section 05 50 00.

- S. Follow recommended practices and guide specifications for cold weather masonry work as set forth in IMIAWC-75.
- T. Using a bristle brush, brush loose mortar from the faces of the walls whenever the scaffolding is moved or raised and at the end of each shift.
- U. Install mortar net at the bottom of each air space. Mortar net thickness to match depth of air space.
- V. Construct faces of walls, and inside and outside corners, plumb, and courses level, within following tolerances:
  - 1. Variation from plumb of lines and surfaces of columns, walls, and arises: 1/4 inch in 10 feet; 3/8 inch in 20 feet; 1/2 inch in 40 feet, and 1/2-inch total.
  - 2. Variation from plumb of external corners and other conspicuous vertical lines: 1/4 inch in 20 feet; 1/2 inch in 40 feet, and 1/2-inch total.
  - 3. Variation from level of exposed lintels, sills, horizontal grooves, and other conspicuous horizontal lines: 1/4 inch in 20 feet; 1/2 inch in 40 feet, and 1/2-inch total.
  - 4. Variation of linear building lines from established position in plan and related portion walls: 1/4 inch in 20 feet; 1/2 inch in 40 feet, and 2-inch total.
  - 5. Variations from plumb in brick control joints: 0-in.

#### 3.04 MORTAR:

##### A. General:

- 1. Machine mix mortar, except small batches by hand mixing, mixed for at least five minutes after materials are in mixer. Where hand mixing is permitted, mix mortar in tight mortar box until required plasticity is obtained. Mix mortar with maximum amount of water.
- 2. Use mortar within 2 hours after mixing.

##### B. Beds:

- 1. Place full mortar beds on masonry unit bearing surfaces bonded to bearing surface of unit below, and to surface of previously installed unit in same course as unit being installed; furrowing of mortar not permitted. Pack mortar under and around joint reinforcement before masonry unit is installed.

2. Make mortar bed of such thickness that cured mortar joint is equal to difference between actual and nominal dimensions of unit being installed.
  3. Do not allow mortar fins to protrude into cores for masonry units which are to be vertically reinforced.
- C. Provide cured mortar joints free from efflorescence.

### 3.05 GROUTING:

- A. Provide clean out units in bottom course at every dowel where height of grout placement exceeds four feet. Remove overhanging mortar, mortar droppings, and obstructions from grout spaces. Seal clean out holes only after masonry work, reinforcement, and final cleaning of grout spaces have been approved by Resident Engineer, and before grouting. Sealing to match surrounding masonry.
- B. Place grout within two hours after mixing.
- C. For vertically reinforced concrete unit masonry, place grout in all cells containing reinforcement, and in lifts of not more than four feet. Consolidate grout at time of placing by either puddling or vibrating; reconsolidate grout by puddling before plasticity is lost. When grouting is stopped for one hour and longer, form horizontal construction joints by stopping grout placement 1-1/2 inches below top of uppermost grouted unit. Use coarse grout in grout spaces which are four inches and larger in all horizontal directions; place fine grout in grout spaces which are smaller than four inches in any horizontal direction.
- D. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, shall be filled solid with grout. For purposes other than vertically reinforced concrete unit masonry, place grout where indicated, and only after mortar joints and other Cementitious materials have cured. Place coarse grout in grout spaces which are two inches and larger in all horizontal directions; place fine grout in grout spaces which are smaller than two inches in any horizontal direction. Place grout at rate which allows consolidation of successive layers while preceding layer is plastic. Placement height not to exceed four feet. Consolidate grout and puddle when grouting stopped for two hours and longer; form horizontal construction joints by stopping grout placement 1/2 course height below top of uppermost grouted unit. Grouting accomplished from back-up face of masonry units.
- E. Prevent grout from coming into contact with finish surfaces which are exposed to view, and with those surfaces which are to receive other finishes.

### 3.06 LAYING CONCRETE MASONRY UNITS:

- A. Lay approved units with moisture absorption ratio of less than 35 percent.

- B. Lay units in running bond with vertical joints breaking not less than 4 in. over units in next course below or as indicated. Lay units, cored vertically, with full beds on shells only. Vertical edges fully buttered.
- C. Do not wet units before laying except in hot weather. Lightly moisten contact surfaces with water using soft brush just prior to laying units.
- D. Install reinforced concrete masonry unit lintels in concrete masonry unit walls and partitions as indicated. Extend lintels at least 8 in. beyond each jamb of masonry opening. Install only completely cured lintels.
- E. Jamb units shall be of the shape and sizes to conform with wall units.

### 3.07 LAYING BRICK:

- A. Brick facing shall be laid with the better face exposed. Lay each brick in full bed and joint of mortar as each course is laid and use enough mortar so that all joints are full and solid. Lay horizontal beds, for brick and without trowel marks with shoved joints. Lay brick in running bond without headers except where other patterns are indicated or specified. To assure full head joints, butter one head of each brick before shoving it in place.
- B. Lay up facing brick separated by continuous air space from backup masonry walls in exterior brick faced insulated cavity walls as indicated. Install rigid board insulation above and below wall ties or horizontal joint reinforcement in air space between facing brick and backup. Provide weep holes in vertical mortar joints of facing brickwork on 24-in. centers just above lintel angles and at bottom of cavity and form by placing preformed plastic weep holes in vertical joints.
- C. Provide brick arches and reinforcement as indicated.
- D. Install galvanized steel lintels as indicated.
- E. Provide 3/8-in. wide control joints in facing brick where indicated.
- F. Provide backer rod and sealant at all control joints.

### 3.08 BONDING AND JOINT REINFORCEMENT:

- A. Bond facing brick of exterior masonry walls to concrete masonry unit by joint reinforcement. Place reinforcement continuously in horizontal joints of concrete masonry units 16-in. on centers, except at control joints where joint reinforcement is interrupted.
- B. Place joint reinforcement, for interior concrete masonry unit walls and partitions, continuously in horizontal joint on 16-in. centers. Interrupt at control joints. Place

special pieces, for reinforcing corners, around columns and intersections, in every joint where reinforcement occurs.

- C. Bond intersecting masonry walls and partitions with box wall ties spaced vertically at 16-in. on centers.

### 3.09 VERTICAL REINFORCEMENT:

- A. Place steel reinforcement bars vertically in all masonry walls as indicated on the Contract Documents.
- B. Locate vertical reinforcement and dowels in first cells of CMU at jambs of all masonry openings and then space horizontally as indicated on the Contract Documents.
- C. Grout cells as specified.

### 3.10 CUTTING AND JOBBING:

- A. Leave slots and opening for inserts, wires, conduits, and similar items of construction, open or cut.
- B. Provide recesses or openings at junction boxes, or other locations as indicated.
- C. Provide openings in exterior walls and interior walls at duct, conduit, exhaust and other wall penetrations. Bridge above openings using concrete masonry units. Reinforced masonry lintels shall be provided at openings greater than 1-ft.-4-in. Install membrane wall flashing at exterior wall openings.
- D. Masonry units to be dried to 35 percent moisture content from prior cutting or grinding before installation of mechanical and electrical services.

### 3.11 BOND BEAMS:

- A. Bond beams shall be filled with grout and reinforced as indicated.

### 3.12 CONTROL JOINTS:

- A. Control joints keys shall be provided as indicated and shall be constructed by using special control joint units and in accordance with the drawings. The vertical mortar joint at control joint locations shall be continuous. The control joint key shall be interrupted in courses containing continuous bond beam steel. Provide backer rod and sealant at all exterior control joints as specified in Section 07 92 00.

### 3.13 COMPRESSIBLE JOINT FILLERS:

- A. Compressible joint fillers shall be provided as indicated and where directed by the Engineer.

### 3.14 CAVITY WALL INSULATION:

- A. Install insulation to cavity wall air/vapor barrier membrane with mastic as recommended by the manufacturer of the insulation at 1 ft. both horizontally and vertically on the inside face. Mastic to be compatible with air/vapor barrier membrane. Fit the courses of insulation between wall ties or horizontal joint reinforcement and other confining obstructions in the cavity. Tightly butt edges of insulation in both directions. Press insulation units firmly into place against the inside wythe of masonry or against other construction including structural members to form a continuous thermal barrier.
- B. Seal joints between insulation units by applying adhesive, mastic or sealant, recommended by the insulation manufacturer, to edges of each unit to form a tight seal as units are shoved into place. Fill the voids in the completed installation with adhesive, mastic or sealant recommended by the insulation manufacturer.
- C. Complete installation and concealment of insulation to avoid prolonged exposure of insulation to direct sunlight by covering exposed insulation.

### 3.15 MEMBRANE FLASHING INSTALLATION AND COORDINATION:

- A. Self-Adhered, Composite Flexible Membrane Flashing: Prepare masonry surfaces to receive flashings smooth and free of projections. Install flashing to dry surfaces at air and surface temperatures of 25 deg. F. and above in accordance with manufacturer's recommendations at locations indicated.
  - 1. Precut pieces of flashing to easily handled lengths for each location.
  - 2. Remove release paper and position flashing carefully before placing it against the surface.
  - 3. When properly positioned, place against surface by pressing firmly into place by hand roller or a blunt object. Fully adhere flashing to substrate to prevent water from migrating under flashing.
  - 4. Overlap adjacent pieces 2 inches and roll all seams with a steel hand roller or a blunt object.
  - 5. Install metal drip edges beneath flashing at exterior face of wall. Stop flashing ½-in. back from outside face of wall and adhere flashing to top of metal drip edge.

6. At heads, sills and all flashing terminations, turn up ends a minimum of 2 inches and make careful folds to form an end dam, with the seams sealed.
7. Do not allow the rubberized asphalt surface of the flashing membrane to come in contact with polysulfide sealants, creosote, uncured coal tar products or EPDM.
8. Do not expose flashing membrane to sunlight for more than thirty days prior to enclosure.
9. Install termination bar fastened at 6-in. o.c. along top edge of all flashings. Apply bead of sealant along top edge of termination bar and flashing.

B. Accessories:

1. Apply surface conditioner at rate recommended by the manufacturer, prior to flashing installation. Allow surface conditioner to dry completely before flashing application.
2. Apply a bead or trowel coat of mastic along flashing top edge, seams, cuts and penetrations.

3.16 FIELD QUALITY CONTROL:

- A. Repair joints that are unsound, not full of mortar, or which have hairline cracks due to shrinkage or poor adhesion, as follows:
1. Cut or rake affected mortar to a depth of 3/4 in.
  2. Brush out debris.
  3. Thoroughly moisten remaining mortar and adjoining masonry and paint with neat cement.
  4. Point joint full of mortar.
  5. Tool joint to a hard, glassy surface.
  6. After first day, wet down walls having repaired joints, at least five times daily, for a minimum of three days.
- B. Remove and reconstruct work injured by climatic conditions, or because of insufficient protection as directed by the Engineer and at no additional cost to the Owner.

- C. Pointing consists of raking out defective joints, and stack bond pattern joints; repairing defective joints; and working joint after mortar has initially set.
  - 1. Joints except control joints, joints in stack bond pattern and joints to be sealed: Tool concave in a manner which will compact and press the mortar against the units. Strike flush joints covered with plaster, drywall, or waterproofing membrane.
  - 2. Control joints, expansion joints and joints to be sealed shall not contain mortar.
  - 3. Defective joints: Rake out the full depth of the joint, patch with mortar, and tool to match adjacent joints.
  
- D. Apply cleaning agent to sample wall area of 20 sq. ft. in location acceptable to Engineer if cleaning by water does not produce satisfactory results to the Engineer.
  - 1. Do not proceed with cleaning until sample area is acceptable to Engineer.
  - 2. Follow manufacturer's printed instructions.
  - 3. Scrub with approved cleaning agent.
  - 4. Immediately rinse with clear water.
  - 5. Work small sections at a time.
  - 6. Work from top to bottom.
  - 7. Protect sash, metal lintels, and other materials which may corrode when masonry is cleaned with acid solution.
  
- E. When left overnight, cover tops of wythes of masonry walls with a by waterproof membrane extending at least 24 inches down both sides. Protect masonry left for greater length of time in accordance with requirements specified in Section 01 50 10. When work is resumed, clean all top surfaces of loose mortar. Wet units thoroughly, except concrete masonry units when required as specified.

### 3.17 FIELD TESTING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Test concrete masonry units in accordance with ASTM C140.
- C. A minimum of two specimens of mortar from separate batches shall be taken each day. A layer of mortar 1/2 to 5/8 in. thick shall be spread on the masonry units and



allowed to stand one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 109.

- D. Test grout compressive strength in accordance with ASTM C1019. A minimum of two specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2,500 psi at 28 days.
- E. Efflorescence Test: Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of “effloresced” will be subjected to rejection.

### 3.18 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## **DIVISION 05 – METALS**

## SECTION 05 05 19

### POST-INSTALLED CONCRETE ANCHORS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide open drilled in concrete anchors and concrete as indicated and specified.

##### 1.02 REFERENCES:

###### A. ASTM International (ASTM):

1. ASTM A307: Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
2. ASTM A449: Specification for Quenched and Tempered Steel Bolts and
3. ASTM A563: Specification for Carbon and Alloy Steel Nuts
4. ASTM F436: Standard Specification for Hardened Steel Washers
5. ASTM A36: Specification for Carbon Structural Steel
6. ASTM A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
7. ASTM A510: Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
8. ASTM A108: Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
9. ASTM F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
10. ASTM F594: Standard Specification for Stainless Steel Nuts
11. ASTM B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
12. ASTM A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
13. Reinforcing Dowels: ASTM A615

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Product specifications with recommended design values and physical characteristics for epoxy dowels, expansion and undercut anchors.
  - 2. Quality Assurance Submittals:
    - a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
    - b. Certificates: ICC ES Evaluation Reports.
  - 3. Manufacturer's installation instructions.
  - 4. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.03.B. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
- B. ICC ESR document for each type and size of anchor to be installed in the work.

1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
  - 1. Installer Qualifications:
    - a. Drilled-in anchors shall be installed by an installer with at least five years of experience performing similar installations.
  - 2. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the installer on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
    - a. hole drilling procedure
    - b. hole preparation & cleaning technique
    - c. adhesive injection technique & dispenser training / maintenance
    - d. rebar dowel preparation and installation
    - e. proof loading/torqueing
  - 3. Certifications: Unless otherwise authorized by the Engineer, anchors shall have one of the following certifications:

- a. ICC ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria.

1.05 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. Store anchors in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS:

2.01 FASTENERS AND ANCHORS:

- A. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
- B. Carbon and Alloy Steel Nuts: ASTM A563.
- C. Carbon Steel Washers: ASTM F436.
- D. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
- E. Wedge Anchors: ASTM A510; or ASTM A108.
- F. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
- G. Stainless Steel Nuts: ASTM F594.
- H. Zinc Plating: ASTM B633.
- I. Hot-Dip Galvanizing: ASTM A153.
- J. Reinforcing Dowels: ASTM A615

2.02 DRILLED-IN ANCHORS

- A. Wedge Anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193. Type and size as indicated on Drawings. The use of drop-in type anchors is prohibited.
  - 1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
  - 2. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with

stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

3. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
  - a. Hilti Kwik Bolt TZ, ICC ESR-1917 (carbon steel and AISI Type 304 Stainless Steel).
  - b. Or equal
- B. Screw Anchors: Screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.
  1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating equivalent to DIN EN ISO 4042 (8µm min.).
  2. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
    - a. Hilti Kwik-HUS-EZ, ICC-ESR 3027.
    - b. Hilti Kwik-HUS EZ-I, ICC-ESR 3027.
    - c. Or equal
- C. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions. Type and size as indicated on Drawings.
  1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038].
  2. Exterior Use: As indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

3. Reinforcing dowels shall be A615 Grade 60.
4. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
  - a. Hilti HAS threaded rods with HIT-HY 200 Safe Set System using Hilti Hollow Drill Bit System for anchorage to concrete, ICC ESR-3187.
  - b. Hilti HIT-Z anchor rods with HIT-HY 200 Safe Set System for anchorage to concrete, ICC ESR-3187.
  - c. Hilti HAS threaded rods with RE 500 SD Injection Adhesive Anchoring System for anchorage to concrete, ICC ESR-2322.
  - d. Hilti HAS threaded rods with RE 500 Injection Adhesive Anchoring System for anchorage to concrete.
  - e. Or equal
5. Reinforcing dowels shall be A615 Grade 60.

## PART 3 - EXECUTION

### 3.01 DRILLED-IN ANCHORS:

- A. Drill holes with rotary impact hammer drills using carbide-tipped bits or hollow drill bit system. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
  1. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
  2. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
  3. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
- B. Perform anchor installation in accordance with manufacturer instructions.
- C. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed

with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.

- D. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
- E. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

### 3.02 REPAIR OF DEFECTIVE WORK

- A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

### 3.03 FIELD QUALITY CONTROL

- A. Testing: 10% of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested unless otherwise directed by the Engineer. If any of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.
  - 1. Tension testing should be performed in accordance with ASTM E488.
  - 2. Torque shall be applied with a calibrated torque wrench.
  - 3. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed  $D/10$ , where D is the nominal anchor diameter.
- B. Minimum anchor embedment, proof loads and torques shall be as recommended by the manufacturer.



3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 05 12 00  
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. The term "Structural Steel" is used as defined in accordance with the AISC Code of Standard Practice.
- B. Provide structural steel as specified and as shown on contract drawings.
- C. Detailing, fabrication and erection of structural steel shall comply with all applicable OSHA regulations.

1.02 REFERENCES:

- A. American Institute of Steel Construction AISC:
  - 1. ANSI/AISC 360-5: Specification for Structural Steel Buildings
  - 2. AISC Manual of Steel Construction, Thirteenth Edition
  - 3. AISC Code of Standard Practice for Steel Buildings and Bridges
  - 4. AISC Specification for Structural Joints using ASTM A 325 or A 490 Bolts
  - 5. AISC Structural Steel Detailing Manual
- B. American Welding Society AWS:
  - 1. [AWS D1.1](#): Structural Welding Code – Steel
- C. Steel Structures Painting Council (SSPC) Publications:
  - 1. [SSPC-PA 1](#): Shop, Field, and Maintenance Painting.
  - 2. [SSPC-PA 2](#): Measurement of Dry Paint Thickness with Magnetic Gages.
  - 3. [SSPC-SP 1](#): Solvent Cleaning.
  - 4. [SSPC-SP 3](#): Power Tool Cleaning.
  - 5. [SSPC-SP 6](#): Commercial Blast Cleaning.
  - 6. [SSPC-SP10](#): Near-White Blast Cleaning.
- D. ASTM International (ASTM):

1. [A 6/A 6M](#): Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
2. [A 36/A 36M](#): Specification for Carbon Structural Steel
3. [A 123](#): Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. [A 143](#): Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement
5. [A 153](#): Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. [A 194/A 194M](#): Specification for Carbon and Alloy-Steel Nuts for Bolts for High-Pressure and High-Temperature Service
7. [A 307](#): Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
8. [A 325](#): Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
9. [A 384](#): Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
10. [A 385](#): Practice for Providing High Quality Zinc Coatings (Hot-Dip)
11. [A 449](#): Specification for Quenched and Tempered Steel Bolts and Studs
12. [A500/A500M](#): Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
13. [A 563](#): Specification for Carbon and Alloy Steel Nuts
14. [A 572](#): Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
15. [A 780](#): Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
16. [A 992](#): Standard Specification for Steel for Structural Shapes for Use in Building Framing
17. [F 436](#): Specification for Hardened Steel Washers
18. [F 1554](#): Standard Specification For Anchor Bolts, Steel, 36, 55, and 105 ksi Yield

E. Occupational Safety and Health Administration (OSHA)

1. Safety and Health Standards for the Construction Industry, 29 CFR 1926 Subpart R Safety Standards for Steel Erection

#### 1.03 DESIGN CRITERIA:

- A. Structural Connections: AISC Specification for Structural Steel Buildings. Design connections not fully detailed on the Drawings to resist the loads shown on the Contract Drawings or specified.
- B. Where beam end reactions are not shown, design the connection for one-half the total allowable uniform load in kips for beams laterally supported at the given span, as determined by the tables for allowable loads on beams in the AISC Manual of Steel Construction, in addition to any axial loads identified on the Drawings.
- C. Unless otherwise noted on Contract Drawings, design connections for ASTM A325 bolts, bearing-type connection with threads included in shear plane.

#### 1.04 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00.
  1. Submit in advance of fabrication complete information necessary for the fabrication of each component and part of the structural steel framing. Include the following:
    - a. Member size and length.
    - b. Bill of materials.
    - c. Material specifications.
    - d. Bolt hole size and bolt size.
    - e. Cuts, copes, and bevels.
    - f. Piece marks for field assembly.
    - g. Splices.
  2. Submit erection drawings showing complete information necessary for the erection of each component part of the structural steel framing. Include the following:
    - a. Dimensions for alignment and elevations of each member.
    - b. Location of members and attachments by match-marking of piece numbers.
    - c. Type, location and details of each field connection.
    - d. Number of shear connectors on each member.

- e. Anchor bolts and setting plans.
- 3. Do not develop shop drawings by using reproductions of contract drawings.
- 4. Submittals for Evidence of Conformity to Specifications: Certified mill test reports containing results of chemical and mechanical test as specified by ASTM A6 for the following material:
  - a. Structural steel shapes.
  - b. Structural steel bars.
  - c. Structural steel plates.
- 5. In addition to the certified mill test reports, the fabricator shall provide an affidavit stating that the structural steel furnished meets the requirements of the ASTM specification for the grade furnished. Qualification test reports bearing witness certification by an independent testing laboratory for each welder, welding operator and tacker to be employed in the work.

1.05 QUALITY ASSURANCE:

- A. Comply with requirements in Section 01 43 00 and as specified.
- B. Provide structural steel in accordance with AISC Standard for Structural Steel Buildings and the Code of Standard Practice for Steel Buildings and Bridges, unless otherwise specified herein.
- C. Design connections not detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the jurisdiction where the Project is located.
- D. Steel fabricator shall have 5 years experience minimum in structural steel fabrications.
- E. Steel erector shall have 5 years experience minimum in structural steel erection.
- F. Welding Qualification and Certification:
  - 1. Furnish written welding procedure for welds in conformance with the AWS D 1.1.
  - 2. Each welder, welding operator and tack welder shall be certified by test to perform type of work required in conformance with AWS D 1.1.
  - 3. If a welder or welding operator has not been engaged in a specific welding process for a period of six months or more, that individual shall be deemed unqualified and shall not perform work on the project until the individual has been qualified again by testing in conformance with AWS D 1.1.

4. Maintain duplicate qualification and certification records at the job site readily available for examination.

G. Tolerances:

1. Maintain tolerances conforming to AISC Code of Standard Practice.
2. Permissible variation tolerances conforming to ASTM A 6.

H. Tension Calibrator:

1. Provide certification by an independent testing laboratory confirming the accuracy of the tension-measuring device when slip-critical connections and connections subject to direct tension are being used. Confirm accuracy not more than 30 days prior to use on project and at intervals not more than six months thereafter.
2. Provide tension calibrator measuring device at the job site when high-strength bolts in slip-critical connections and connections subject to direct tension are being installed and tightened.
3. Frequency and of number confirmation tests to be performed and the test procedure to be employed to conform to the AISC Specification for Structural Joints.
4. Return tension calibrator measuring device to the independent testing laboratory for certification if Engineer questions its accuracy.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements in Section 011006.
- B. Load structural members in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.
- C. Protect structural steel members and packaged materials from corrosion and deterioration. Store material in a dry area.
- D. Support materials stored outdoors above ground surfaces on wood runners and protected with acceptable effective and durable covers.
- E. Do not place materials on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed by the Engineer.

1.07 FIELD MEASUREMENTS:

- A. The Contractor shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

- B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

## PART 2 - PRODUCTS

### 2.01 STRUCTURAL STEEL:

- A. W shapes in conformance with ASTM A 992 unless otherwise indicated or specified.
- B. C, M, S and HP shapes in conformance with ASTM A 572, Grade 50, unless otherwise specified or shown on contract drawings.
- C. Angles, plates and bars in conformance with ASTM A 36.
- D. Round, square and rectangular structural tube members (HSS) in conformance with ASTM A 500, Grade B.
- E. Steel pipe in conformance with ASTM A 53, Grade B.
- F. Hot-Dip Galvanized Carbon Steel in conformance with ASTM A 123.

### 2.02 FASTENERS:

- A. Carbon Steel Bolts, Nuts and Washers: ASTM A 307, Grade A.
- B. High-strength fasteners in conformance with ASTM A325, Type 1.
- C. Nuts and washers ASTM A 563 and F 436.
- D. Hot-dip Galvanized Bolts, nuts and washers in conformance with ASTM A 153.

### 2.03 ANCHOR BOLTS:

- A. Steel anchor bolts in conformance with ASTM F1554, grade 36.

### 2.04 WELDED STUDS:

- A. Weld studs in conformance with the requirements of ASTM A108, Grade 1015 or 1020.

### 2.05 WELDING:

- A. Class E70XX electrodes.
- B. Provide equipment for welding, electrodes, welding wire and fluxes capable of producing indicated welds when used by certified welders under AWS welding procedures. Provide welding materials that comply with requirements of AWS Structural Welding Code.

## 2.06 SHOP FABRICATION:

- A. Fabricate each element and connection as indicated on the fabrication shop drawings accepted by the Engineer. Fabricate and shop assemble work to the greatest extent practical in conformance with following publications:
  - 1. AISC Manual
  - 2. AISC Specification for Structural Joints
  - 3. AISC Detailing Manual
  - 4. AWS Structural Welding Code
- B. Perform shearing, manual flame cutting with mechanically guided torch and chipping such that it will not induce residual stress in metal being cut. Radii of re-entrant corners shall be as large as practicable but not less than 3/4 inch. Perform flame cutting so that metal being cut is not carrying stress. Finish exposed edges.
- C. Provide full cross section bearing on milled ends of columns, crane rails, monorails and bearing stiffeners.

## 2.07 CONNECTIONS:

- A. Connect members with ASTM A 325 high strength bolts unless otherwise specified or shown on contract drawings. Provide clean-cut holes without torn or ragged edges and remove outside burrs.
- B. Provide high-strength bolted construction assemblies in accordance with the AISC Specifications for Structural Joints.
  - 1. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.
  - 2. Joint surfaces shall be free of burrs and foreign materials. Score hot-dipped galvanized contact surfaces with a wire brush or blasted prior to assembly. Grinding of surfaces is not permitted.
  - 3. If the thickness of the material is not greater than the normal diameter of the bolt plus 1/8 inch, the holes may be punched. If the thickness of the material is greater than the normal diameter of the bolt plus 1/8 inch, drill it full size or subpunch 1/16 inch smaller than the bolt diameter and ream to full size.
  - 4. Provide bolt hole diameters not more than 1/16 inch in excess of the nominal bolt diameter unless otherwise specified in contract drawings.
  - 5. Provide required slotted or oversize bolt holes as specified in the AISC Specification for Structural Joints. Tighten each bolt to provide the minimum



tension shown in the AISC Specification for Structural Joints for the size and grade of bolts used

6. Provide required slotted or oversize bolt holes as specified in the AISC Specification for Structural Joints.

C. Provide full cross section bearing on milled ends of columns, crane rails, monorails, and bearing stiffeners.

D. Welded Connections:

1. Weld connections indicated or specified.

2. Provide complete weather seal weldments made with 1/16 inch minimum continuous fillets to members having Type S and E Service and to welded connections that will be galvanized.

E. Make connections with ASTM A 307 carbon steel bolts only when specified or shown in contract drawings.

F. Provide ASTM F 1554 anchor bolts with washer and heavy hex nuts. Provide hot-dip galvanized anchor bolts, washers and heavy hex nuts with galvanized steel.

#### 2.08 SHOP PAINTING:

A. Apply shop prime coat to structural steel, except to members or portions of members to be embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise specified. Provide surface preparation as described for the specified coating system.

B. Immediately after surface preparation, apply primer as specified in Section 09 91 00. Use painting methods that will result in full coverage of joints, corners, edges, and exposed surfaces.

C. Structural steel encased in masonry or which will be inaccessible in the finished work shall receive two shop coats of primer.

D. Provide prime coats compatible with fire proofing system.

#### 2.09 GALVANIZE:

A. Provide hot-dip galvanizing in conformance with ASTM A 123, Grade 100 to steel indicated or specified to be galvanized coated.

B. Provide hot-dip galvanizing, in conformance with ASTM A 153, to bolts, nuts and washers that will be used with galvanized steel.

- C. Complete fabrication and prepare surfaces of steel by removing weld spatter, flux, residue, burrs and metal surface defects before galvanizing. Clean weldments with power wire brush prior to galvanizing.
  - D. Provide steel dipped into solution of zinc chloride plus ammonium chloride immediately prior to galvanizing. Do not use galvanizing process utilizing flux blanket overlaying molten zinc.
  - E. Chromate treat pieces that will be in contact with or encased in concrete or masonry after galvanizing.
    - 1. Two coats of one of the following coating systems may be substituted for the chromate treatment:
      - a. Series 161 Tneme-Fascure by Tnemec Co. Inc.
      - b. Kop-Coat Super Hi-Gard by Kop-Coat Inc.
      - c. Valspar-Series 89 by Valspar Corp., Baltimore
      - d. Or accepted equivalent product.
    - 2. Prepare the steel surface in conformance with the manufacturer's printed instructions immediately before applying the initial coat of the two coat system.
  - F. Tap bolt nuts after hot-dip galvanizing in conformance with ASTM A 563.
  - G. Inspect galvanized material for compliance with these specifications. Mark the material with a clearly visible stamp indicating the name of the galvanizer, the ASTM number and the weight of zinc coating in ounces per sq. ft.
- 2.10 GALVANIZE TOUCH-UP:
- A. Galvanize Touch-Up: Where galvanizing is damaged, touch-up abraded areas, using brushed-on method, with zinc-rich coating. Touch-up repair with zinc-rich coating of not less than 3 mil and not more than 6 mil dry film thickness.
  - B. Touch-up damaged galvanized surfaces with one of the following zinc rich coatings:
    - 1. Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA
    - 2. ZiRP, zinc-rich coating by Duncan Galvanizing Corp., Everett, MA
    - 3. ZRC Cold Galvanizing Compound or ZRC Galvilite by ZRC Worldwide, Division of Norfolk Corp., Marshfield, MA;
    - 4. Or accepted equivalent product.

## PART 3 - EXECUTION

### 3.01 ERECTION OF STRUCTURAL STEEL:

- A. Conform to the referenced AISC standards. Brace and secure work until permanent connections are completed. Provide accessories and fasteners to secure the work in place whether or not shown or specified.
- B. Erect work plumb, square, and true to line and level and in precise positions. Provide temporary bracing and guys to counteract loads and stresses to which structure may be subjected, including those due to erection equipment and its operation.
- C. Align the various members to the lines and elevations indicated within the specified erection tolerances. Make adjustments to members prior to making permanent connections. Permanently connect the work in a sequence that will minimize lock-in stress.
- D. Splice members only where shown or specified. On exposed welded connections, 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 the removal of paint on surfaces adjacent to field welds.
- E. Do not enlarge holes in members by burning or the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to place bolts. Do not use gas-cutting torches in the field for correcting fabrication errors in the structural framing.

### 3.02 DAMAGED MEMBERS:

- A. Replace members that are bent, twisted, or damaged. Remove members that are impaired in appearance, strength, or serviceability and replace with new members at no additional cost to Owner.

### 3.03 MISFITS AT BOLTED CONNECTIONS:

- A. Immediately notify the engineer where misfits in erection bolting are encountered. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.
- B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and submit a proposed method of remedy for review by the Engineer.

### 3.04 ANCHOR BOLTS:

- A. Install anchor bolts by using templates, setting drawings, and instructions provided by the fabricator. Verify positions of bolts prior to delivery of steel; report errors or

deviation for adjustment. After anchor bolts have been embedded, protect threads by applying grease and by having the nuts screwed on until the metalwork is installed.

3.05 COLUMN BASEPLATES AND BEARING PLATES:

- A. Set columns with base plates attached and bearing plates for beams and similar structural members to their proper alignment and elevation using shim packs. Tighten anchor bolts after members have been positioned and plumbed. Protruding wedges, shims, or other leveling devices shall not be removed but cut off flush with the base plate prior to packing with grout.

3.06 HIGH STRENGTH BOLTS:

- A. Provide workmanship and techniques for bolted construction in conformance with requirements of AISC Specification for Structural Joints and as indicated or specified.
- B. Install ASTM A 325 bolts with hardened washer under element being turned in tightening. Install plate washers in both outer plies when using oversize and slotted holes. Install galvanized washer under bolt head and nut when using galvanized bolts.
- C. Do not reuse galvanized high-strength bolts, nuts and washers.

3.07 WELDING:

- A. Workmanship and techniques for welded construction to conform to requirements of AWS Structural Welding Code and as indicated or specified.
- B. No field welding permitted unless indicated on Engineer approved fabrication shop drawings.
- C. No field welding permitted on galvanized steel.

3.08 CLEAN-UP:

- A. Upon completion of the work, remove surplus materials, rubbish, and debris resulting from the operations, including disused equipment and implements of service, and leave the entire structure and site, insofar as the work of this section is concerned, in a neat, clean, and acceptable condition.

3.09 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400

END OF SECTION

## SECTION 05 50 00

### MISCELLANEOUS METAL

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide, erect, set and fasten miscellaneous metal items as indicated and specified including surface preparation and shop prime/painting, except as noted below.
- B. Items to be cast in concrete which are to be furnished under this Section for installation under Division 3:
  - 1. Sleeves and inserts.
  - 2. Anchor bolts with layout templates (except anchor bolts for structural steel and anchor bolts for equipment).
  - 3. Overhead door edge angles, recessed slab angles, and anchor assemblies.
- C. Items to be set in masonry which are to be furnished under this Section for installation under Section 04 20 00.
  - 1. Loose lintels, bent plates, miscellaneous plates.
  - 2. Anchor bolts for attachment of masonry to structural frame.
  - 3. Miscellaneous steel framing and shelf angles supporting masonry and precast concrete.

##### 1.02 REFERENCES:

- A. Aluminum Association (AA):
  - 1. AA M12C22A41.
    - a. M12: Mechanical Finish, Non-Specular.
    - b. C22: Chemical Finish, Medium Matte.
    - c. A41: Clear Anodic Coating, Class I.
  - 2. AAM12C22A42:
    - a. M12: Mechanical Finish, Non-Specular.
    - b. C22: Chemical Finish, Medium Matte.

- c. A42: Dark Bronze Anodic Coating, Class 1.
- B. American Institute of Steel Construction (AISC):
  - 1. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
- C. American Welding Society (AWS):
  - 1. D1.1: Structural Welding Code Steel.
- D. Aluminum Association Standard Anodic Finish (AASAF).
- E. ASTM International (ASTM):
  - 1. A36: Specification for Structural Steel.
  - 2. A53: Specification for Pipe, Steel Black and Hot-dipped, Zinc-Coated Welded and Seamless.
  - 3. A123: Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products.
  - 4. A153: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 5. A167: Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
  - 6. A269: Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
  - 7. A276: Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
  - 8. A312: Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
  - 9. A325: Specification for High Strength bolts for Structural Steel Joints.
  - 10. A366: Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
  - 11. A569: Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
  - 12. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

13. B26: Specification for Aluminum-Alloy Sand Castings.
14. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
15. B211: Specification for Aluminum-Alloy Bars, Rods, and Wire.
16. B221: Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
17. B241: Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
18. B247: Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings and Rolled Ring Forgings.
19. B249: Specification for General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, and Shapes.
20. B308: Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded.
21. B429: Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

#### 1.03 DESIGN REQUIREMENTS:

##### A. Railings and Guardrails:

1. Railings and guardrails shall be designed for a live load of 100 plf vertical plus 50 plf horizontal applied concurrently or a concentrated load of 200 pounds applied in any direction at any point along the rail, whichever produces the most extreme condition.
2. Intermediate rails, balusters and panels or fillers shall be designed for a uniform load of 25 psf over the gross area of the guard of which they are a part. This loading need not be added to the loading of the main members prescribed above.
3. Handrails shall be designed for a live load of 50 plf applied in any direction or a concentrated load of 200 pounds applied in any direction at any point along the handrail, whichever produces the most extreme condition.

#### 1.04 SUBMITTALS:

##### A. Shop Drawings: Submit the following in accordance with Section 01 33 00:

1. Manufacturer's literature describing standard items.

2. Shop drawings showing materials, sizes, finishes, locations, attached hardware and fittings, and details for manufactured items and fabricated metalwork, including field erection details showing cuts, copes, miter connections, holes, thread fasteners and welds. Indicate welds, both shop and field, by symbols conforming to AWS standards. Indicate coatings or other protection against corrosion.
3. Setting diagrams, erection plans, templates and directions for installation of backing plates, anchors, and other similar items.
4. Manufacturer's specifications, load tables, anchor details, installation details for grating plank.
5. Material, product data and specifications with standards designated.
6. One sample of finished railing proposed for use. Submit with shop drawing submittal.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Obtain field measurements prior to preparation of shop drawings and fabrication.
- C. Welding Qualification and Certification:
  1. Furnish written welding procedure for all welds in conformance with AWS Structural Welding Code.
  2. Each welder, tacker and welding operator shall be certified by test within the past six months to perform type of work required in conformance with AWS Structural Welding Code. Testing shall be conducted and witnessed by an independent testing laboratory.
  3. Maintain duplicate qualification and certification records at the job site readily available for examination.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01 10 06 and as specified.
- B. Identify and match-mark, materials, items and fabrications, for installation and field assembly.
- C. Deliver items to jobsite as complete units, wherever practicable, ready for installation or erection, with anchors, hangers, fasteners and miscellaneous metal items required for installation.



- D. Carefully handle and store materials, protected from weather, rusting and other damage.
- E. Store structural shapes, pipes, tubes and sheets off the ground on suitable supports, with webs of flanged shapes vertical.

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

#### A. Steel:

- 1. Conform to latest issue for the following:
  - a. Steel Shapes and Plates: ASTM A36
  - b. Steel Pipe: ASTM A53.
  - c. Nuts, Bolts, Rivets, Washers, and Anchorage Devices: ASTM A325 and AISC Specification.
  - d. Steel Sheets: Cold-rolled or hot-rolled carbon steel, ASTM A366, or ASTM A569.

#### B. Stainless Steel:

- 1. Type 316 unless otherwise indicated or specified.
- 2. General: Type (or Grade) 304L for welding, otherwise Type (or Grade) 304.
- 3. Shapes and Bars: ASTM A276
- 4. Plate, Sheet, and Strip: ASTM A167
- 5. Tubing: ASTM A269
- 6. Pipe: ASTM A312, Schedule 40S

#### C. Aluminum:

- 1. Plates, rolled or extruded shapes, sheets or castings conforming (unless otherwise permitted or indicated) to the following Aluminum Association alloy and temper designations:
  - a. Rolled structural sheets and plates: ASTM B209-6061-T6
  - b. Rolled Structural Shapes: ASTM B308-6061

- c. Extruded structural shapes, bars and tubes: ASTM B221 Alloy 6061-T6
  - d. Extruded structural tube or pipe: ASTM B429 Alloy 6061 T-6
  - e. Gratings (bearing bars): ASTM B211-6061-T6  
(crimp bars): ASTM B211-6061-T5
  - f. Castings: ASTM B26-214
  - g. Sheets: ASTM B209-Alclad 3003-H14 and 3003
  - h. Bolts and nuts: Type 316 stainless steel
  - i. Pipe railings: ASTM B241-6061-T6
  - j. Handrail posts: ASTM B241-6061-T6
  - k. Die and hand forgings: ASTM B247 Alloy 6061-T6
  - l. Welding filler rods: ASTM B241-6061-T6
  - m. Plank: ASTM B211-6061-T6 or ASTM B221-6063-T6
- D. Bolts, washers and nuts: Type 316 stainless steel
- E. Welding:
- 1. Provide filler materials appropriate and compatible for the alloys and tempers in accordance with the AWS Structural Welding Code.
  - 2. Provide Class 5356 electrodes.

## 2.02 FABRICATION:

### A. General:

- 1. Fabricate true to shape, size and tolerances as indicated and specified with straight lines, square corners or smooth bends; free from twists, kinks, warps, dents, and other imperfections. Straighten work bent by shearing or punching.
- 2. Dress exposed edges and ends of metal smooth, with no sharp edges and with corners slightly rounded. Construct connections and joints exposed to weather to exclude water.
- 3. Provide sufficient quantity and size of anchors for the proper fastening of work.

4. Fabricate details and connection assemblies in accordance with drawings and with projecting corners clipped and filler pieces welded flush.
  5. Weld shop connections, bolt or weld field connections, unless otherwise noted or specified.
  6. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.
  7. Use connections of type and design required by forces to be resisted, and to provide secure fastening.
  8. Welding:
    - a. Grind exposed edges of welds to a 1/8-inch minimum radius. Grind burrs, jagged edges and surface defects smooth.
    - b. Prepare welds and adjacent areas such that there is (1) no undercutting or reverse ridges on weld bead, (2) no weld spatter on or adjacent to weld or any other area to be painted, and (3) no sharp peaks or ridges along weld bead. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
  9. Bolting:
    - a. Provide Type 316 stainless steel stud bolts and nuts with heavy aluminum washer for fastening of aluminum material.
    - b. Draw up bolts or nuts tight, and deform threads where possible. Use bolts of lengths required so that bolts do not project more than 1/4-inch beyond face of nut. Do not use washers unless specified. Provide hexagonal head bolts with hexagonal nuts.
    - c. Provide holes required for the connection of adjacent or adjoining work wherever noted on drawings. Locate holes for bolting equipment to supports to a tolerance of + 1/16-inch of exact dimensions indicated.
    - d. Provide plastic protection caps.
- B. Fit work together in fabrication shop and deliver complete, or in parts, ready to be set in place.
- C. Fabricated Products:
1. Pipe Sleeves in Concrete Construction: Weld standard weight, black steel pipe, with anchors to exterior to accommodate passage of conduits, pipes ducts and similar items.

2.03 LOOSE LINTELS AND CMU PARTITION SUPPORTS:

- A. Furnish loose lintels and CMU partition supports as indicated on drawings. Fabricate from structural steel shapes and plates. Hot-dip galvanize after fabrication.

2.04 FINISHES:

- A. After fabrication, provide interior and exterior aluminum pipe railing assemblies, kick plates, and posts with Aluminum Association Standard clear anodized finish, Designation C22A41.

2.05 ALUMINUM PROTECTION:

- A. Protect aluminum against electrolysis from all sources as specified in Section 011006. Under no circumstances shall aluminum contact a dissimilar metal.
  - 1. Members in Contact with Concrete Masonry or Mortar: Bitumastic paint, or coal tar epoxy.
- B. Manufacturers:
  - 1. 46H-413 Hi-Build Thene Tar by Tnemec Co., Inc.
  - 2. Bitumastic 300M by Carboline Co.
  - 3. Targuard by Sherwin Williams.
  - 4. Or approved equal.

2.06 GUARD POSTS:

- A. 8-inch diameter ASTM A53 Schedule 80 seamless, galvanized steel pipe filled solidly with Class A concrete, slope top 15 degrees as indicated.

2.07 BOLLARDS:

- A. 6-inch diameter ASTM A53, Schedule 80 seamless, galvanized steel pipe filled solidly with Class A concrete, slope top 15 degrees as indicated.
- B. Weld 1-inch thick galvanized steel plate to pipe bottom and provide four (4) holes for galvanized steel expansion bolts and washers as indicated.

2.08 STRUCTURAL DOOR FRAMES:

- A. Provide at roll-up door jambs and heads as indicated.
- B. Fabricate of structural steel angles and plates welded. Grind welds smooth.

- C. Weld strap anchors on back of angles to secure frame to masonry.
  - D. Hot-dip galvanize after fabrication.
- 2.09 MISCELLANEOUS ITEMS:
- A. Provide items of miscellaneous metalwork not particularly specified, of the shape, size, material and detail indicated and suitable for the purpose intended.
- 2.10 GALVANIZING:
- A. Conform to ASTM A123 or ASTM A153 for zinc-coating by hot-dip process.

### PART 3 - EXECUTION

- 3.01 GENERAL:
- A. Accurately set and properly secure in place as indicated and specified. Where bolted connections are used, draw closely together and draw nuts tightly. Use bolts of lengths so that they do not project more than 1/4-inch beyond face of nut. Do not use washers unless specified. Provide hexagonal head bolts with hexagonal nuts.
  - B. Locate anchors and anchor bolts and build into connecting work. Insert expansion bolts into drilled holes.
  - C. After erection, clean aluminum with mild soap and water, followed by clear water rinse, after erection.
  - D. Furnish all embedded items to General Contractor for installation into concrete formwork.
  - E. Miscellaneous metal items specified shall be installed as indicated, specified and in accordance with accepted shop drawings.
- 3.02 ALUMINUM PROTECTIVE COATING:
- A. Protect aluminum from contact with dissimilar metals, concrete, masonry, mortar or grout.
  - B. Coat surfaces of aluminum with heavy coat of bitumastic paint, or coal tar epoxy.
  - C. Before coating application, clean contact surfaces, remove dirt, grease, oil, foreign substances, followed by immersing in, or wipe thoroughly with, an acceptable solvent. Rinse with clean hot water and dry thoroughly.

3.03 GUARD POSTS:

- A. Install guard posts as indicated and in accordance with accepted shop drawings.

3.04 BOLLARDS:

- A. Install bollards as indicated and in accordance with accepted shop drawings.

3.05 STRUCTURAL DOOR FRAMES:

- A. Provide structural steel angles, plates and strap anchors as indicated.

3.06 ANGLE PROTECTION:

- A. Provide structural steel angles and strap anchors as indicated and specified.

3.07 GALVANIZING:

- A. Touch-up abraded hot-dip galvanized areas by the brush applied method with zinc-rich coatings as specified herein having dry film thickness of not less than 6 mils. Make all repairs to galvanized surfaces in conformance with ASTM A 780.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 05 53 00

### FLOOR ACCESS HATCHES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide floor access hatches and accessories as indicated and in compliance with Contract Documents.
- B. This section includes:
  - 1. Floor Access Hatches.
- C. Furnish all labor, materials, equipment and incidentals necessary to install the products specified.

##### 1.02 REFERENCES:

- A. ASTM International (ASTM):
  - 1. A6: General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.
  - 2. A36: Standard Specification for Carbon Structural Steel.
  - 3. A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 4. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
  - 5. A325: Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
  - 6. A502: Steel Structural Rivets.
  - 7. A569: Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip Commercial Quality.
  - 8. A570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
  - 9. A575: Steel Bars, Carbon, Merchant Quality, M-Grades
  - 10. A576: Steel Bars, Carbon, Hot-Wrought, Special Quality.

11. A675: Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
  12. A786: Rolled Steel Floor Plates.
  13. A1554: Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength
  14. B26: Specification for Aluminum-Alloy Sand Castings.
  15. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  16. B221: Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
  17. B247: Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings and Rolled Ring Forgings.
  18. B580: Standard Specification for Anodic Oxide Coatings on Aluminum
- B. American Welding Society (AWS):
1. D1.1: Structural Welding Code.
  2. D1.2: Structural Welding Code - Aluminum.
- C. National Association of Architectural Metal Manufacturers (NAAMM)
- D. Aluminum Association:
1. Aluminum Association Designation System for Aluminum Finishes
  2. AAMA 607.1: Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum
- 1.03 DESIGN CRITERIA:
- A. Floor Access Hatches
1. 300 psf meeting AASHTO HL-93 loading.
- 1.04 SUBMITTALS:
- A. Submit the following shop drawings in accordance with Section 01 33 00.
1. Detail shop drawings indicating:
    - a. Dimensions.



- b. Sectional assembly.
  - c. Location and identification mark.
  - d. Connections and fastening methods.
  - e. Size and location of supporting frames required.
  - f. Materials of construction.
  - g. Installation instructions.
2. Catalog data and design tables showing limits for span length and deflection under load.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Obtain field measurements prior to preparation of shop drawings and fabrication.
- C. Steel:
  - 1. Conform to codes for arc and gas welding in building construction of AWS and to AISC Specifications. Prepare surfaces to be welded according to requirements of AWS D1.1. No welding shall be done when base metal lower than 0 degrees F.
  - 2. Qualify welding operators in accordance with AWS D1.1. Qualification tests shall be run by recognized testing laboratory accepted by Engineer at Contractor's expense.
- D. Aluminum:
  - 1. Weld with gas metal arc (GMA) or gas tungsten arc (GTA) processes in accordance with manufacturer's recommendations as accepted and in accordance with recommendations of AWS D1.2.

1.06 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. Store to avoid damage.
- C. Remove material that has become damaged as to be unfit for use.

- D. Identify and match-mark all materials, items, and fabrications for installation and field assembly.
- 1.07 FIELD MEASUREMENTS:
- A. Verify dimensions and make any field measurements necessary and be fully responsible for accuracy and layout of the work.
  - B. Review the Contract Drawings and report any discrepancies to the Engineer for clarification prior to starting fabrication.

## PART 2 - PRODUCTS

### 2.01 FLOOR ACCESS HATCHES:

- A. Manufacturers of Prefabricated Floor Access Hatches:
  - 1. Bilco Company, Type J series.
  - 2. Halliday, W series.
  - 3. Thompson Fabrication Company, TE series.
  - 4. Or approved equal.
- B. Component Fabrication:
  - 1. Provide access hatches and frames of, type and size as shown on Drawings.
  - 2. Where hatches are noted with drainage channel, drainage channel frame shall be 1/4-inch thick trough frame with continuous anchor flange around perimeter. Weld 1-1/2 inch diameter drain coupling to frame trough unless indicated otherwise on Drawings.
  - 3. Door leaves: 1/4-inch diamond plate with reinforcing on underside for live load. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.
  - 4. Door Hardware:
    - a. Equip doors with heavy stainless steel hinges with stainless steel pins. Hinges shall be through bolted to cover and frame with stainless steel bolts.

- b. Equip doors with fully enclosed compression springs and hold - open arm with positive locking device with conveniently positioned release handle for easy and controlled closing.
  - c. Hardware shall be Type 316 stainless steel.
5. Locking and Latching Devices:
- a. Stainless steel snap lock mounted on bottom of door leaf with a removable topside handle and socket recessed in cover.
6. Factory finish on aluminum surfaces shall be on aluminum surfaces shall be anodic coating, architectural Class I, clear coating 0.7 mil complying with AAMA 607.1 on exposed surfaces.
7. Manufacturer shall warranty in writing against defects in materials or workmanship for five years.
8. Fall Protection Safety Grate:
- a. Color shall be safety yellow with powder coat factory finish.
  - b. Provide torsion rod lift assistance for ease of operation.
  - c. Provide an aluminum or stainless steel hold open arm to automatically lock the panel in the fully open 90 degree position.
  - d. Provide a stainless steel release handle for closing the grating panel with a provision for locking the panel to prevent unauthorized access.
  - e. All other hardware shall be Type 316 stainless steel.
9. Ladder Safety Extension Post:
- a. Install ladder safety extension post on fixed ladders below hatch cover and design with a telescoping tubular section that locks automatically when fully extended. Completely assemble the unit with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions. Ladder safety post shall be powder coated steel, as manufactured by the Bilco Company or approved equal.

## PART 3 - EXECUTION

### 3.01 EXAMINATION:

- A. Upon receipt of material at job site, inspect all materials for shipping damage. Damaged items shall be replaced at no cost to Owner.
- B. Examine supports for size, layout and alignment. Surface shall be free of debris.
- C. Correct defects considered detrimental to proper installation.

### 3.02 PROTECTION:

- A. Protect aluminum from contact with dissimilar metals, concrete, masonry or mortar. Paint aluminum in contact with concrete in accordance Section 05 55 00. Under no circumstances shall aluminum contact concrete or dissimilar metal.
- B. Apply one coat of bituminous paint coating.
- C. Before coating application, clean contact surfaces, remove dirt, grease, oil, foreign substances, followed by immersing in, or wipe thoroughly with, an acceptable solvent. Rinse with clean hot water and dry thoroughly.

### 3.03 INSTALLATION:

- A. Install and make connections in accordance with accepted submittals and manufacturer's written instructions.
- B. Install materials accurately in location and elevation, level and plumb. Field fabricate as necessary for accurate fit.
- C. Coordinate and furnish anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

### 3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

**DIVISION 06 – WOOD, PLASTIC AND COMPOSITES**

SECTION 06 10 00  
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide the necessary materials to do rough carpentry as indicated and specified.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B18.2.1: Square and Hex Bolts and Screws (Inch Series).
2. B 18.2.3.8M: Metric Hex Lag Screws.
3. B 18.6.1: Wood Screws (Inch Series).

B. ASTM International (ASTM):

1. A 307: Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
2. A 563/A563M: Specification for Carbon and Alloy Steel Nuts.
3. C 954: Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. to 0.112 in. in Thickness.
4. D 5516: Standard Test Method for Evaluating the Flexural Properties of Fire-Retardant Treated Softwood Plywood Exposed to Elevated Temperatures.
5. D 5664: Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
6. E 488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
7. F 568M: Specification for Carbon and Alloy Steel Externally threaded metric Fasteners.

8. F 593: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
  9. F 594: Specification for Stainless Steel Nuts.
  10. F 738M: Specification for Stainless Steel Metric Bolts, Screws, and Studs.
  11. F 836M: Specification for Style 1 Stainless Steel Metric Nuts.
  12. F 1667: Specification for Driven Fasteners: Nails, Spikes, and Staples.
- C. American Wood Preserver's Association (AWPA) Standard:
1. C20: Structural Lumber – Fire-Retardant Treatment by Pressure Process.
  2. P5: Wood Pressure Treated with Water-Borne Preservatives.
- D. Council of American Building Officials (CABO):
1. CABO NER 272: Pneumatic or Mechanically Driven Staples, Nails, P-Nails and Allied Fasteners for Use in All Types of Building Construction.
- E. Federal Specifications:
1. TT-W-550: Wood Preservative, Chromated Copper Arsenate Mixture.
  2. TT-W-571I(2): Wood Preservation, Treating Practices.
- 1.03 SUBMITTALS:
- A. Shop Drawings: Submit the following in accordance with Section 01 33 00:
1. Material Specifications including grade and species.
  2. Details of construction for each item specified.
  3. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
  4. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver to jobsite and store off the ground in a manner to ensure proper drainage, ventilation, and protection from the weather.
- C. Protect lumber and plywood from extreme changes in temperature and humidity.

PART 2 - PRODUCTS

2.01 LUMBER MATERIALS:

- A. Provide lumber of grades and species indicated below for various uses listed:
  - 1. Nailers, cant strips and blocking: Standard grade
    - a. Douglas Fir, coast and inland.
    - b. Fir, white
    - c. Hemlock, eastern and west coast
    - d. Spruce, eastern, Engelmann's and Sitka
    - e. Or approved equal.
  - 2. Plywood: Structural grade.
    - a. Douglas Fir, Coast and inland.
    - b. Spruce, Eastern, Englemann's and Sitka.
    - c. Or approved equal.
- B. Sizes indicated are nominal.
- C. Moisture content of lumber:
  - 1. Kiln dried lumber not over 2-in. nominal thickness: Not to exceed 19 percent.



2. Lumber over 2-in. nominal thickness, not kiln dried: To conform to the rules of the association under which it is graded. Incorporate into structure without further seasoning.

#### 2.02 WOOD PRESERVATIVES:

- A. For wood encased in or in contact with concrete or masonry, and wood items incorporated in the roofing, use preservatives conforming to following:

1. AWWPA standard P5
2. Federal Specification TT-W-550

#### 2.03 FIRE-RETARDANT-TREATED MATERIALS:

- A. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements in AWWPA C20 (lumber). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Use treatment for which chemical manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested by a qualified independent testing agency according to ASTM D 5664, for lumber.
2. Use treatment that does not promote corrosion of metal fasteners.
3. Use Interior Type A High Temperature (HT), unless otherwise indicated.

#### 2.04 PLYWOOD:

- A. Plywood sheathing shall be of a thickness as indicated on the drawings conforming to Douglas Fir Plywood Association requirements for exterior, Grade C-C, Group 1, unsanded and shall bear the stamp of the American Plywood Association.

#### 2.05 FASTENERS:

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

1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

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

- C. Power-Driven Fasteners: CABO NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M).
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
  - 1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Securely fasten and neatly fit carpentry with screws, nails, bolts, or spikes of ample size and suitable type.
  - 1. Secure wood work to masonry and other hard surfaces with expansion bolts and plugs or shield in a manner to provide rigid and permanent support.
  - 2. Countersink screws and bolts. Putty holes and sand smooth.
- B. Install fire retardant treated plywood and blocking as indicated.
- C. Plywood:
  - 1. Plywood sheathing shall be installed with the face grain perpendicular to the supports, with end joints staggered and located at supports. A minimum of 1/16-in. space shall be allowed at end joints and 1/8-in. space at edge joints. Nails for securing the roof panel shall be 6d ring-shank or spiral thread nails spaced 6-in. on centers along panel edges and 12-in. on centers at intermediate supports.

D. Wood Preservatives:

1. Apply preservatives in accordance with Federal Specification TT-W-571I(2), Treating Practices, Table III, Obtain and submit notarized certificate of treatment from treatment company.
2. Prior to treatment, ensure that lumber is sawed to exact length and bored as required insofar as practicable.
3. Apply two heavy coats of preservative to any surfaces cut or bored after treatment, prior to installation.

3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 06 17 00

### METAL-PLATE-CONNECTED FRT WOOD TRUSSES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide metal-plate-connected fire retardant treated (FRT) wood trusses, bridging, bracing, anchorage, and preservative treatment of wood as indicated and specified.
- B. The term "metal-plate-connected wood trusses" as defined in this Section, includes planar structural units consisting of metal-plate-connected members fabricated from dimensioned lumber, cut and assembled before delivery to the Project site.

##### 1.02 REFERENCES:

- A. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7: Minimum Design Loads for Buildings and Other Structures
- B. American National Standards Institute:
  - 1. ANSI/TP1.1: National design standard for Metal-Plate-Connected Wood Truss Construction.
  - 2. TPI HIB: Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses.
  - 3. TPI DSB: Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses.
- C. ASTM International (ASTM):
  - 1. A 123: Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - 2. A 153/A 153M: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 3. A 143: Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting.

4. A 384: Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
5. A 385: Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
6. A 307: Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
7. A 563/A 563: Specification for Carbon and Alloy Steel Nuts.
8. A 653/ A 653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
9. A 666: Specification for Annealed or Cold-Worked Austenitic stainless Steel Sheet, strip, Plate, and Flat Bar.
10. A 780: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
11. F 568: Specification for Carbon and Alloy Steel externally Threaded Metric Fasteners.

D. American Society of Mechanical Engineers:

1. 10. B18.2.1: Square and Hex Bolts and Screws.
2. 11. B18.2.3.8: Hex Lag Screws.

E. U.S. Department of Commerce, National Institute of Standards and Technology:

1. DOC PS 20: American Softwood Lumber Standard.

F. Council of American Building Officials:

1. CABO NER-272: Pneumatic or Mechanically Driven Staples, Nails, P-Nails and Allied Fasteners for Use in All Types of Building Construction.

G. Federal Specifications:

1. FS FF-N-105B: Nails, Brads, Staples and Spikes: Wire, cut and Wrought.

H. International Code Conference (ICC):

1. International Building Code

### 1.03 SUBMITTALS:

#### A. Submit the following in accordance with Section 01 33 00:

1. Completely detailed shop drawings for all trusses. Indicate all dimensions, architectural details, connections, openings and lifting devices. Mark each member for identification. Show mark on erection plan and place legibly on unit at time of manufacture. Do not fabricate members before shop drawings are approved by the Engineer.
2. Manufacturer's specifications, anchor details and installation details.
3. Shop drawings showing materials, sizes, finishes, locations of appurtenances and attached hardware and fittings.
4. Setting diagrams, erection plans, templates including field erection details showing cuts, copes, connections, holes and threaded fasteners.
5. Drawings shall bear the seal and signature of a Professional Structural Engineer holding current registration in the state of Delaware.
6. Drawings shall include as minimum information for each truss:
  - a. Codes and specifications to which structural design conforms.
  - b. Span, depth, slope, camber, weight and spacing of trusses.
  - c. Deflections under live and total loads.
  - d. Required bearing widths and locations.
  - e. Top Chord Dead Load
  - f. Top Chord Live Load
  - g. Bottom Chord Dead Load
  - h. Bottom Chord Live Load
  - i. Concentrated loads and their points of application
  - j. Wind and seismic criteria
  - k. Vertical and horizontal support reactions under the various design loading combinations.
  - l. Member material specifications, sizes and gauges.
  - m. Truss web bracing, and splices as required.
  - n. Bridging member sizes, connections and locations.
  - o. Truss connection Requirements:
    - (1) Truss anchorage
    - (2) Truss ply to ply
    - (3) Field Splices

#### B. Drawings of modifications or changes in features or details that are necessitated by design requirements. Make all such modifications without additional compensation.

- C. Manufactures design drawings shall bear the seal and signature of a structural engineer licensed in the state where the trusses are to be installed. Drawings shall be approved by the Engineer prior to fabrication.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Design trusses in accordance with these specifications and where any applicable design feature is not specified herein, design shall be in accordance with applicable provisions of the latest edition of National Design Specifications for Wood Construction (NDS) American Forest and Paper Association (AFPA), Design Specifications for Metal Plate Connected Wood Trusses (ANSI/TPI 1), and the Governing Building Code.
- C. Fabrication shall be performed by a firm that participates in a recognized quality-assurance program that involves inspection by the Southern Pine Inspection Bureau (SPIB); Timber Products Inspection, Inc.; Truss Plate Institute (TPI); or other independent inspecting and testing agency acceptable to the Engineers and authorities having jurisdiction and is experienced in fabricating metal-plate-connected wood trusses similar to those indicated for this Project and with a record of successful in-service performance.
- D. Installation shall be performed by a firm that has completed wood truss installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- E. Provide product certificates signed by an officer of the truss fabricating firm certifying that the metal-plate-connected wood trusses supplied for the project comply with specified requirements and shop drawing.
- F. Provide Material test reports from a qualified independent testing agency indicating and interpreting test results relative to compliance
- G. Provide material certificates for dimensioned lumber specified to comply with minimum allowable unit stresses. Indicate species and grade for each use and design values approved by the American Lumber standards Committee (ALSC) Board of review.
- H. Provide wood treatment data as follows, including chemical treatment manufacturer's instructions for handling, storing, installing, and finishing treated materials:
  - 1. For each type of preservative-treated wood product, include certification by treating plant starting type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.

2. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated before shipment to truss fabricator.
3. For fire-retardant-treated wood products, include certification by treating plant that treated materials comply with specified standard and other requirements as well as data relative to bending strength, stiffness, and fastener-holding capacities of treated materials.

#### 1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in conformance with Section 011006 and as specified.
- B. Transport, handle and store materials to protect from weather, rusting, corrosion or other damage.
- C. Store structural members off the ground on supports, with webs vertical. Cover and protect from snow, rain and ground splatter.
- D. Use nylon slings or padded cables for handling trusses. Do not drop or drag trusses.
- E. Provide galvanized bolts, nuts and washers. Ship and store together in wood or metal containers.

### PART 2 - PRODUCTS

#### 2.01 DESIGN REQUIREMENTS:

- A. Design trusses in accordance with the latest edition of ASCE 7, the specified building code and these specifications.
- B. Design roof trusses for the dead load of the member and the superimposed dead load of all ceiling and roof components.
- C. Design roof trusses for the uniform and concentrated live loads, wind loads and seismic loads indicated on the drawings and specified. The roof trusses shall carry an Underwriter's Laboratories wind uplift Class-90 rating.
- D. Design all individual framing members of the building roof and truss system for the snow, live, wind and seismic loads indicated.
- E. Vertical deflection building trusses shall not exceed 1/240th of the span under design loads. Vertical deflection building trusses supporting plaster ceilings shall not exceed 1/360th of the span under design loads.



- F. The roof coverings shall be designed for the specified live load and the wind load, and shall carry an Underwriters' Laboratories wind uplift Class 90 rating. Deflection of the roof panels shall not exceed 1/180th of its span when supporting these loads.
- G. The truss manufacturer shall obtain information for all additional loads required for the design from the contractor and incorporate these loads into the design.
- H. The structural analysis shall include the effect of geometric irregularities such as hatches, dormer openings and perimeter support members.
- I. Truss system, with framing components and accessories shall provide a complete framing system, ready for deck installation.
- J. Truss design shall provide minimum clear truss panel openings of 16 inches x 14 inches to accommodate ductwork.
- K. Design Loads:
  - 1. Design roof trusses for the dead load of the truss and the superimposed dead load of all components attached to or supported from the truss, including all roofing and ceiling materials, piping ductwork and lighting. As a minimum, the truss design shall consider a uniform dead load of 15 pounds per square foot applied to the top chord and 10 pounds per square foot applied to the bottom chord.
  - 2. Design roof trusses for the uniform and concentrated live loads, wind loads and seismic loads indicated on the drawings and specified.
  - 3. Design roof trusses for actual piping and equipment loads to be supported by the member. As a minimum the roof frames shall be designed for a uniform piping load of 15 pounds per square foot of tributary area or a concentrated load of 2000 pounds located at any point along the length of the member, whichever produces the most severe condition.
  - 4. Live Load: The trusses shall be designed for a minimum live load of 35 psf.
  - 5. Wind Load: Wind loads shall be determined in accordance with ASCE 7.
  - 6. Snow Load: Snow loads shall be determined in accordance with ASCE 7.
  - 7. Seismic Loads: Seismic loads shall be computed in accordance with ASCE 7.
  - 8. Loading Combinations: Load combinations shall be as prescribed in ASCE 7.
  - 9. Design trusses for loads resulting from lifting, transporting and installing.

10. Trusses, connections and anchorages shall be designed for a lateral (seismic/wind) load applied at the end anchorage equivalent to 200 pounds per linear foot of supporting wall.

## 2.02 DIMENSION LUMBER:

- A. Provide trusses fabricated of Southern Yellow Pine members.
- B. Factory mark each piece of lumber with type, grade, mill, and grading agency.
- C. Lumber shall be dressed lumber, surfaced four sides, manufactured to actual sizes required by PS 20 and comply with the following:
  1. Moisture content: Seasoned, with 15 percent maximum moisture content at time of dressing and shipment for sizes 2 inches or less in nominal thickness.
  2. Species and grade that complies with the following for species group as defined in NFOPA 01 for extreme fiber stress in bending  $F_b$  for single and repetitive members, and for modulus of elasticity E.
    - a. Chord members:  $F_b$  of 1,500 psi for single member use and 1,750 psi for repetitive member used, and E for 1,600,000 psi.
    - b. Web Members:  $F_b$  of 1,500 psi for single member use and 1,750 psi for repetitive member use, and E of 1,600,000 psi.
  3. Fire retardant treated lumber, if applicable, shall meet specifications of truss design and ANSI/TPI 1 and shall be redried after treatment in accordance with APA Standard C20. Allowable values must be adjusted in accordance with NDS. Truss manufacturer shall supply certificate of compliance for treated material.

## 2.03 CONNECTOR PLATES:

- A. Provide metal connector plates from one source and by a single manufacturer.
- B. Fabricate connector plates from metal complying with requirements indicated:
  1. Hot-Dip Galvanized Steel Sheet: Structural quality sheet, zinc coated by hot-dip process complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; Grade 33 and not less than 0.0359 inch (0.91 mm) thick.
  2. Stainless-Steel Sheet: ASTM A 666, Type 316, chromium nickel steel sheet; 33,000 psi (230 Mpa) minimum yield strength and not less than 0.035 inch thick.
  3. Fasteners: Provide fasteners of the size and type indicated that comply with requirements specified below for material and manufacture:

- a. Nails Wire, Brads, and Staples: FS FF-N-105
- b. Power Driven Fasteners: CABO NER-272
- c. Wood screws: ASME B18.2.1
- d. Lag Bolts and Screws: ASME B18.2.1 (ASME B18.2.3.8M)
- e. Bolts: steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and flat washers.

#### 2.04 FRAMING ANCHORS:

- A. Framing anchors shall be furnished by a single supplier.
- B. Provide products with allowable design loads published by manufacturer that meet or exceed those indicated or required. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- C. Provide hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type indicated.
- D. Stainless steel shall be ASTM A 666, type 304 or 316, chromium nickel steel sheet; 33,000 psi (230 Mpa) minimum yield strength.

#### 2.05 ACCESSORIES:

- A. Anchors:
  - 1. Hurricane Anchors for wood to wood: Steel sheet zinc-coated by hot-dip process prior to fabrication to comply with ASTM A653 for Coating designation.
  - 2. Anchor bolts for fastening wood sleepers shall comply with ASTM A307 and shall be galvanized to ASTM A153. Anchor bolts shall be placed in coordination with location of the trusses.

#### 2.06 GALVANIZE:

- A. Provide hot-dip galvanizing in conformance with ASTM A 123, Grade 100 to all steel indicated or specified to be galvanized.

- B. Provide hot-dip galvanizing, in conformance with ASTM A 153, to all bolts, nuts and washers that will be used with galvanized steel.
  - 1. Prepare the steel surface in conformance with the manufacturer's printed instructions immediately before applying the initial coat of the two coat system.
  - 2. Tap bolt nuts after hot-dip galvanizing in conformance with ASTM A 563.
  - 3. Inspect galvanized material for compliance with these specifications. Mark the material with a clearly visible stamp indicating the name of the galvanizer, the ASTM number and the weight of zinc coating in ounces per sq. ft.

2.07 GALVANIZE TOUCH-UP:

- A. Galvanize Touch-Up: Where galvanizing is damaged, touch-up abraded areas, using brushed-on method, with zinc-rich coating. Touch-up repair with zinc-rich coating of not less than 3 mil and not more than 6 mil dry film thickness.
- B. Touch-up all damaged galvanized surfaces with one of the following zinc rich coatings:
  - 1. Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA
  - 2. ZIRP, zinc-rich coating by Duncan Galvanizing Corp., Everett, MA
  - 3. ZRC Cold Galvanizing Compound or ZRC Galvilite by ZRC Worldwide, Division of Norfolk Corp., Marshfield, MA;
  - 4. Or equal.

2.08 FIRE-RETARDANT-TREATED MATERIALS:

- A. Where fire-retardant-treated wood is indicated, comply with applicable requirements of AWWA C20 (lumber). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Provide fire-retardant-treated wood acceptable to authorities having jurisdiction and for which a current model code research or evaluation report exists that evidences compliance of fire-retardant-treated wood for application indicated.
- C. For interior locations, use chemical formulation that produces treated lumber with the required design properties under conditions present after installation.
- D. Bending strength, stiffness, and fastener-holding capacities shall not reduced below values published by manufacturer of chemical formulation under elevated temperature

and humidity conditions simulating installed conditions when tested by a qualified independent testing agency.

- E. No form of degradation shall occur due to acid hydrolysis or other causes related to treatment.
- F. Contact with treated wood shall not promote corrosion of the fasteners.
- G. Inspect each piece of treated lumber after drying and discard damaged or defective pieces.

2.09 FABRICATION:

- A. Fabricate each element and connection as indicated on the fabrication shop drawings approved by the Engineer.
- B. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- C. Fabricate metal connector plates to size, configuration, thickness, and anchorage details required to withstand design loadings for types of joint designs indicated.
- D. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances listed. Position members to produce design camber indicated.

Tolerance	
Length < 30 feet	1/2-inch
Length > 30 feet	3/4-inch
Height < 60 inches	1/4-inch
Height > 60 inches	1/2-inch

- E. Connect truss members by metal connector plates located and securely embedded simultaneously into both sides of wood members by air or hydraulic press

PART 3 - EXECUTION

3.01 ERECTION:

- A. Do not install trusses until supporting construction is in place, braced and secured.
- B. Verify that rough-in utilities and/or chases that will interface with the trusses or truss bracing are in correct locations and do not interfere with truss placement
- C. Do not install trusses before unacceptable conditions have been corrected. Commencement of construction activities of this section indicates installer's acceptance of conditions.

- D. Assemble trusses delivered to the Project site in more than one piece before installation using the correct fasteners.
- E. Hoist trusses in place by lifting equipment suited to size and types of trusses required, exercising care not to damage truss members or joints.
- F. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- G. Hold trusses securely in place with temporary bracing and stays to resist all vertical and lateral loads, until members are permanently fastened and floors and roofs completed.
- H. Space, adjust, and align trusses in location before permanently fastening as indicated on the drawings
- I. Anchor trusses securely at all bearing points using metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.
- J. Securely connect each truss ply required for forming built-up girder trusses.
- K. Anchor trusses to girder trusses as indicated on the approved shop drawings.
- L. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- M. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated
- N. Install wood trusses within installation tolerances of ANSI/TPI 1.
- O. Do not cut or remove truss members.
- P. Report errors in shop fabrication or deformation resulting from handling or transportation immediately to Engineer. Remove from job site incorrectly fabricated or deformed material at no additional cost to the Owner.
- Q. Do not alter trusses in the field.
- R. Align and adjust members forming parts of a complete assembly before permanent fastening.

3.02 GALVANIZE TOUCH-UP:

- A. Galvanize Touch-Up: Where galvanizing is damaged, touch-up abraded areas, using brushed-on method, with zinc-rich coating. Touch-up repair with zinc-rich coating of not less than 3 mil and not more than 6 mil dry film thickness.
- B. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 06 60 10

### FIBERGLASS REINFORCED PRODUCTS AND FABRICATIONS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. This section includes:
  - 1. FRP Grating.
  - 2. FRP Structural Shapes.
  - 3. FRP Railing.
  - 4. FRP Ladders.
- B. Furnish all labor, materials, equipment and incidentals necessary to install the fiberglass polymer products as shown on the Drawings.

##### 1.02 REFERENCES

- A. ASTM International (ASTM):
  - 1. [D70](#): Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method).
  - 2. [D256](#): Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
  - 3. [D635](#): Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
  - 4. [D638](#): Standard Test Method for Tensile Properties of Plastics.
  - 5. [D695](#): Standard Test Method for Compressive Properties of Rigid Plastics.
  - 6. [D696](#): Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degree C and 30 Degree C with a Vitreous Silica Dilatometer.
  - 7. [D732](#): Standard Test Method for Shear Strength of Plastics by Punch Tool.



8. [D790](#): Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
9. [D792](#): Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
10. [D2583](#): Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
11. [D3918](#): Standard Terminology Relating to Reinforced Plastic Pultruded Products.
12. [E84](#): Standard Test Method for Surface Burning Characteristics of Building Materials.
13. [G152](#): Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
14. [G153](#): Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

### 1.03 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00 - Submittals.
  1. Detail shop drawings indicating:
    - a. Field verified dimensions.
    - b. Sectional assembly.
    - c. Location and identification mark.
    - d. Connections, connections to structure and fastening methods.
    - e. Size and location of supporting frames required.
    - f. Materials of construction.
    - g. Installation instructions.
  2. Catalog data and design tables showing limits for span length and deflection under various and concentrated loads.
  3. Provide signed and sealed Shop Drawings and calculations, which are prepared by a Registered Professional Engineer licensed in the State in which the fiberglass reinforced product will be installed.

#### 1.04 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00 - Quality Assurance.
- B. Provide documentation showing that the Contractor doing this work has a minimum of 5 years experience in the manufacture and installation of FRP systems similar to that indicated for this project, with sufficient capacity to produce required units without causing delay of work.
- C. Install materials in accordance with the manufacturer's instructions.

#### 1.05 DELIVERY STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 011006 – Delivery, Storage and Handling.
- B. Store materials during and after shipment to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to materials, including damage due to over exposure to sun.
- C. Remove material that is damaged from the site, at no cost to the Owner.
- D. Identify and match-mark all materials, items, and fabrications for installation and field assembly.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Seasafe, Inc.
- B. Strongwell
- C. IMCO Reinforced Plastics, Inc.
- D. International Grating, Inc.
- E. Fibergrate Composite Structures, Inc.
- F. Creative Pultrusions, Inc.
- G. Or approved equal.
- H. Provide new materials free from defects and imperfections that might affect performance of finished product.

- I. After fabrication, seal cut ends, holes and abrasions of FRP shapes with a compatible resin coating to prevent intrusion of corrosion and moisture.
- J. Fabricate so that exposed surfaces are smooth and true to form.
- K. Manufacture FRP products using vinyl ester resin with flame retardant and UV inhibitor additives. Provide synthetic surface veil covering exterior surface. Provide FRP shapes with flame spread of 25 or less in accordance with ASTM E84.
- L. Provide FRP products exposed to weather with ultraviolet inhibitor and one mil thick UV coating to shield from ultra-violet light.
- M. Provide Type 316L stainless steel metal accessories unless noted otherwise.

## 2.02 FRP GRATING

- A. Design Requirements:
  - 1. Grating:
    - a. Design grating and support system to sustain dead loads and superimposed live loads.
    - b. 100 psf uniform live load or 300 pound concentrated live load, whichever produces maximum stress.
  - 2. Deflection:
    - a. 1/4-inch maximum under uniform live load of 100 psf for grating.
    - b. L/240 maximum for support members.
- B. Fabricate grating from pultruded bearing bars and cross rods. Assemble grating using a locking cross-rod design that makes a permanent connection between the cross-rod and bearing bar, and is completely bond into a one-piece panel.
- C. Color shall be gray.
- D. Provide grating with a slip resistant epoxy grit surface.
- E. Use Type 316L stainless steel grating hold down clamps spaced as required by manufacturer, but not greater than 4 feet on center. Provide two at each support with a minimum of four per panel.
- F. Position grating sections flat and square with ends bearing minimum 1-1/4 inches on supporting structure.

- G. Maximum Grating Clearances:
  - 1. 1/2-inches from concrete walls.
  - 2. 1/4-inches between sections and at ends.

## 2.03 STRUCTURAL SHAPES

- A. Design requirements:
  - 1. Design Loads:
    - a. Design structural framing to sustain dead loads and superimposed live loads.
    - b. 100 psf uniform live load or 300 pound concentrated live load, whichever produces maximum stress.
  - 2. Deflection:
    - a. L/240 maximum.
- B. Manufacture structural shapes by the pultrusion process.
- C. Provide structural shapes with a UV inhibitor.
- D. Provide structural shapes containing a glass fiber reinforced vinyl ester resin matrix, approximately 50 percent glass by weight with a synthetic surface veil outer layer covering the exterior surfaces. Provide glass strand rovings shall be for longitudinal strength. Provide continuous strand glass mats or stitched reinforcements shall for transverse strength.
- E. Provide Type 316L stainless steel bolts and washers.
- F. Abrade joint surfaces to be bonded to remove surface gloss and be free of burrs or other foreign materials that would prevent proper adhesion.

## 2.04 RAILING

- A. Design requirement:
  - 1. Design railing system to meet the configuration and loading requirements of OSHA, IBC or local buildings codes. Apply requirements of the most stringent code.
- B. Fully bond all post to rail connections with an epoxy adhesive and with an internal connection for added strength and durability. Provide smooth transitions between post and rail connections.

- C. Provide kickplates where required by OSHA. Kick plate shall be 4 inches by 1/2-inch thick pultruded shape attached to posts with stainless connectors.
- D. Color shall be safety yellow.
- E. Fabricate handrail to standard two-rail design unless noted otherwise.
  - 1. Post Locations:
    - a. No greater than 12 inches from horizontal or vertical change in handrail direction.
    - b. Post centers shall be no greater than 60 inches apart on any straight run of rail.
    - c. Post centers shall be no greater than 48 inches apart on inclined rail section.
- F. Provide side mounted, base mounted, embedded, or removable anchorage mounted handrail as noted on Drawings.
- G. Accurately locate handrail sections and erect plumb and level.

## 2.05 LADDERS

- A. Design requirement:
  - 1. Design ladder to meet the configuration and loading requirements of OSHA, IBC or local buildings codes. Apply requirements of the most stringent code.
- B. Provide ladder side rails 2 inches by 2 inches by 0.156 inches minimum thickness square tubes manufactured by the pultrusion process.
- C. Provide ladder rungs pultruded 1 inch diameter minimum solid round bar with slip resistance epoxy grit surface.
- D. Install ladder fiberglass stand-off brackets at a maximum of 4 feet on center.
- E. Ladder shall be safety yellow.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Remove and replace damaged items at no cost to Owner.



**DIVISION 07 – THERMAL AND MOISTURE PROTECTION**

SECTION 07 11 13

BITUMINOUS DAMPPROOFING

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. Provide and apply materials for below grade dampproofing as indicated and specified.

1.02 REFERENCES:

- A. ASTM International (ASTM):

- 1. D 1227: Specification for Emulsified Asphalt used as a Protective Coating for Roofing.
- 2. D 1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:

- 1. Product data for each type of product specified, including data substantiating that materials comply with requirements for each dampproofing material specified. Include recommended method of application, recommended primer, number of coats, and coverage or thickness.
- 2. Product data from dampproofing manufacturer stating the specified VOC content and compliance.
- 3. Recycled Content Submittal:
  - a. For products having recycled content, documentation indicating specified percentages by weight of postconsumer and preconsumer recycled content.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified herein.
- B. Installer Qualifications: Engage an experienced Installer who has completed bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.



- C. Single-Source Responsibility: Obtain primary dampproofing materials and primers from one source and by a single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver and store packaged materials in original packages.
- C. Packages or materials showing evidence of damage or inclusion of foreign material will be rejected.

1.06 PROJECT CONDITIONS:

- A. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.
- B. Weather Limitations: Proceed with dampproofing only when existing and forecasted weather conditions will permit work to be performed according to manufacturer's recommendations and warranty requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS:

- A. Hydrocide 700B Semimastic by ChemRex, Inc.; Sonneborn Building Products Div.
- B. Liquid Asphalt 472 Emulsion by Koppers Industries, Inc.
- C. 220AF Fibered Dampproofing by Karnak Chemical Corporation.
- D. Or approved equal.

2.02 BITUMINOUS DAMPPROOFING:

- A. Cold-Applied, Asphalt Emulsion Dampproofing: Asphalt-based emulsions recommended by the manufacturer for dampproofing use when applied according to the manufacturer's printed instructions.
  - 1. Semimastic Grade: Emulsified asphalt semimastic, prepared with mineral-colloid emulsifying agents and containing fibers other than asbestos, complying with ASTM D 1227, Type II, Class I.

2. VOC Content: 0.25 lb/gal. (30 g/L) or less.

## PART 3 – EXECUTION

### 3.01 PREPARATION:

- A. Clean substrate of projections and substances detrimental to work; comply with recommendations of manufacturer.
- B. Install cant strips and similar accessories as shown and as recommended by manufacturer.
- C. Fill voids, seal joints, and apply bond breakers as recommended by manufacturer.
- D. Install separate flashings and corner protection stripping, as recommended by manufacturer, where indicated to precede application of dampproofing. Comply with details shown and with manufacturer's recommendations.
- E. Prime substrate as recommended by manufacturer.
- F. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

### 3.02 INSTALLATION, GENERAL:

- A. Comply with manufacturer's printed instructions except where more stringent requirements are indicated and where Project conditions require extra precautions to ensure satisfactory performance of work.
- B. Application: Apply dampproofing to the following surfaces.
  1. Exterior, below-grade surfaces of exterior concrete walls in contact with earth or other backfill, where indicated on the drawings.
- C. Apply vertical dampproofing down walls from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when the Project is completed.
- D. Semimastic Grade: Brush or spray apply a coat of asphalt emulsion dampproofing at a rate of 5 gal./100 sq. ft., to produce a uniform, dry-film thickness of not less than 30 mils.

3.03 PROTECTION AND CLEANING:

- A. Protect exterior, below-grade dampproofing membrane from damage until backfill is completed. Remove overspray and spilled materials from surfaces not intended to receive dampproofing.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 07 11 19

### AIR/VAPOR BARRIER MEMBRANE

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide air/vapor barrier membrane and accessories as indicated and specified.

##### 1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
  1. ASTM D 412: Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
  2. ASTM E 96: Test Methods for Water Vapor Transmission of Materials.
  3. ASTM E 283: Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
  4. ASTM E 330: Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
  5. ASTM E 699: Criteria for Evaluation of Agencies Involved in Testing Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee E-6.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  1. Product Data: Submit manufacturer's product data for each material. Include standard details, certified test results, installation instructions, and recommendations for sealing penetrations and perimeter.
  2. Samples: Submit two labeled samples of each product, not less than 6 by 12 inches in size.
  3. Shop Drawings for Air/Vapor Barrier Membrane Mockup: Submit shop drawings for mockup indicating size of mockup, details of construction, and expansion and control joints. Include relationship with adjacent materials, sequence of installation and materials and methods for sealing penetrations. Address shop drawing review

comments prior to construction of mockup. Revise to show changes necessary to mockup.

4. Shop Drawings: Submit shop drawings indicating details of construction, including expansion and control joints. Include relationship with adjacent materials, sequence of installation and materials and methods for sealing penetrations. Shop drawings shall include details of each connection, as applicable to the project:
  - a. Walls and floor slab.
  - b. Wall openings.
  - c. Walls and ceilings.
  - d. Walls and ceilings across control joints.
  - e. Different wall systems.
  - f. Walls, floors, and ceilings to utility, pipe, and duct penetrations.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Installer Qualifications:
  1. Each worker who is installing air barriers must be either a Certified Applicator as defined in Paragraph 1.05.C below or an installer who is registered with ABAA.
- C. Air/vapor barrier installers must be trained and certified by NECA (National Energy Conservation Association) and PSDI (Professional Skills Development Institute) for energy conservation.
- D. Single-Source Responsibility: Obtain air/vapor barrier materials from a single manufacturer.
- E. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).
- F. Mockups of Air Vapor Barrier Membrane Installation: Prior to installation on the building, construct a mockup of a typical exterior wall assembly to indicate relationship of materials with air barrier and quality of workmanship. Mockup shall use actual air barrier membrane and wall materials as indicated in Section 04 20 00. Remove mockup assemblies from site at completion of project. Mockup is subject to acceptance by Engineer, rebuild mockups which are rejected at no additional cost to the Owner.

G. Project Meetings:

1. Pre-Construction Meeting: After completion of mockup shop drawings, but prior to construction of mock-up, convene a meeting with representatives of materials to be incorporated in the mockup and installers of mockup. Agenda shall include sequence and details of construction to ensure continuity of air barrier.
2. Pre-Installation Meeting: Convene a pre-installation meeting a minimum of one week prior to commencing work of this section. Attendees shall include representatives of air barrier manufacturer, exterior wall installers and all other associated trades involved in air/vapor barrier installation including project superintendent. Agenda shall include the following:
  - a. Review of submittals.
  - b. Review of mock-ups.
  - c. Coordination with sequence of installation with adjacent materials.
  - d. Schedule for subsequent work covering air barrier.
  - e. Procedures for quality assurance.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.

PART 2 - PRODUCTS

2.01 AIR/VAPOR BARRIER MEMBRANE SHEETING:

- A. Air/Vapor Barrier Membrane Sheet: Class A, fire rated, 2-mil thick polyamide film for use at ceiling against fiberglass insulation.
- B. Transition Materials: To provide an air barrier between the membrane and adjacent materials, provide transition materials consisting of extruded low-modulus silicone sheet and silicone sealant intended to adhere to polyethylene side of membrane and adjacent material. Provide the following materials as recommended by the manufacturer of the air barrier membrane:
  1. Cleaning Agent: Toluene.
  2. Silicone Sheet: Provide preformed corners.
  3. Silicone Sealant.

C. Performance Criteria:

1. Air permeability no greater than 0.004 CFM/Ft<sup>2</sup> under pressure differential of 0.3 in. of water.
2. Moisture Control: Maximum permeability no greater than 1 perm.

D. Manufacturers: Subject to compliance with requirements, provide one of the following products:

1. CertainTeed Saint-Gobain.
2. Monsey Bakor.
3. Grace Construction Products.
4. Carlisle Coatings & Waterproofing Inc.
5. Or approved equal.

2.02 LIQUID AIR/VAPOR BARRIER MEMBRANE:

A. Liquid Air Barrier Membrane: Water-based asphalt emulsion modified with a blend of synthetic rubbers and special additives, compatible with sheet membranes.

B. Transition Materials: To provide an air barrier between the membrane and adjacent materials, provide transition materials consisting of extruded low-modulus silicone sheet and silicone sealant intended to adhere to polyethylene side of membrane and adjacent material. Provide the following materials as recommended by the manufacturer of the air barrier membrane:

1. Cleaning Agent: Toluene.
2. Silicone Sheet: Provide preformed corners.
3. Silicone Sealant.

C. Performance Criteria:

1. Air permeability no greater than 0.004 CFM/Ft<sup>2</sup> under pressure differential of 0.3 in. of water.
2. Moisture Control: Maximum permeability no greater than 0.1 perms.

D. Manufacturers: Subject to compliance with requirements, provide one of the following products:

1. Rubber Polymer Corp.
2. Monsey Bakor.
3. Grace Construction Products.
4. Carlisle Coatings & Waterproofing Inc.
5. Or approved equal.

### PART 3 – EXECUTION

#### 3.01 PREPARATION:

A. Clean substrate surfaces to receive air vapor barrier membrane in accordance with manufacturer's instructions. Apply primer if recommended by manufacturer.

B. Installation:

1. Strictly comply with air barrier membrane manufacturer's printed instructions, reviewed submittals and the following:
  - a. Apply materials within manufacturer's requirements for temperature and weather conditions.
  - b. Do not apply to wet or frozen substrates.
  - c. Do not allow contamination with dust or dirt.
  - d. Seal completely at edges, perimeter and penetrations.
2. Protect installed work from damage due to harmful weather exposures, physical abuse, and other causes.
3. Provide temporary protection over air barrier membrane if materials covering air barrier membrane will not be installed within manufacturer's recommended time limit for exposure.
4. Repair damage to air barrier membrane caused by construction activities or subsequent work prior to covering.



3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 07 13 26

### SELF-ADHERING SHEET WATERPROOFING

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION:

- A. Provide self-adhering sheet waterproofing and accessories as indicated and specified.

##### 1.02 REFERENCES:

###### A. ASTM International (ASTM):

1. ASTM C 578: Specification for Rigid, Cellular Polystyrene Thermal Insulation.
2. ASTM C 836: Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
3. ASTM D 412: Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension.
4. ASTM D 570: Test Method for Water Adsorption of Plastics.
5. ASTM D 1970: Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
6. ASTM D 4258: Practice for Surface Cleaning Concrete for Coating.
7. ASTM D 4263: Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
8. ASTM D 5385: Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
9. ASTM D 6135: Practice for Application of Self-Adhering Modified Bituminous Waterproofing.
10. ASTM E 96: Test Methods for Water Vapor Transmission of Materials.
11. ASTM E 154: Test Methods for Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls, or as Ground Cover.

### 1.03 SUBMITTALS:

#### A. Submit the following in accordance with Section 01 33 00:

1. **Product Data:** Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
2. **Shop Drawings:** Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. **Samples:** For the following products:
  - a. 12-in. by- 12-inch square of waterproofing and flashing sheet.
4. **Installer Certificates:** Signed by manufacturers certifying that installers comply with requirements.
5. **Product Test Reports:** From a qualified independent testing agency indicating and interpreting test results of waterproofing for compliance with requirements, based on comprehensive testing of current waterproofing formulations.
6. **Sample Warranty:** Copy of special waterproofing manufacturer's and Installer's warranty stating obligations, remedies, limitations, and exclusions before starting waterproofing.

### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. **Installer Qualifications:** A qualified installer who is authorized, approved, or licensed by waterproofing manufacturer to install manufacturer's products.
- C. **Source Limitations:** Obtain waterproofing materials through one source from a single manufacturer.
- D. **Preinstallation Conference:** Before installing waterproofing, conduct conference at Project site to comply with requirements of Section 01 31 19. Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver liquid materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- C. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by waterproofing manufacturer.
- D. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- E. Store rolls according to manufacturer's written instructions.
- F. Protect stored materials from direct sunlight.

1.06 PROJECT CONDITIONS:

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
  - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.07 WARRANTY:

- A. Special Manufacturer's Warranty: Written warranty, signed by waterproofing manufacturer agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight during specified warranty period.
  - 1. Warranty does not include failure of waterproofing due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in substrate exceeding 1/16 inch in width.
- B. Warranty Period: Five years after date of Substantial Completion.
- C. Special Installer's Warranty: Written waterproofing Installer's warranty, signed by Installer, covering Work of this Section, for warranty period of two years.

## PART 2 - PRODUCTS

### 2.01 RUBBERIZED-ASPHALT SHEET WATERPROOFING:

- A. Rubberized-Asphalt Sheet: 60-mil- thick, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated to a 4-mil- thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
1. Physical Properties: As follows, measured per standard test methods referenced:
    - a. Tensile Strength: 250 psi minimum; ASTM D 412, Die C, modified.
    - b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
    - c. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970.
    - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
    - e. Puncture Resistance: 40 lbf minimum; ASTM E 154.
    - f. Hydrostatic-Head Resistance: 150 feet minimum; ASTM D 5385.
    - g. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
    - h. Vapor Permeance: 0.05 perms; ASTM E 96, Water Method.
- B. Manufacturers: Subject to compliance with requirements, provide one of the following products:
1. Carlisle Corporation, Carlisle Coatings & Waterproofing Div.; CCW Mira DRI 860/861.
  2. W.R. Grace & Co.; Bituthene. 3000/Bituthene Low Temperature.
  3. Monsey Bakor; Elasto-Seal 2000/2000 LT.
  4. Or approved equal.

## 2.02 AUXILIARY MATERIALS:

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
  - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Liquid primer recommended for substrate by manufacturer of sheet waterproofing material.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by manufacturer of sheet waterproofing material.
- D. Sheet Strips: Self-adhering, rubberized-asphalt composite sheet strips of same material and thickness as sheet waterproofing.
- E. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, trowel grade or low viscosity.
- F. Substrate Patching Membrane: Low-viscosity, two-component, asphalt-modified coating.
- G. Mastic, Adhesives, and Tape: Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer.
- H. Insulation is provided in Section 07 21 00.

## PART 3 - EXECUTION

### 3.01 INSPECTION:

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.
  - 1. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer.
  - 2. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
  - 3. Verify that compacted subgrade is dry, smooth, and sound; ready to receive HDPE sheet.
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 SURFACE PREPARATION:

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
  - 1. Install sheet strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
- F. Bridge and cover isolation joints, expansion joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
  - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
  - 1. Install membrane strips centered over vertical inside corners. Install 3/4-in. fillets of liquid membrane on horizontal inside corners and as follows:
    - a. At footing-to-wall intersections, extend liquid membrane each direction from corner or install membrane strip centered over corner.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

### 3.03 RUBBERIZED-ASPHALT SHEET APPLICATION:

- A. Install self-adhering sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
    - 1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, rubberized-asphalt sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.
  - D. Apply continuous sheets over sheet strips bridging substrate cracks, construction, and contraction joints.
  - E. Seal exposed edges of sheets at terminations not concealed by metal counterflashings or ending in regrets with mastic or sealant.
  - F. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheets extending 6 inches beyond repaired areas in all directions.
  - G. Correct deficiencies in or remove sheet waterproofing that does not comply with requirements, repair substrates, reapply waterproofing, and repair sheet flashings.
- 3.05 PROTECTION AND CLEANING:
- A. Protect waterproofing from damage and wear during remainder of construction period.
  - B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
- 3.06 CONTRACT CLOSEOUT:
- A. Provide in accordance with Section 017400.

END OF SECTION



SECTION 07 21 00  
BUILDING INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide building insulation as indicated and specified including the following:

1. Foundation insulation (supporting backfill).
2. Building rigid insulation (above grade)
3. Building insulation in batt/blanket form.

1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM) Publications:

1. ASTM C578: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
2. ASTM C665: Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
3. ASTM D4397: Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
4. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
5. ASTM E119: Standard Methods for Fire Tests of Building Construction and Materials.
6. ASTM E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 deg. C.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Product Data: Each type of insulation product and accessory specified.

2. Recycled Content Submittal:

- a. For products having recycled content, documentation indicating specified percentages by weight of postconsumer and preconsumer recycled content.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Fire Performance Characteristics: Provide insulation materials that meet the following:
  1. Surface Burning Characteristic: ASTM E84.
  2. Fire Resistance Ratings: ASTM E119.
  3. Combustion Characteristics: ASTM E136.
- C. Single Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's recommendations for handling, storage, and protection during installation.
- C. Protect Plastic Insulation as Follows:
  1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
  2. Protect against ignition at all times. Do not deliver plastic insulating materials to project site ahead of installation time.
  3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.06 DEFINITIONS:

- A. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r values," they represent the reciprocal of thermal conductivity (k values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick.

Thermal resistivities 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.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Provide insulating materials that comply with requirements and with referenced standards.
  - 1. Preformed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.

### 2.02 PERIMETER FOUNDATION RIGID INSULATION:

- A. Description:
  - 1. Extruded Polystyrene Board Insulation: ASTM C578, Type IV, 25 psi.
- B. Manufacturers:
  - 1. Greenguard: PACTIV Building Products.
  - 2. Styrofoam: DuPont.
  - 3. Foamular 250: Owens Corning.
  - 4. Or approved equal.

### 2.03 CONCRETE FACED PERIMETER FOUNDATION RIGID INSULATION:

- A. Manufacturers / Products:
  - 1. WallGUARD Insulated Sheathing Panels by T. Clear Corporation.
  - 2. Tech-Crete Concrete Faced Wall Insulated Panels by Tech-Crete Processors Ltd.
  - 3. National Concrete Accessories
  - 4. Or approved equal.

B. Description:

1. Concrete faced exterior insulation consisting of 3/8 inch thick modified concrete panel laminated to extruded expanded polystyrene where indicated at grade and above.
  - a. Concrete face:
    - (1) Compressive strength Minimum 2600 PSI, tested to ASTM D2394.
    - (2) Flexural strength: Minimum 1500 PSI, tested to ASTM C947.
    - (3) Linear variations with change in moisture to air dry: Width 0.02 percent, length 0.02 percent, tested to ASTM D1037 at 50 percent relative humidity and 73 degree F.
    - (4) Surface burning characteristics: Flame spread/smoke developed rating 0/0, tested to ASTM E84.
    - (5) Weigh per square foot: 1.95 pounds.
    - (6) Fastener pull through: Minimum 195 pounds.
    - (7) K-factor: 1.6.
  - b. Extruded polystyrene:
    - (1) Type: ASTM C578, Type X.
    - (2) Density: 1.3 PCF.
    - (3) Compressive Strength: 25 PSI.
    - (4) R-value per inch at 75 degrees F: 5.0.
    - (5) Water absorption: Maximum 0.30 percent by volume.
    - (6) Water vapor permeance: 0.733 for 1-1/2 inch thickness; 0.55 for 2 inch thickness.
    - (7) Surface burning characteristics: Maximum flame spread/smoke developed rating 5/165, tested to ASTM E84.

## 2.04 RIGID INSULATION (ABOVE GRADE):

### A. Description:

1. Extruded Polystyrene Board Insulation: ASTM C578, Type VII, 60 psi.
2. Recycled Content: Provide extruded polystyrene board insulation with recycled content so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than thirty (30) percent.

### B. Manufacturers:

1. Greenguard: PACTIV Building Products.
2. Styrofoam: The Dow Chemical Company.
3. Foamular 60: Owens Corning.
4. Or approved equivalent product.

## 2.05 BUILDING INSULATION IN BATT FORM:

### A. Description:

1. Unfaced Mineral Fiber Blanket/Batt Insulation, ASTM C665. Thickness, full depth of cavity. Where cavity requires insulation that is thicker than standard size, install next larger size and compress into cavity.

### B. Manufacturers:

1. Certainteed.
2. Owens Corning.
3. Johns Manville.
4. Or approved equal.

## PART 3 - EXECUTION

### 3.01 EXAMINATION:

- A. Examine substrates and conditions with Installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not

proceed with installation of insulation until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION:

- A. Clean substrates of substances harmful to insulations, including removal of projections that might puncture insulation.

### 3.03 INSTALLATION, GENERAL:

- A. Comply with insulation manufacturer's instructions applicable to products and application indicated. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.
- B. Extend insulation full thickness as indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections that interfere with placement.
- C. Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness. Where cavity requires insulation that is thicker than standard size, install next larger size and compress into cavity.

### 3.04 INSTALLATION OF PERIMETER RIGID INSULATION:

- A. On vertical surfaces, set units in accordance with manufacturer's instructions. Use type of adhesive and fasteners recommended by manufacturer of insulation.
  - 1. Place against outside face of foundation walls from top of foundation wall down to top of footing unless otherwise indicated on drawings.

### 3.05 INSTALLATION OF GENERAL BUILDING INSULATION:

- A. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units. Fill voids in thermal envelope not covered by the work of other sections.
- B. Stuff glass fiber insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume (to a density of approximately 2.5 pcf).

### 3.06 PROTECTION:

- A. General: Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where

insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.07 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 07 31 13

### ASPHALT SHINGLES

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION:

- A. Provide asphalt shingles and accessories as indicated and specified.

##### 1.02 REFERENCES:

- A. American Society for Testing and Materials:

1. ASTM A 167: Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
2. ASTM A 525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
3. ASTM A 526: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
4. ASTM B 209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
5. ASTM B 370: Specification for Copper Sheet and Strip for Building Construction.
6. ASTM B 749: Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
7. ASTM D 224: Specification for Smooth-Surfaces Asphalt Roll Roofing (Organic Felt)
8. ASTM D 225: Specification for Asphalt Shingles (Organic Felt) Surfaced with Mineral Granules.
9. ASTM D 226: Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
10. ASTM D 249: Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules.
11. ASTM D 1970: Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.



12. ASTM D 2178: Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
13. ASTM D 3018: Specification for Class A Asphalt Shingles Surfaced with Mineral Granules.
14. ASTM D 3019: Specification for Lap Cement Used with Asphalt Roll Roofing.
15. ASTM D 3161: Test Method for Wind-Resistance of Asphalt Shingles.
16. ASTM D 3462: Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules.
17. ASTM D 3909: Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules.
18. ASTM D 4869: Specification for Asphalt-Saturated Organic Felt Shingle Underlayment Used in Roofing.
19. ASTM E 108: Method for Fire Tests of Roof Coverings.

B. Underwriters Laboratories (UL):

1. UL 790: Test for Fire Resistance of Roof Covering Materials.
2. UL 997: Wind Resistance of Prepared Roof Covering Materials.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Product data for each type of product specified, including details of construction relative to materials, dimensions of individual components, profiles, textures, and colors.
2. Samples for initial selection in the form of manufacturer's sample finishes showing the full range of colors and profiles available for each type of asphalt shingle indicated.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Fire-Test-Response Classification: Where products with a fire-test-response classification are specified, provide asphalt shingles identical to those tested according to ASTM E 108 or UL 790 and listed by UL or another testing and inspecting agency

acceptable to authorities having jurisdiction. Identify each bundle of asphalt shingles with appropriate markings indicating fire-test-response classification of applicable testing and inspecting agency.

- C. Wind-Resistance-Test Characteristics: Where wind-resistant asphalt shingles are indicated, provide products identical to those tested according to ASTM D 3161 or UL 997 and passed. Identify each bundle of asphalt shingles with appropriate markings of applicable testing and inspecting agency.
- D. Mockup: Prior to installing shingles, construct mockups to verify selections made under sample submittals and to demonstrate aesthetic effects as well as quality of materials and execution. Build mockups to comply with the following requirements, using materials indicated for final Work.
  - 1. Locate mockups on site in the location and of the size indicated or, if not indicated, as directed by the Engineer.
  - 2. Demonstrate the proposed range of aesthetic effects and workmanship.
  - 3. Obtain Engineer's approval of mockups before start of final unit of Work.
    - a. Accepted mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

#### 1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver materials to Project site in manufacturer's unopened bundles or containers with labels intact.
- C. Handle and store materials at Project site to prevent water damage, staining, or other physical damage. Store roll goods on end. Comply with manufacturer's recommendations for job-site storage, handling, and protection.

#### 1.06 PROJECT CONDITIONS:

- A. Weather Limitations: Proceed with installing asphalt shingles only when existing and forecasted weather conditions will permit work to be performed according to manufacturers' recommendations and warranty requirements, and when substrate is completely dry.

#### 1.07 WARRANTY:

- A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract

Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

- B. Special Warranty: Submit a written warranty signed by manufacturer agreeing to repair or replace asphalt shingles that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, deformation or deterioration of asphalt shingles beyond normal weathering.
  - 1. Warranty Period: Manufacturer's standard but not less than 20 years after date of Substantial Completion.

#### 1.08 EXTRA MATERIALS:

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
  - 1. Furnish 1 square coverage of asphalt shingles, identical to those to be installed, in unbroken bundles.

### PART 2 – PRODUCTS

#### 2.01 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering asphalt shingles that may be incorporated in the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide asphalt shingles produced by one of the following:
  - 1. CertainTeed Corporation.
  - 2. Elk Corporation of America.
  - 3. GAF Building Materials Corporation.
  - 4. Or approved equal.
- C. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
  - 1. Ridge Vents:
    - a. Ridge Filter Shinglevent; Air Vent, Inc.

- b. Ridge Filtervent; Air Vent, Inc. (for Class A).
  - c. Cobra Ridge Vent; GAF Building Materials Corporation.
  - d. Or approved equal.
2. Waterproof Underlayment:
- a. WinterGuard; CertainTeed Corporation.
  - b. Bituthene Ice and Water Shield; Grace: W.R. Grace & Co.
  - c. Nordshield Ice and WaterGard; Nord Bitumi US, Inc.
  - d. Or approved equal.

## 2.02 ASPHALT SHINGLES:

- A. Colors, Blends, and Patterns: Where manufacturer's standard products are indicated, provide asphalt shingles with the following requirements:
  - 1. Provide Engineer's selections from manufacturer's full range of colors, textures, and patterns for asphalt shingles of type indicated.
- B. Square-Tab, Fiberglass Strip Shingles: Conforming to ASTM D 3018 Type I – Self-Sealing; UL Certification of ASTM D 3462, ASTM D 3161 Class “F” (110-mph)/UL997 Wind Resistance and UL Class A Fire Resistance; glass fiber mat base; ceramically colored/UV resistant mineral surface granules across the entire face of the shingle; algae-resistant; full two layer laminated four tab shingle, plus additional random tabs. Base of Design: CertainTeed Grand Manor. Color as selected by Architect from manufacturer's standards
- C. Ridge Shingles: Manufacturer's standard, factory-precut units to match asphalt shingles.

## 2.03 METAL TRIM AND FLASHING:

- A. Sheet Metal Materials: Furnish the following sheet metal materials:
  - 1. Stainless Steel: ASTM A 167, Type 304, with No. 2B or 2D finish, minimum 0.015 inch thick, unless otherwise indicated.
- B. Metal Drip Edge: Brake-formed sheet metal with at least a 6-inch roof deck flange and a 1-1/2-inch fascia flange with a 3/8-inch drip at lower edge. Furnish the following material in lengths of 8 or 10 feet.

1. Material: Stainless steel.

C. Metal Flashing: Job-cut to sizes and configurations required.

1. Material: Stainless steel.

#### 2.04 ACCESSORIES:

A. Felt Underlayment: Type II, 36-inch wide, asphalt-saturated organic felt, complying with ASTM D 226 (No. 30) or ASTM D 4869.

B. Waterproof Underlayment: Minimum 40-mil thick, self-adhering, polymer-modified, bituminous sheet membrane, complying with ASTM D 1970. Provide primer when recommended by underlayment manufacturer.

C. Ridge Vent: High-density polypropylene, nonwoven modified polyester, or other UV-stabilized plastic designed to be installed under asphalt shingles at ridge.

D. Smooth-Surface Roll Roofing: Organic roofing felt saturated with asphalt and coated on both sides with an asphaltic compound, 36 inches wide, weighing at least 50 lb/square and complying with ASTM D 224, Type II or III.

E. Mineral-Surface, Organic-Felt Roll Roofing: Mineral-granular-surfaced, organic-felt-based, asphalt roll roofing, 36 inches wide, complying with ASTM D 249, Type I.

F. Mineral-Surface, Glass-Felt Roll Roofing: Mineral-granular-surfaced, glass-felt-based, asphalt roll roofing, 36 inches wide, complying with ASTM D 3909.

G. Asphalt Plastic Cement: Nonasbestos fibrated asphalt cement, complying with ASTM D 4586.

H. Roll-Roofing Lap Cement: Nonasbestos asphalt lap cement, complying with ASTM D 3019, Type III.

I. Nails: Aluminum or hot-dip galvanized steel, 0.120-inch diameter barbed shank, sharp-pointed, conventional roofing nails with a minimum 3/8-inch diameter head and of sufficient length to penetrate 3/4 inch into solid decking or at least 1/8 inch through plywood sheathing.

1. Where nails are in contact with flashing, prevent galvanic action by providing nails made from the same metal as that of the flashing.

## PART 3 – EXECUTION

### 3.01 EXAMINATION:

- A. Examine substrate for compliance with requirements for substrates, installation tolerances, and other conditions affecting performance of asphalt shingles. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION:

- A. Clean substrates of projections and substances detrimental to application. Cover knotholes or other minor voids in substrate with sheet metal flashing secured with noncorrosive roofing nails.
- B. Coordinate installation with flashings and other adjoining work to ensure proper sequencing. Do not install roofing materials until all vent stacks and other penetrations through roof sheathing have been installed and are securely fastened against movement.

### 3.03 INSTALLATION:

- A. General: Comply with manufacturer's instructions and recommendations but not less than those recommended by ARMA's "Residential Asphalt Roofing Manual" or "The NRCA Steep Roofing Manual."
  - 1. Fasten asphalt shingles to roof sheathing with nails.
- B. Felt Underlayment: Apply 1 layer of felt underlayment horizontally over entire surface to receive asphalt shingles, lapping succeeding courses a minimum of 2 inches, end laps a minimum of 4 inches, and hips and valleys a minimum of 6 inches. Fasten felt with sufficient number of roofing nails or noncorrosive staples to hold underlayment in place until asphalt shingle installation.
  - 1. Apply an additional layer of felt underlayment on roof decks with a slope of 2 to 4 inches per foot.
  - 2. Omit felt underlayment at areas of waterproof underlayment. Lap felt underlayment over waterproof underlayment as recommended by manufacturer but not less than 2 inches.
- C. Waterproof Underlayment: Apply ice and water shield on entire roof.
- D. Flashing: Install metal flashing and trim as indicated and according to details and recommendations of the "Asphalt Roofing" section of "The NRCA Steep Roofing Manual" and ARMA's "Residential Asphalt Roofing Manual."

- E. Install asphalt shingles, beginning at roof's lower edge, with a starter strip of roll roofing or inverted asphalt shingles with tabs removed. Fasten asphalt shingles in the desired weather exposure pattern; use number of fasteners per shingle as recommended by manufacturer. Use vertical and horizontal chalk lines to ensure straight coursing.
  - 1. Cut and fit asphalt shingles at valleys, ridges, and edges to provide maximum weather protection. Provide same weather exposure at ridges as specified for roof. Lap asphalt shingles at ridges to shed water away from direction of prevailing wind.
  - 2. Use fasteners at ridges of sufficient length to penetrate sheathing as specified.
  - 3. Pattern: Manufacturers recommendations for product selected.
- F. Ridge Vents: Install ridge vents according to manufacturer's instructions.

3.04 ADJUSTING:

- A. Replace any damaged materials installed under this Section with new materials that meet specified requirements.

3.05 CONTRACT COSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 07 46 46

### FIBER CEMENT TRIM AND ACCESSORIES

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION:

- A. Fiber cement soffit trim, fascia, moulding and accessories.

##### 1.02 REFERENCES:

- A. American Society for Testing and Materials:

1. ASTM C1186 - Standard Specification for Flat Fiber-Cement Sheets
2. ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test, Tool and Tape.
3. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:

1. Product Data: Manufacturer's data sheets on each product to be used, including:
  - a. Preparation instructions and recommendations.
  - b. Storage and handling requirements and recommendations.
  - c. Installation methods.
2. Shop Drawings: Provide detailed drawings of atypical non-standard applications of cementitious materials which are outside the scope of the standard details and specifications provided by the manufacturer.
3. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
4. Verification Samples: For each finish product specified, two samples, minimum size 4 by 6 inches, representing actual product, color, and patterns.



1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Installer Qualifications: Minimum of 2 years experience with installation of similar products.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Architect.
  - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
  - 3. Refinish mock-up area as required to produce acceptable work.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store cementitious material on edge or lay flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 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.

1.07 WARRANTY:

- A. Product Warranty: Limited, non-pro-rated product warranty.
  - 1. Soffit for 30 years.
- B. Product Warranty: Limited, product warranty.
  - 1. Trim boards for 15 years.
- C. Finish Warranty: Limited product warranty against manufacturing finish defects.

1. When used for its intended purpose, properly installed and maintained according to manufacturer's published installation instructions, for a period of 15 years from the date of purchase: will not peel; will not crack; and will not chip. Finish warranty includes the coverage for labor and material.

D. Workmanship Warranty: Application limited warranty for 2 years.

## PART 2 – PRODUCTS

### 2.01 MANUFACTURERS:

#### A. Acceptable Manufacturer:

1. James Hardie Building Products, Inc.
2. Allura.
3. GAF.

#### B. Substitutions: Approved equal.

C. Requests for approval of equal substitutions will be considered in accordance with provisions of Section 01 25 00.

### 2.02 FIBER CEMENT MATERIAL REQUIREMENTS:

#### A. Soffit panel:

1. Complies with ASTM C 1186 Type A Grade II.
2. Complies with ASTM E 136 as a noncombustible material.
3. Complies with ASTM E 84 Flame Spread Index = 0, Smoke Developed Index = 5.
4. CAL-FIRE, Fire Engineering Division Building Materials Listing - Wildland Urban Interface (WUI) Listed Product.
5. National Evaluation Report No. NER 405 (BOCA, ICBO, SBCCI, IBC, IRC).

#### B. Trim:

1. 3/4 inch thick, smooth sanded edge. Width as indicated on drawings.
2. Fascia boards as manufactured by James Hardie Building Products, Inc.

## 2.03 FASTENERS:

### A. Wood Framing Fasteners:

1. Wood Framing: 4d common corrosion resistant nails.
2. Wood Framing: 6d common corrosion resistant nails.
3. Wood Framing: 8d box ring common corrosion resistant nails.
4. Wood Framing: 0.089 inch shank by 0.221 inch head by 2 inches corrosion resistant siding nails.
5. Wood Framing: 0.093 inch shank by 0.222 inch head by 2 inches corrosion resistant siding nails.
6. Wood Framing: 0.093 inch shank by 0.222 inch head by 2-1/2 inches corrosion resistant siding nails.
7. Wood Framing: 0.091 inch shank by 0.221 inch head by 1-1/2 inches corrosion resistant siding nails.
8. Wood Framing: 0.091 inch shank by 0.225 inch head by 1-1/2 inches corrosion resistant siding nails.
9. Wood Framing: 0.121 inch shank by 0.371 inch head by 1-1/4 inches corrosion resistant roofing nails.
10. Wood Framing: No. 11 gauge 1-1/4 inches corrosion resistant roofing nails.
11. Wood Framing: No. 11 gauge 1-1/2 inches corrosion resistant roofing nails.
12. Wood Framing: No. 11 gauge 1-3/4 inches corrosion resistant roofing nails.

## 2.04 FINISHES:

### A. Factory Finish for fiber cement board:

1. Base of Design: Hardieplank Select Cedarmill, Color to be selected.
2. Definition: Factory applied finish.

3. Process:
    - a. Factory applied finish by fiber cement manufacturer in a controlled environment within the fiber cement manufacturer's own facility utilizing a multi-coat, heat cured finish within one manufacturing process.
    - b. Each finish color must have documented color match to delta E of 0.5 or better between product lines, manufacturing lots or production runs as measured by photospectrometer and verified by third party.
  4. Protection: Factory applied finish protection such as plastic laminate that is removed once fiber cement component is installed.
  5. Accessories: Complete finishing system includes pre-packaged touch-up kit provided by fiber cement manufacturer. Provide quantities as recommended by manufacturer.
- B. Factory Finish Color for Trim, Soffit and Fascia Colors:
1. Base of Design: HardieTrim Smooth, Color to be selected.

## PART 3 – EXECUTION

### 3.01 EXAMINATION:

- A. Do not begin installation until substrates have been properly prepared.
- B. If framing preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Nominal 2 inch by 4 inch wood framing selected for minimal shrinkage and complying with local building codes, including the use of water-resistive barriers or vapor barriers where required. Minimum 1-1/2 inches (38 mm) face and straight, true, of uniform dimensions and properly aligned.
  1. Install water-resistive barriers and claddings to dry surfaces.
  2. Repair any punctures or tears in the water-resistive barrier prior to the installation of the fiber cement product.
  3. Protect trim and accessories from other trades.

### 3.02 PREPARATION:

- A. Clean surfaces thoroughly prior to installation.

- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Install a water-resistive barrier is required in accordance with local building code requirements.
- D. The water-resistive barrier must be appropriately installed with penetration and junction flashing in accordance with local building code requirements.
- E. Install weather barrier in accordance with local building code requirements.
- F. Use Seam Tape and joint and laps.
- G. Install flashing and Flex Flashing

### 3.03 INSTALLATION – TRIM BOARDS:

- A. Install materials in strict accordance with manufacturer's installation instructions. Install flashing around all wall openings.
- B. Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 3/4 inch or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
- C. Place fasteners no closer than 3/4 inch and no further than 2 inches from side edge of trim board and no closer than 1 inch from end. Fasten maximum 16 inches on center.
- D. Maintain clearance between trim and adjacent finished grade.
- E. Trim inside corner with a single board trim both side of corner.
- F. Outside Corner Board Attach Trim on both sides of corner with 16 gage corrosion resistant finish nail 1/2 inch (13 mm) from edge spaced 16 inches (406 mm) apart, weather cut each end spaced minimum 12 inches (305 mm) apart.
- G. Provide flashing separation to isolate trim from mortar or masonry, as recommended by manufacturer.
- H. Seal gap with high quality, paint-able caulk.
- I. Shim frieze board as required to align with corner trim.
- J. Do not fasten Trim boards to Trim boards.
- K. Shim frieze board as required to align with corner trim.

- L. Install Trim Fascia boards to rafter tails or to sub fascia.

3.04 FINISHING:

- A. Finish unprimed fiber cement boards with a minimum one coat high quality, alkali resistant primer and one coat of either, 100 percent acrylic or latex or oil based, exterior grade topcoats or two coats high quality alkali resistant 100 percent acrylic or latex, exterior grade topcoat within 90 days of installation. Follow paint manufacturer's written product recommendation and written application instructions.
- B. Finish factory primed fiber cement board with a minimum of one coat of high quality 100 percent acrylic or latex or oil based exterior grade paint within 180 days of installation. Follow paint manufacturer's written product recommendation and written application instructions.

3.05 PROTECTION:

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 07 60 00

FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide flashing, sheet metal work, and appurtenant work as indicated and specified.

1.02 REFERENCES:

- A. National Roofing Contractors Association (NRCA).
- B. Sheet Metal and Air Conditioning Contractors Association (SMACNA).
- C. Federal Specifications (Fed. Spec.):
  - 1. QQ-A-250/2D: Aluminum Alloy 3003, Plate and Sheet.
  - 2. QQ-C-576B (1): Copper Flat Products with Slit, Slit and Edge-rolled, Sheared, Sawed, or Machined Edges, (Plate, Bar, Sheet, and Strip).
  - 3. SS-C-153C: Cement, Bituminous, Plastic.
- D. American Society for Testing and Materials (ASTM) Publications:
  - 1. A167: Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
  - 2. B101: Specification for Lead-coated Copper Sheets.
- E. American Wood-Preservers' Association (AWPA).

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Manufacturers' literature describing products.
  - 2. Shop drawings showing fabricated items, complete details of joints, supports, and fasteners.
  - 3. Setting drawings, or templates and setting instructions, for exact installation.

#### 1.04 JOB CONDITIONS:

- A. Protect exposed finishes against construction damage; remove protection prior to final acceptance.

#### PART 2 - PRODUCTS

##### 2.01 GENERAL:

- A. Thickness: Except where otherwise indicated, comply with minimum gauge requirements as specified in SMACNA's "Architectural and Sheet Metal Manual."
- B. Flashing Compound: Polyisobutylene type, non-skinning, nondrying sealant, bulk conforming to Fed. Spec. SS-C-153, Type 1, or tape as required by installation conditions, 1-in. minimum width by 1/16-in. minimum thickness.
- C. Fasteners (Nails, Screws, Rivets, and Bolts and Nuts): Same material as item being fastened.
- D. Nailers: Wood as specified in Section 06 10 00.

##### 2.02 FLASHING:

- A. Metal:
  - 1. Stainless Steel: Stainless steel sheets, Type 304, finish 2D, Condition A (annealed) conforming to the applicable requirements of ASTM A167, and not less than 26 gage or 0.018 in. thick.

##### 2.03 ALUMINUM GUTTERS, DOWNSPOUTS AND ACCESSORIES:

- A. Materials:
  - 1. Aluminum alloy 3003-H14, flat prefinished sheets. Corrugated downspouts will not be acceptable.
  - 2. Thickness: .032 in.
  - 3. Gutter Size: 6-in. wide x 4-3/4-in. with Ogee profile.
  - 4. Downspout Size: 4-in. x 4-in.
  - 5. Joints: Factory welded joints every 10 ft. o.c.
  - 6. Accessories: 2-in. wide aluminum strap channels. Finish similar to downspouts.



7. Finish: Kynar 500 (Fluoropolymer) finish.
8. Color: To be selected by Engineer/Architect from manufacturer's full range of colors.

## 2.04 FABRICATION:

### A. General:

1. Fabricate in accordance with SMACNA's "Architectural and Sheet Metal Manual", and applicable requirements of NRCA's "A Manual of Roofing Practice", unless indicated otherwise.
2. Form and fabricate sheet metal in shop, when possible. Identify bulk materials from which items are field fabricated by manufacturer's trademark printed or embossed at frequent intervals.
3. Provide profiles with interactions that are sharp, even and true, with plane surfaces free from buckles and waves; and seams that follow direction of water flow.
4. Reinforce correctly for strength and appearance.
5. Cut, fit, and drill sheet metal as required to accommodate related, adjacent or adjoining work.
6. Fold, bend or return exposed edges of sheet metal. Raw edges not permitted.

### B. Sheet Metal Joints:

1. Provide lock joints; where impractical, lap, rivet, solder, or weld joints, or join as recommended by manufacturer.
2. Join joints and miters as recommended by manufacturer.
3. Weld in accordance with applicable AWS specification, when positive joining is required.
4. Turn lock joints, on exposed surfaces, in direction of flow.

- C. Expansion and Contraction of Sheet Metal Runs: Provide loose locking slip joint at maximum eight feet from external or internal corners, maximum 24 feet length of straight runs unless manufacturer recommends more frequent interval, and one at center of runs less than 20 feet but more than eight feet.

## PART 3 - EXECUTION

### 3.01 PREPARATION:

- A. Coordinate work with installation of adjoining work.

### 3.02 GENERAL:

- A. Conform with procedures and methods of installation and applicable details indicated and described in SMACNA's "Architectural and Sheet Metal Manual" and NRCA's "A Manual of Roofing Practice."
- B. Where installation requires fabrication at the job site, conform to applicable requirements of Article 2.05.
- C. Install standard catalog products in accordance with manufacturer's instructions, unless otherwise indicated.
- D. Install work watertight; insure that items are installed in true and accurate alignment with other items and related work, that joints are accurately fitted, that corners are reinforced and that exposed surfaces are free of dents.
- E. Apply flashing compound at slip joints or wherever metal-to-metal contact occurs and movement may be anticipated to occur.
- F. Fastenings:
  - 1. Fasten sheet metal runs to underlying material by nailing through slotted holes in flange at three inches on center, unless otherwise indicated or required by manufacturer.
  - 2. Provide waterproof washers wherever fasteners penetrate flashing.
  - 3. Bolts, nuts, screws and other type fasteners in contact with aluminum shall be stainless steel.

### 3.03 GUTTER AND DOWNSPOUT INSTALLATION:

- A. Attach gutters as indicated. Attach downspouts to walls with aluminum strap channels and stainless steel fasteners.
- B. Space strap channels every 2 ft. o.c. maximum.
- C. Provide elbows, shoes, wire strainers, fastenings, and accessories with downspouts.
- D. Conform to approved shop drawings.

3.04 ALUMINUM PROTECTION AND CLEANING:

A. Contact Separation with Dissimilar Metals:

1. Separate by painting metal surface with suitable bituminous paint or by layer of roofing felt.
2. Coat aluminum surfaces with bituminous paint, if contact with concrete, brick masonry or mortar after erection.
3. Clean aluminum gutters, downspouts and other exposed aluminum work with mild soap and water, after erection.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 07 84 00

### FIRESTOPPING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide firestopping as indicated and specified including the following:
  - 1. Penetrations through fire resistance rated floor and roof construction including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
  - 2. Penetrations through fire resistance rated walls and partitions including both empty openings and openings containing cables, pipes, ducts, conduits, and other penetrating items.
  - 3. Penetrations through smoke barriers and construction enclosing compartmentalized areas involving both empty openings and openings containing penetrating items.
  - 4. Sealant joints in fire resistance rated construction, including gypsum drywall partitions, masonry walls and adjacent construction.
- B. General Contractor shall be responsible for providing firestopping for the project.

##### 1.03 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
  - 1. E84: Test Methods for Surface Burning Characteristics of Building Materials.
  - 2. E119: Test Methods for Fire Tests of Building Construction and Materials.
  - 3. E814: Test Method for Fire Tests of Through-Penetration Fire Stops.
- B. Underwriters Laboratories Inc.
  - 1. UL Fire Resistance Directory.

#### 1.04 SYSTEM PERFORMANCE REQUIREMENTS:

- A. 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.
- B. 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.
- C. 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-ratings shall be per code but not less than 1 hour. 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 penetrations located outside fire resistive shaft enclosures.
  - 3. Where firestop systems protect penetrations located in construction containing doors required to have a temperature rise rating.
  - 4. Where firestop systems protect penetrating items larger than a 4 inch diameter nominal pipe or 16 square inches in overall cross sectional area.
- D. Fire Resistive Joint Sealants: Provide joint sealants with fire resistance ratings indicated, as determined per UL 2079, but not less than that equaling or exceeding the fire resistance rating of the construction in which the joint occurs.
- E. 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 penetration 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.
- F. 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:

A. Submit the following in accordance with Section 01 33 00:

1. Product Data: Submit manufacturer's literature for each type of Firestop material to be installed. Indicate product characteristics, typical uses, performance and limitation criteria, and test data.
2. Shop Drawings: Show typical installation details for the methods of installation. Indicate which firestop materials will be used where and thickness for different hourly ratings. Include firestop design designation of qualified testing and inspecting agency evidencing compliance with requirements for each condition indicated.
  - a. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgement derived from a similar UL system design or other tests shall be submitted to local authorities having jurisdiction for their review and approval prior to installation. Manufacturer's engineering judgement shall follow the requirements set forth by the International Firestop Council.
3. Certificates: Submit certificates signed by manufacturers of firestopping products certifying that their products comply with specified requirements.
4. Installation Instructions: Submit manufacturer's installation procedures for each type of product.

## 1.06 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Fire-Test-Response Characteristics: Provide firestopping that complies with the following requirements and those specified under the "System Performance Requirements" article:

1. Firestopping tests are performed by UL, Warnock Hersey, or another agency performing testing and follow-up inspection services for firestop systems that is acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per ASTM E 814.
3. Fire-resistive joint sealant systems are identical to those tested for fire-response characteristics per ASTM E 119.

- C. 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.
- D. Single Source Responsibility: Obtain through penetration firestop systems for each kind of penetration and construction condition indicated from a single manufacturer.
- E. 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."
- F. Coordinating Work: Coordinate construction of openings and penetrating items to ensure that designated through penetration firestop systems are installed per specified requirements.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Section 01 31 19.
- H. Field Testing of firestop systems will be performed for each type of firestop systems.

#### 1.07 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 01 1006 and as specified.
- B. Deliver firestopping products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number and shelf life.
- C. Store and handle firestopping materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

#### 1.08 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.

#### 1.09 SEQUENCING AND SCHEDULING:

- A. Coordinate the work of this Section as required with the work of other trades.

- B. Coordinate construction of openings and penetrating items to ensure that firestopping systems are installed according to specified requirements.
- C. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- D. Do not cover up those firestopping installations that will become concealed behind other construction until Owner's inspection agency and authorities having jurisdiction, if required, have examined each installation.
  - 1. Notify the Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations. Confirm dates and times on days preceding each series of installations.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. All firestop products and systems shall be designed and installed so that the basic sealing system will allow the full restoration of the thermal and fire-resistance properties of the barrier being penetrated with minimal repair if penetrants are subsequently removed.
  - 1. Provide paintable firestop products at locations exposed to the public. Mechanical and electrical rooms are not considered public spaces.
  - 2. Provide VOC compliant materials.
- B. Compatibility: Provide through-penetrations firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- C. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
  - 1. Permanent forming/damming/backing materials, including, but not limited to, the following:
    - a. Slag-/rock-wool-fiber insulation.



- b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
  - c. Fire-rated form board.
  - d. Fillers for sealants.
- 2. Temporary forming materials.
  - 3. Substrate primers.
  - 4. Collars.
  - 5. Steel sleeves.

#### 2.02 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
  - 1. Specified Technologies Inc. (STI), Somerville, NJ.
  - 2. Hilti, Inc., Tulsa, OK.
  - 3. 3M Fire Protection Products, St. Paul, MN.
  - 4. Or approved equal.

#### 2.03 MATERIALS:

- A. Firestop Mortar:
  - 1. Specified Technologies Inc. SpecSeal Mortar.
  - 2. Bio K-10. Durmast.
  - 3. Hilti CP 637 Firestop Mortar.
  - 4. Or approved equal.
- B. Firestop Sealants and Caulks:
  - 1. STI SpecSeal Sealant.
  - 2. 3M CP25WB + Caulk.

3. Bio Fireshield Biotherm and Biostop.
4. Hilti FS-ONE High Performance Intumescent Firestop Sealant.
5. Or approved equal.

C. Firestop Putty:

1. STI Spec-Seal Firestop Putty Bars and Pads.
2. 3M Fire Barrier Moldable Putty Stix and Putty Pads.
3. Hilti CP 617 and CP 618 Putty Pads and Putty Sticks.
4. Or approved equal.

D. Firestop Collars:

1. STI SpecSeal Firestop Collars.
2. 3M PPD Collars.
3. Hilti CP 643 and CP 642 Firestop Collars.
4. Or approved equal.

E. Wrap Strips:

1. SpecSeal Wrap Strip.
2. 3M FS-195 Wrap Strip.
3. Hilti CP 645 Firestop Wrap Strips.
4. Or approved equal.

F. Cast-In-Place Firestop Device:

1. Hilti CP 680 Cast-In-Place Firestop Device.
2. Or approved equal.

G. Fire Safing Insulation:

1. Fibrex Insulations, Inc.

2. Owens Corning HT, Inc.
3. Thermafiber LLC.
4. Or approved equal.

H. Accessories: Forming/damming materials - mineral fiberboard or other type recommended by manufacturer.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.02 PREPARATION:

- A. Surface Cleaning: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and the following requirements:
  1. Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
  2. 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.
  3. Remove laitance and form release agents from concrete.
  4. 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.
- B. 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 contact 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:
  - 1. Completely fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- D. Install fire safing insulation at all interior full-height fire rated walls at roof intersections.

### 3.04 FIELD QUALITY CONTROL:

- A. Allow for 3 random samples of each type of firestopping system to be inspected. Reinstall disturbed samples to comply with requirements.
- B. Do not proceed to enclose firestopping with other construction until reports of examinations are issued.
- C. Where deficiencies are found, repair or replace firestopping so that it complies with requirements.

### 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.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 07 92 00

### JOINT SEALANTS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

A. Provide joint sealants as indicated and specified including the following:

1. Exterior Joints in Vertical Surfaces and Non-traffic Horizontal Surfaces as Indicated Below:
  - a. Control and expansion joints in unit masonry.
  - b. Perimeter joints between materials listed above and frames of doors and louvers.
  - c. Other joints as indicated.
2. Interior Joints in Vertical Surfaces and Horizontal Non-traffic Surfaces as Indicated Below:
  - a. Control and expansion joints on exposed interior surfaces of exterior walls.
  - b. Perimeter joints on both sides of exterior openings where indicated.
  - c. Other joints as indicated.
3. Interior Joints in Horizontal Traffic Surfaces as Indicated Below:
  - a. Joints as indicated.

##### 1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM) Publications:

1. ASTM C 834: Standard Specification for Latex Sealing Compounds.
2. ASTM C 919: Standard Practice for Use of Sealants in Acoustical Applications.
3. ASTM C 920: Standard Specification for Elastomeric Joint Sealants.
4. ASTM C 1193: Standard Guide for Use of Joint Sealants.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Product Data: For each joint sealant product specified.
2. Samples: For selection purposes submit three (3) of manufacturer's standard color chart including bead samples, consisting of strips of actual products showing full range of colors available, for each product exposed to view.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in service performance.
- C. Single Source Responsibility for Joint Sealant Materials: Obtain joint sealant materials from a single manufacturer for each different product required.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- C. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 SYSTEM PERFORMANCE REQUIREMENTS:

- A. Provide joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.
- B. Provide joint sealants for interior applications that have been produced and installed to establish and maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

### 1.07 PROJECT CONDITIONS:

- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
  - 2. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer or below 40 degrees F.
  - 3. When joint substrates are wet.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

### 1.08 SEQUENCING AND SCHEDULING:

- A. Sequence installation of joint sealants to occur not less than 21 nor more than 30 days after completion of waterproofing, unless otherwise indicated.

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 1. Provide paintable sealants at locations that are exposed to view.

### 2.02 TYPES/MANUFACTURERS:

- A. Type 1 - General Purpose Exterior Sealant: Polyurethane; ASTM C920, Type M, Grade NS, Class 25; two component.
  - 1. MasterSeal NP-2; Master Builders Solutions
  - 2. Dymeric 240FC; Tremco



3. Sikaflex-2c, NS; Sika
  4. Dynatrol II; Pecora
  5. Or approved equal.
- B. Type 2 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, single component, paintable.
1. Tremflex 834; Tremco
  2. AC-20; Pecora
  3. Chem-Calk 600; Bostik
  4. Or approved equal.
- C. Type 3 - Bathroom Sealant: White silicone; ASTM C920, Uses M and A; single component, mildew resistant.
1. Sanitary 1700; GE Silicones
  2. 898 Silicone; Pecora
  3. 786 MR Silicone; Dow Corning
  4. Or approved equal.
- D. Type 4 - Acoustical Sealant: Butyl or acrylic sealant; ASTM C920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
1. Tremco Acoustical Sealant; Tremco
  2. AC-20 FTR Acoustical Sealant; Pecora Corp.
  3. Sheetrock Acoustical Sealant; United States Gypsum Co.
  4. Or approved equal.

#### 2.03 JOINT SEALANT BACKING:

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

- B. Plastic Foam Joint Fillers: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
  - 1. Closed cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
- C. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self adhesive tape where applicable.

#### 2.04 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealant substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint sealant performance. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

#### 3.02 PREPARATION:

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant

manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil free compressed air.
  3. Remove laitance and form release agents from concrete.
  4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealant manufacturer based on preconstruction joint sealant substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.03 INSTALLATION OF JOINT SEALANTS:

- A. General: Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Installation of Sealant Backings: Install sealant backings to comply with the following requirements:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    - a. Do not leave gaps between ends of joint fillers.
    - b. Do not stretch, twist, puncture, or tear joint fillers.
  2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.
- E. Installation of Sealants: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
1. Provide concave joint configuration unless otherwise indicated.
- G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, and to comply with sealant manufacturer's directions for installation methods, materials, and tools that produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.
- 3.04 CLEANING:
- A. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
- 3.05 PROTECTION:
- A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or

deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.

3.06 SCHEDULE:

- A. Exterior Joints for Which No Other Sealant Type is Indicated: Type 1; colors to be selected.
- B. Joints Between Exterior Metal Frames and Adjacent Work (except masonry): Type 2.
- C. Interior Joints for Which No Other Sealant is Indicated: Type 2; colors to be selected.
- D. Joints Between Plumbing Fixtures and Walls/Floors: Type 3.
- E. Exposed and Concealed Joints where Acoustical Sealant is indicated and required: Type 4, colors to be selected.

3.07 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## **DIVISION 08 – OPENINGS**

SECTION 08 11 00

METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide doors, frames, vision panels, and accessories as indicated and specified.

1.02 REFERENCES:

- A. Aluminum Association (AA).
- B. American Architectural Manufacturers Association (AAMA) Specification.
  - 1. AAMA 2605-02: Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
  - 2. AAMA 611-98: Voluntary Guide Specification for Anodized Architectural Aluminum.
- C. National Association of Architectural Metal Manufacturers (NAAMM).
- D. Underwriters' Laboratories, Inc. (UL).
- E. American Society for Testing and Materials (ASTM) Publications:
  - 1. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. National Association of Architectural Metal Manufacturers (NAAMM).
- G. Hollow Metal Manufacturers Association (HMMA):
  - 1. 810: Hollow Metal Doors.
  - 2. 820: Hollow Metal Frames.
  - 3. 830: Hardware Preparation and Locations for Hollow Metal Doors and Frames.
  - 4. 840: Installation and Storage of Hollow Metal Doors and Frames.

5. 862: Guide Specifications for Commercial Security Hollow Metal Doors and Frames.
6. 861: Guide Specifications for Commercial Hollow Metal Doors and Frames.

#### 1.03 SUBMITTALS:

##### A. Submit the following in accordance with Section 01 33 00:

1. Submit shop drawings of doors and frames indicating dimensions, gages of metals, fastening and anchorage method for frames, types of finishes, and alloy of aluminum for acceptance. Include certification that preparation for hardware is in accordance with templates furnished by hardware manufacturer.
2. Submit manufacturer's specifications for all types of doors and frames.
3. For informational purposes only, submit manufacturer's installation instructions for all types of doors, frames, vision panels and sidelights.
4. Submit three (3) color charts for aluminum finish.
5. Submit certified performance results for sound-retarding doors and frames tested in accordance with ASTM E 90.
6. Submit certificates, as required for doors and frames, of testing agency fire-rating.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Testing Agency Qualifications: Testing agency fire-rating certification with approval of authority having jurisdiction and re-examination service.
- C. Requirements of Regulatory Agencies: Provide openings having indicated fire-resistive rating of 3/4-hour or longer with doors and frames bearing testing agency-issued label for required fire rating.
- D. Energy Efficiency: Provide Doors and Frames with U-value under 0.45.

#### 1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Before delivery, identify type and size of each door with markings that will not damage finish.



- C. Preassemble frames and door mullions in shop and deliver to project site with spreader bar at sill, or tie in pairs to form box.
- D. Store all doors and frames in a weathertight enclosure and do not expose to the elements.

## PART 2 - PRODUCTS

### 2.01 PREPARATION:

- A. Verify details; obtain copy of accepted hardware schedule templates and other information.
- B. Verify size, design and fire-resistive rating of each opening.
- C. Coordinate details of construction with other work supporting or adjoining frames and doors.

### 2.02 HOLLOW-METAL DOORS:

#### A. Manufacturers:

1. Ceco Door Products; a United Dominion Company.
2. Curries Company.
3. Steelcraft; a Division of Ingersoll-Rand.
4. Or approved equal.

#### B. General:

1. Construct 1-3/4-in. thick full flush type hollow metal doors.
2. Face sheets: Not less than 14 gage for exterior doors and 16 gage for interior doors.
3. Face sheets: A60 galvanized steel, free of seams or joints. Conform to ASTM A653 for galvanized sheet steel.
4. Core Construction:
  - a. Interlocking vertical channels or Z-members of not lighter than 22-gage steel, spaced not more than 6-in. apart and spot welded to face sheets not less than 6-in. on centers.

5. Sound-Deadening and Thermal Insulation: Chemically-inert, non-combustible, moisture-resistant material in accordance with accepted manufacturer's recommendations. Conform to requirements of labeling authority for labeled door insulation.
6. Face sheets spot welded to the core.
7. Weld tops and bottoms of the doors flush or closed with a recessed channel.
8. Mortise and reinforce doors for hinges with not less than 7-gage steel.
9. Reinforce doors for surface applied hardware and lock faces with 12-gage steel.
10. Drill and tap doors for locks and hinges at the factory.
11. Drill and tap for surface applied hardware in the field.
12. Glazed doors: Furnish snap-in glazing strips not requiring screws.
13. Secure stationary, sightproof, 20-gage cold-rolled sheet steel louvers into openings in doors by metal moldings screwed on both sides of door.
14. Furnish doors bearing Underwriter's Laboratory, Inc., label as indicated.
15. Provide UL approved astragal on pairs of labeled doors.

#### 2.03 PRESSED-METAL FRAMES:

- A. Provide pressed-metal frames for hollow metal doors by same manufacturer as doors including frames for wood doors, vision panels and sidelights.
- B. Fabricate frames of not less than 14 gage for exterior doors and 16 gage for interior doors of A60 galvanized steel with integral stops and rabbets.
- C. Assemble heads and jambs with accurately fitted, fully welded, smoothly ground miter joints.
- D. Weld angle spreaders to bottom of jambs to assure safe shipment and perfect alignment in field.
- E. Anchors for frames:
  1. Provide three corrugated adjustable loose T-anchors on each jamb of frames under 8 ft. and additional anchors for frames 8 ft. and higher.

2. Provide floor anchor clips, on each jamb, with holes for securing to concrete floor slab.
  - F. Provide anchors for frames attachment to wood and metal studs as recommended by frame manufacturer.
  - G. Mortise frames for strike plates and hinges.
  - H. Weld steel reinforcing plates to frames for hinges; drill and tap plates to accommodate mortise type template hinges; and weld galvanized dust covers over reinforcing plates to prevent clogging of tapped holes by mortar.
  - I. Provide label frames with three Underwriters Laboratories, Inc., labeled, adjustable loop anchors per jamb.
  - J. Provide vinyl thermal break frames at all exterior doors and insulated doors unless otherwise indicated.
  - K. Sound-Deadening and Thermal Insulation: Chemically-inert, non-combustible, moisture-resistant material in accordance with accepted manufacturer's recommendations. Conform to requirements of labeling authority for labeled door insulation.
- 2.04 VISION PANELS:
- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
  - B. Provide glazed lites in accordance with Section 08 81 00 Glass and Glazing.
- 2.05 HARDWARE PREPARATION:
- A. Provide frames and doors with cut-outs and reinforcement for mortise hardware and reinforcement for surface mounted hardware in accordance with templates supplied by hardware manufacturers. Additionally, drill and tap as required for hardware.
  - B. Make total thickness of reinforced conditions equal to nominal diameter of fasteners required by hardware items.
  - C. Provide plaster guards or mortar boxes in back of hardware cut-outs in and welded to frames.
  - D. Provide frames and doors having fire-resistive ratings with hardware preparation conforming to requirements of labeling authority.
  - E. Welding hinges to door frames not permitted.

- F. Drill door frames for installation of mutes. Do not drill frame stops of soundproof openings.

#### 2.06 FINISHES:

- A. General: Comply with NAAMM's "Metal Finished Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
- B. Steel Work:
  - 1. Hollow Metal Doors: Chemically wash, rinse, and dry followed by one shop coat of metallic primer.
  - 2. Door Frames: Phosphate treat and shop coat with baked-on metallic primer.
  - 3. Hollow Metal Doors and Frames: Galvanized in accordance with ASTM A653, cleaned, phosphatized and followed by one shop coat of baked-on primer.

### PART 3 - EXECUTION

#### 3.01 INSPECTION:

- A. Examine accepted hardware schedules and verify proper coordination of hardware, doors and frames.
- B. Examine opening locations and verify following:
  - 1. Correctness of dimensions, backing or support conditions.
  - 2. Absence of defects that would adversely affect frame or door installation.
- C. Do not begin work until unsatisfactory conditions are corrected.

#### 3.02 PREPARATION:

- A. Protect aluminum components of aluminum doors, frames and vision panels in contact with plaster, concrete, or masonry, or connected to dissimilar metals in accordance with Section 05 50 00.

#### 3.03 INSTALLATION:

- A. Install and adjust doors, frames, and vision panels and sidelights, and appurtenances in accordance with the manufacturer's printed recommendations.
  - 1. Clips, bolts, screw and rivets: Type 304 Stainless steel, type and sized as recommended by door manufacturer.

- B. Set frames and anchor in position, plumb, square, level and in alignment.
- C. Brace frames until the anchors are set.
- D. Fill the backs of pressed metal frames with mortar only as required by manufacturer, and specified in Section 04 20 00.
- E. Hang doors in frames with proper clearances.
- F. Make final adjustments for proper and easy operation of doors after hardware installation and glazing.
- G. Standard Steel Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
  - 1. Non-Fire-Rated Standard Steel Doors:
    - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
    - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
    - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
    - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
  - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

#### 3.04 ADJUSTING:

- A. Prime Coat Touch-Up: Immediately after installation, sand smooth and touch-up rust areas and other areas where prime has been damaged, with prime touch-up paint.
- B. Make adjustments as required for correct function and smooth operation.
- C. Protect frames and doors from damage to surface or profile.

#### 3.05 PROTECTION:

- A. After erection, protect doors, frames, vision panels and finishing hardware from damage due to installation of other work or from lime, acid, cement, or other harmful compounds.
- B. Replace damaged doors, frames and finishing hardware as determined by the Engineer/Architect with new items and at no additional expense to the Owner.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 08 31 00

### ACCESS PANELS AND FRAMES

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION:

- A. Access panels and frames ceilings.
- B. Accessories.

##### 1.02 REFERENCES:

###### A. American International (ASTM):

1. ASTM A36/A36M-12, Standard Specification for Carbon Structural Steel
2. ASTM A153/A153M-09, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
4. ASTM A666-10, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar]
5. ASTM A879/A879M-12, Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
6. ASTM A1008/A1008M-12a, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
7. ASTM B209-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
8. ASTM B221-12a, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
9. ASTM F2329-11, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

B. International Code Council (ICC):

1. International Building Code (IBC) - current Edition.

C. Intertek Testing Services/Warnock-Hersey International (ITS/WHI).

D. National Fire Protection Association (NFPA):

1. NFPA 80-2013, Standard for Fire Doors and Other Opening Protectives
2. NFPA 252-2012, Standard Methods of Fire Tests of Door Assemblies
3. NFPA 288-2012, Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies.

E. Underwriters Laboratories, Inc. (UL):

1. UL 10B-2008, Fire Tests of Door Assemblies
2. Classified Building Materials Index

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Product Data:

- a. Materials description for access panels and frames including details showing mounting type, relationships to surrounding construction, panel and frame type, materials, and construction, and locking features.
- b. Installation instructions for each product specified.

2. Shop Drawings:

- a. Include details of each frame type, elevation of panel, anchorage and accessory items.
- b. Schedule showing each type of access panel and frame, locations, sizes, latching or locking provisions, and other data pertinent to installation.
- c. Indicate installation procedures and accessories required for a complete installation.



3. Samples: For each panel face material, at least 3 by 5 inches (75 by 125 mm) in size, in specified finish.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Comply with standards referenced in Article 1.02 REFERENCES.
- C. Provide access panels and frames produced by a single manufacturer.

#### 1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver, store, and handle access panels and frames using means and methods that will prevent damage, deterioration, or loss.
  1. Deliver units in manufacturer's original packaging, properly labeled for identification.

### PART 2 – PRODUCTS

#### 2.01 ACCESS PANELS AND FRAMES MANUFACTURER:

- A. Acceptable Manufacturers: Provide products by the following or an approved equal.
  1. J. L. Industries, Inc., a division of Activar Construction Products Group
  2. Acudor Products
  3. Cendrex
  4. Or approved equal.
- B. Substitutions: Manufacturers seeking approval of their products are required to comply with the Owner's Instructions to Bidders, generally contained in the Project Manual.

#### 2.02 INTERIOR ACCESS PANELS AND FRAMES:

- A. Insulated flush access panel.
  1. Manufacturer's standard recessed ceiling access panel.

2. Frame and Trim: 16-gauge steel with 1-inch flange, and welded-on masonry anchor.
3. Panel: Insulated 20-gauge steel with continuous hinge; 2-inch thickness.
4. Finish: Powder coat paint - white.
5. Standard Latch/Lock: Universal turn ring and key lock "U".
6. General Use: Ceilings.
7. Style Options:
  - a. Frame and Trim, and Panel Material: Galvanized steel.
  - b. Lock Feature: Mortise Slam Lock prep (U3)

#### 2.03 MATERIALS:

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- D. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
- E. Frame Anchors: Same type as panel face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot dip galvanized steel according to ASTM A153/A153M or ASTM F2329.
- G. Furnish inserts and anchoring devices which must be built into other work for installation of access panels

#### 2.04 FABRICATION:

- A. General: Furnish each access panel assembly manufactured as an integral unit, complete and ready for installation.

- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Panels and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panel frames to types of supports indicated.
  - 1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
  - 2. For concealed flanges with plaster bead for full bed plaster applications, provide zinc coated expanded metal lath and exposed casing bead welded to perimeter of frames.
  - 3. Provide mounting holes in frames for attachment of units to metal or wood framing.
  - 4. Provide mounting holes in frame for attachment of masonry anchors.
- D. Recessed Access Panels: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
- E. Latching Mechanisms: Furnish number required to hold panels in flush, smooth plane when closed.
  - 1. For cylinder locks, furnish 2 keys per lock and key all locks alike.

## PART 3 – EXECUTION

### 3.01 EXAMINATION:

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Notify the Contractor in writing of conditions detrimental to proper and timely completion of the installation.
  - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION:

- A. General: Comply with manufacturer's written instructions for installing access panels and frames.

- B. Install panels flush with adjacent finish surfaces or recessed to receive finish material.

### 3.03 ADJUSTING AND CLEANING:

- A. Adjust access panels to operate easily without binding. Verify that integral locking/latching devices operate properly.
- B. Remove panels and frames that are warped, bowed, or otherwise damaged, and replace with new components.
- C. On completion of access panel installation, clean interior and exterior surfaces as recommended by manufacturer.

### 3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 08 33 23

### INSULATED OVERHEAD COILING DOORS

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION:

- A. Provide insulated, prefinished overhead coiling doors as indicated and specified.

##### 1.02 SYSTEM DESCRIPTION:

###### A. Design Requirements:

1. Wind Loading: Design doors to withstand up to wind load criteria indicated on structural drawings.
2. Cycle Life:
  - a. Design doors of standard construction for normal use of up to 20 cycle per day maximum.

##### 1.03 SUBMITTALS:

###### A. Submit the following in accordance with Section 01 33 00:

1. Product data and specifications.
2. Shop Drawings: Include special conditions not detailed in Product Data. Show interface with adjacent work.
3. Refer to Paragraph 1.05 below.
4. For information purposes only, submit manufacturer's installation instructions.
5. Submit Operation and Maintenance Manuals.
6. Certificate stating that installed materials comply with this specification.
7. Submit wiring diagrams.
8. Submit color charts for specified finish.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Manufacturer Qualifications: Provide each overhead coiling door as a complete unit produced by a single manufacturer, including frames, curtains, brackets, guides, hoods, counterbalance mechanisms, weatherstripping, hardware, electric operator, pushbutton stations, control wiring and installation accessories.
- C. Wind Loading: Design and reinforce overhead coilings doors to withstand a 25-psf wind-loading pressure.
- D. Energy Requirements: Provide Doors and Frames which comply with current applicable IECC requirements, as indicated on the drawings.

#### 1.05 DELIVERY STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver all units from the factory to the site crated, braced and protected against distortion and damage during transit and unloading. Label all parts to comply with shop drawings for designations.
- C. Store in clean and dry locations, properly supported above floor to allow free movement of air and to prevent bending or warping. Units showing effects of rough handling will be rejected.
- D. Follow manufacturer's instructions.

#### 1.06 WARRANTY:

- A. Standard Warranty: Two years from date of shipment against defects in material and workmanship.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS:

- A. Cornell Iron Works
- B. The Cookson Company
- C. North American Door/Division of Jim Walkers Co.
- D. Or approved equal.

## 2.02 MATERIALS:

### A. Curtain:

1. Slat Material: (Interior and Exterior):
  - a. Extruded Aluminum: 18 gauge, factory finish.
  - b. Insulation: 7/8 inch foamed-in-place, closed cell urethane.
  - c. Total Slat Thickness: 15/16 inch.
2. Bottom Bar: Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge.
3. Fabricate interlocking sections with high strength nylon endlocks on alternate slats each secured with two 1/4 inch rivets. Provide windlocks on every fourth slat as a minimum.

- B. Guides: Fabricate with minimum 3/16 inch structural steel angles. Provide windlock bars of same material. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.

Top of coil side guide angles to be removable for ease of curtain installation.

### C. Counterbalance Shaft Assembly:

1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.
2. Spring Balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs. Provide wheel for applying and adjusting spring torque.

- D. Brackets: Fabricate from minimum 3/16 inch steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.

- E. Hood: 18 gauge aluminum with reinforced top and bottom edges. Provide minimum 1/4 inch steel intermediate support brackets.

### F. Finish:

1. Provide the following factory finish for slats (interior and exterior), bottom bar, guides, brackets, and hood, unless otherwise noted above:
  - a. Factory Finish.
  - b. Custom color to be selected by Architect/Engineer.

G. Weatherstripping:

1. Bottom Bar: Replaceable, 3-point, compressible vinyl gasket extending into guides.
2. Bottom Bar, Motor Operated Doors: Weather/sensing edge with neoprene or rubber astragal extending full width of door bottom bar.
3. Guides: Replaceable vinyl strip on guides sealing against fascia side of curtain.
4. Lintel Seal: Nylon brush seal fitted at door header to impede air flow.
5. Hood: Neoprene/rayon baffle to impede air flow above coil.

2.03 ACCESSORIES:

A. Locking:

1. Crank Hoist: Padlockable slide bolt on coil side of bottom bar at each jamb extending into slots in guides.
2. Manual Chain Hoist: Padlockable chain keeper on guide.
3. Padlockable slide bolt on coil side of bottom bar at each jamb extending into slots in guides.
4. Provide heavy duty padlocks with two (2) keys for each door.

- B. Operator and Bracket Mechanism Cover: Provide 18 gauge aluminum metal cover to provide weather resistance and to enclose exposed moving operating components at coil area of unit. Finish to match door hood.

2.04 OPERATION:

- A. Manual Chain Hoist: Provide chain hoist operator with endless steel chain, chain pocket wheel and guard, geared reduction unit, and chain keeper secured to guide.
- B. Supply standard duty, cUL listed, gearhead hoist type operator(s) size to provide indicated operation speed below; 3/4 H.P., 120 Volts, 1 Phase. Provide cUL listed electric



door operator assembly of size and capacity recommended by door manufacturer; complete with electric motor and factory pre-wired motor controls, worm-gear reduction unit, solenoid operated brake, 3-button OPEN/CLOSE/STOP control station. Motor shall be high starting torque, continuous duty, industrial type, protected against overload by a current sensing or thermal overload device. Speed reduction shall be worm-gear-in-oil-bath gear reducer with synthetic "All Climate" oil and shall provide 45:1 speed reduction. Door drive shall utilize minimum #50 roller chain and sprockets. Operator shall be equipped with an electrically interlocked floor level disconnect and chain hoist for manual operation and an electric solenoid-actuated brake to stop the motor and hold the door in position. Operator shall be capable of driving the door at a speed of 8 to 9 inches per second. Fully adjustable, driven linear type limit switch mechanism shall synchronize the operator with the door. Low friction nylon limit nuts fitted on threaded steel shaft, rotating on oilite self-lubricating bronze bushings. The motor shall be removable without affecting the limit switch settings.

1. Control Station: Surface mounted, "Open/Close/Stop" push buttons; NEMA Type 7 or 12.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

- A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings.
- B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.
- C. Commencement of work by installer is acceptance of substrate.

#### 3.02 INSTALLATION:

- A. General: Install door and operating equipment with necessary hardware, anchors, inserts, hangers and supports.
- B. Follow manufacturer's installation instructions and approved shop drawings.

#### 3.03 ADJUSTING:

- A. Following completion of installation, including related work by others, lubricate, test, and adjust doors for ease of operation, free from warp, twist, or distortion.

#### 3.04 CLEANING:

- A. Clean surfaces soiled by work as recommended by manufacturer.

B. Remove surplus materials and debris from the site.

3.05 DEMONSTRATION:

A. Demonstrate proper operation to Owner's Representative.

B. Instruct Owner's Representative in maintenance procedures.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 08 71 00

FINISH HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section Includes:

1. Finish hardware for doors as specified and as listed in "Hardware Groups" and required by actual conditions.
2. Include screws, special screws, bolts, special bolts, expansion shields, and other devices for proper application of hardware.

B. General Requirements:

1. Provide items, articles, materials, operations, and methods listed, mentioned or scheduled herein or on drawings, in quantities as required to complete project. Provide hardware that functions properly. Prior to furnishing hardware, advise Engineer of items that will not operate properly, are improper for conditions, or will not remain permanently anchored.

1.02 REFERENCES:

- A. ANSI 156: American National Standards Institute
- B. DHI: Door and Hardware Institute
- C. BHMA: Builders Hardware Manufacturers Association

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Hardware Schedule: Submit hardware schedule in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Schedules, which do not comply, will be returned for correction before checking. Hardware schedule shall clearly indicate Engineer's hardware group and manufacturer of each item proposed. The schedule shall be reviewed prior to submission by a certified Architectural Hardware Consultant (AHC).

- a. Provide illustrations from manufacturers catalogs and data in brochure form for all products, including model, function, design, finishes, and options.
  - b. Check specified hardware for suitability and adaptability to details and surrounding conditions. Indicate unsuitable or incompatible items and proposed substitutions in hardware schedule.
  - c. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
  - d. Furnish other Contractors, and Subcontractors concerned, with copies of final approved hardware schedule. Submit necessary templates and schedules as soon as possible to door fabricators in accordance with schedule that is required for fabrication.
  - e. Samples: Lever design or finish sample: Provide samples if requested by Engineer.
2. Installation Instructions: Provide manufacturer's written installation and adjustment instructions for finish hardware. Send installation instructions to site with hardware after approval of finish hardware.
  3. Templates: Submit templates and final approved hardware schedule to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.
  4. Closeout Submittals: Comply with Section 017400 including specific requirements indicated.
    - a. Operating and maintenance manuals: Submit sets containing the following:
      - (1) Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
      - (2) Catalog pages for each product.
      - (3) Name, address, and phone number of local representative for each manufacturer.
      - (4) Parts list for each product.
    - b. Copy of final approved hardware schedule, edited to reflect "As installed."
    - c. Copy of final keying schedule.

- d. One complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- e. Copy of all warranties; including all appropriate reference numbers for manufacturers to identify the project.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Manufacturer: Obtain each type of hardware (ie. latch and locksets, hinges, closers) from single manufacturer, although several may be indicated as offering products complying with requirements.
- C. Supplier: Recognized architectural finish hardware supplier, with warehousing facilities, who has been providing hardware for period of not less than 3 years. The supplier shall be, or employ, a certified Architectural Hardware Consultant (AHC), who is registered in the continuing education program as administered by the Door and Hardware Institute. The hardware schedule shall be prepared and signed by a certified AHC.
- D. Installer: Firm with 3 years experience in installation of similar hardware to that required for this project, including specific requirements indicated.
- E. Regulatory Label Requirements: Provide nationally recognized testing agency label or stamp on hardware for labeled openings. Where UL requirements conflict with drawings or specifications, hardware conforming to UL requirements shall be provided. Conflicts and proposed substitutions shall be clearly indicated in hardware schedule.
- F. Pre-Installation Conference: Prior to the installation of hardware, manufacturer's representatives for locksets, closers, and exit devices shall arrange and hold a jobsite meeting to instruct the installing contractor's personnel on the proper installation of their respective products. A letter of compliance, indicating when this meeting is held and who is in attendance, shall be sent to the Engineer and Owner.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver hardware to jobsite in manufacturer's original packaging, marked to correspond with approved hardware schedule. Do not deliver hardware until suitable locked storage space is available. Check hardware against reviewed hardware schedule. Store hardware to protect against loss, theft or damage.
- C. Deliver hardware required to be installed during fabrication of hollow metal, aluminum, wood, or stainless steel doors prepaid to manufacturer.

1.06 GUARANTEE/WARRANTY:

- A. General: Guarantee workmanship and material provided against defective manufacture. Repair or replace defective workmanship and material appearing within period of one year after Substantial Completion.
- B. Provide five year factory warranty on exit devices against defects in material and workmanship from date of occupancy of Project.
- C. Provide ten year factory warranty on door closer body against defects in material and workmanship from date of occupancy of Project.
- D. Replace shortages and incorrect items with correct material at no additional cost to Owner.
- E. At completion of project, a qualified factory representative shall inspect closer installations. After this inspection, letter shall be sent to Engineer reporting on conditions, verifying that closers have been properly installed and adjusted.

1.07 SEQUENCING AND SCHEDULING:

- A. Deliver finish hardware to the jobsite in a timely manner so as not to delay progress of other trades.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Manufacturers listed have been chosen to establish a standard of quality, design, and function.
- B. Manufacturer information:
  - 1. The following is a list of approved manufacturers, address, and website (if available). This information is being supplied for reference only and in no way implies product acceptance. Only the products listed in the respective category are considered to be acceptable for this project.

a.	ABH	Elk Grove, IL
b.	Corbin-Russwin	Monroe, NC
c.	Detex	New Braunfels, TX
d.	Don-jo	Sterling, MA
e.	Folger Adam	Lemont, IL
f.	Glynn-Johnson	Indianapolis, IN
g.	Hager	St. Louis, MI

h.	HES	Phoenix, AZ
i.	Key Control	Katy, TX
j.	LCN	Princeton, IL
k.	Locknetics	Forestville, CT
l.	Lund	Bath, OH
m.	Markar	Lancaster, NY
n.	McKinney	Scranton, PA
o.	National Guard	Memphis, TN
p.	Norton	Monroe, NC
q.	Pemko	Memphis, TN
r.	Precision	Romulus, MI
s.	Reese	Rosemont, MN
t.	Rixson	Monroe, NC
u.	Rockwood	Altoona, PA
v.	Sargent	New Haven, CT
w.	Schlage	Colorado Springs, CO
x.	Securitron	Sparks, NV
y.	Sentrol	Tualatin, OR
z.	Stanley	New Britain, CT
aa.	Telkee	Dover, DE
bb.	Von Duprin	Indianapolis, IN
cc.	Westguard	Twinsburg, OH
dd.	Or approved equal	

2.02 BUTTS AND HINGES:

A. Acceptable Manufacturers and Products:

	Type	McKinney	Hager	Stanley	Or approved equal.
1.	Type 1	T4A3795	BB1262	FBB268	
2.	Type 2	TA2714	BB1279	FBB179	
3.	Type 3	TA2314	BB1191	FBB191	
4.	Type 4	T4A3786	BB1168	FBB168	
5.	Type 5	T4A3386	BB1199	FBB199	

B. Application:

1. Exterior over 36 inches wide: Type 5
2. Exterior 36 inches wide or less: Type 3
3. Interior doors 36 inches wide or less: Type 3

4. Provide NRP (non-removable pins) at out-swinging lockable doors (interior or exterior).

C. Size:

1. 1-3/4 inch Doors: 4-1/2 inch by 4-1/2 inch

D. Quantity:

1. 2 - hinges per leaf for openings through 60 inches high.
2. 1 - additional hinge per leaf for each additional 30 inches in height or fraction thereof.

- E. Drill 5/32 inch hole and use No. 12, 1-1/4 inch steel threaded to the head wood screws for hinges on wood doors.

2.03 LOCKSETS – MORTISE:

A. Acceptable Manufacturers and Products:

	Manufacturer	Series
1.	Sargent	8200 x LNL
2.	Schlage	L9000 x 06A
3.	Corbin-Russwin	ML2000 x NSA
4.	Or approved equal.	

- B. Provide lock series and functions as specified in Hardware Groups, with the provisions below. Sargent product numbers are referenced in the Hardware Groups.

1. Cylinders: Refer to keying requirements
2. Backsets: 2-3/4 inches.
3. Strikes: Provide wrought boxes and strikes with proper lip length to protect trim but not to project more than 1/8 inch beyond trim, frame or inactive leaf. Where required, provide open back strike and protected to allow practical and secure operation.



2.04 DEADLOCKS:

A. Acceptable Manufacturers and Products:

	Manufacturer	Series
1.	Sargent	4870
2.	Schlage	L460
3.	Corbin-Russwin	DL4000
4.	Or approved equal.	

B. Provide deadlock series and functions as specified in Hardware Groups, with the provisions below. Sargent product numbers are referenced in the Hardware Groups.

1. Cylinders: Refer to keying requirements.
2. Backsets: 2-3/4 inches.
3. Strikes: Provide manufacturers standard wrought brass, bronze, or steel strike.

2.05 EXIT DEVICES:

A. Acceptable Manufacturers and Products:

	Manufacturer	Series
1.	Sargent	80 Series
2.	Von Duprin	98/35 Series
3.	Precision	Apex Series
4.	Or approved equal.	

B. Provide exit device series and functions as specified in Hardware Groups. Sargent product numbers are referenced in the Hardware Groups.

- C. All exit devices shall be UL listed for panic. Exit devices for labeled doors shall be UL listed as "Fire Exit Hardware".
- D. Where lever trim is specified, provide lever design to match lockset levers.
- E. Provide cylinders for exit devices with locking trim and cylinder dogging.
- F. Provide cylinder dogging feature for non-rated exit devices.
- G. Provide keyed removable mullions, as specified in the Hardware Groups.

2.06 KEYING:

A. Acceptable Manufacturers and Products: Karpilow Safe & Lock, LLC, Bridgeport CT.

- B. Provide manufacturers standard removable core cylinders. Provide construction cores with construction master keying for use during construction. The hardware supplier shall install permanent master keyed cores upon completion of the project.
- C. Factory key all cylinders with manufacturer retaining permanent keying records.
- D. Submit proposed keying schedule to Engineer. Meet with Owner and Engineer to review schedule.

2.07 DOOR TRIM:

A. Acceptable Manufacturers and Products:

	Type	Rockwood	Hager	Donjo	Or approved equal
1.	Push Plate	70	30S	71	
2.	Pull	BF111	H4J	H20	
3.	Pull, offset	BF157	H12J	H1157	
4.	Push Bar	47	130S	147	
5.	Kick Plate	K1050 B4E	194S	90 B4E	
6.	Door Edges	306B	182P	1299	

B. Push Plates:

- 1. Rockwood #70, provide 4 inches by 16 inch unless otherwise indicated.
- 2. Where width of door stile prevents use of 4 inch wide plate, provide push plate 3 1/2 inches wide.

C. Push Bars:

- 1. Rockwood #47, unless otherwise indicated.
- 2. Where required, mount back to back with pull.

D. Pull, offset:

- 1. Rockwood #BF157, unless otherwise indicated.
- 2. Where required, mount back to back with push bar.

E. Pulls:

- 1. Rockwood #BF111, unless otherwise indicated.

2. Where required, mount back to back with push bar.

F. Pull Plate:

1. Rockwood #BF111 pull x #70 plate, provide plate 4 inches by 16 inch unless otherwise indicated.
2. Where width of door stile prevents use of 4 inch wide plate, provide push plate 3 1/2 inches wide.

G. Kick Plates and Armor Plates:

1. Minimum of 0.050 inch thick, beveled 4 edges.
2. At single doors provide width 1-1/2 inch less than door width on stop side and one inch less than door width on face side.
3. At pairs of doors provide width one inch less than door width on either sides.
4. Provide Height:
  - a. Mop Plates: 4 inches, unless otherwise indicated.
  - b. Kick Plates: 8 inches, unless otherwise indicated.
  - c. Armor Plates: 34 inches, unless otherwise indicated.

H. Edge Guards:

1. Minimum .050" thick, stainless steel.
2. Rockwood #306B x 42 inches high as noted in Hardware Groups.

2.08 DOOR CLOSERS:

A. Acceptable Manufacturers and Products:

	Type	Sargent	LCN	Norton	Or approved equal.
1.	Stop Arm	351-CPS	4040S-CUSH	UNI-7500-BF	
2.	Stop/Holder Arm	351-CPSH	404S-H-CUSH	UNI-7500BF-H	

B. Provide all closers on exterior openings with a stop arm, unless noted otherwise.

- C. Provide all closers on interior openings with a regular arm or heavy duty parallel arm, unless noted otherwise.
- D. Provide drop plates, brackets, or adapters for arms as required to suit details.
- E. Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors. Closers shall not be visible in corridors, lobbies and other public spaces unless necessary.
- F. Provide closers for doors as noted in Hardware Groups and, in addition, provide closers for labeled doors whether or not specifically noted in group.
- G. Provide closers meeting the requirements of UBC 7-2 and UL 10C positive pressure tests.
- H. Provide bolt attachments or blocking for mineral core door application as directed by Engineer and/or door specifications.

2.09 OVERHEAD STOPS/HOLDERS:

- A. Acceptable Manufacturers and Products:

	Type	Sargent	ABH	Glynn Johnson	Or approved equal.
1.	Surface, med. Duty	1540	3300	450	
2.	Surface, heavy duty	590	9000	900	

- B. Provide 1540 Series overhead stop for interior doors equipped with regular arm surface type closer that swing more than 140 degrees before striking wall, and for doors that open against equipment, casework, sidelights, other objects that would make wall stops inappropriate. Provide 590 Series overhead stop for exterior doors where specified.
- C. Provide bolt attachments or blocking for mineral core door application as directed by Engineer and/or door specifications.

2.10 THRESHOLDS:

- A. Acceptable Manufacturers and Products:

		Interior Door Saddle Type	Exterior Door Stop Type	Or approved equal.
	Manufacturer	Series	Series	
1.	Pemko	171	2000B	
2.	Reese	S205	5483	
3.	National Guard	425	896	

- B. Provide thresholds as indicated on drawings and as specified.
  - 1. Refer to drawings for special details. Provide accessories, shims and fasteners.
  - 2. Where thresholds occur at openings with one or more mullions, they shall be cut for the mullions and extended continuously for the entire opening.

2.11 WEATHERSTRIPPING:

A. Acceptable Manufacturers and Products:

	Type	Pemko	Reese	National Guard	Or approved equal.
1.	Sweeps	315CN	323	200N	
2.	Jambs	316AV	DS75	152	
3.	Astragals	18061CP	964C	C607	
4.	Rain Drip	346C	R201	16D	

- B. Where weatherstripping is specified in hardware groups, provide 316AV at jambs, unless detailed or scheduled otherwise.
  - 1. Provide self-tapping fasteners for weatherstripping being applied to hollow metal frames.
- C. Where astragals are specified in hardware groups, provide 2 pieces of 18061CP unless detailed or scheduled otherwise.
- D. Where sweeps are specified in hardware groups, provide 315CN unless detailed or scheduled otherwise.
- E. Where rain drips are specified in hardware groups, provide 346C x full frame width, unless detailed otherwise.

2.12 GASKETING:

A. Acceptable Manufacturers and Products:

	Type	Pemko	Reese	National Guard	Or approved equal.
1.	Smoke	PK55D	F-897B	2525	

- B. Where smoke gasket is specified in hardware groups, provide PK55D, unless detailed otherwise.

- C. Provide accessories, shims and fasteners.
- D. Provide gaskets for 20-minute doors and doors designated for smoke and draft control.
- E. Where frame applied intumescent seals are required by the manufacturer, provide gaskets that comply with UBC 7-2 and UL 10C positive pressure tests.

2.13 SILENCERS:

- A. Acceptable Manufacturers and Products:

	Type	Westguard	Hager	Donjo	Or approved equal.
1.	Hollow Metal Frame	650ST	307D	1608	

- B. Where weatherstripping or gasketing is not used provide the appropriate silencer for each frame.

2.14 FASTENERS:

- A. Including, but not limited to, wood or machine screws, bolts, nuts, anchors, etc. of proper type, material, and finish required for installation of hardware.
- B. Use phillips head for exposed screws. Do not use aluminum screws to attach hardware.
- C. Provide self-tapping (TEC) screws for attachment of sweeps and stop-applied weatherstripping.
- D. Install all hardware with only fasteners provided by the manufacturer for use with the specific product and according to the manufacturers written instructions.

2.15 TYPICAL FINISHES AND MATERIALS:

- A. Finishes, unless otherwise specified:
  - 1. Butts: Exterior Doors
    - a. US32D (BHMA 630) on Stainless Steel
  - 2. Continuous Hinges:
    - a. US32D (BHMA 630) on Stainless Steel
  - 3. Flush Bolts:

- a. US26D (BHMA 626) on Brass or Bronze
- 4. Exit Devices:
  - a. US32D (BHMA 630) on Stainless Steel
- 5. Locks and Latches:
  - a. US32D (BHMA 630) on Stainless Steel
- 6. Push Plates, Pulls and Push Bars:
  - a. US32D (BHMA 630) on Stainless Steel
- 7. Kick Plates, Armor Plates, and Edge Guards:
  - a. US32D (BHMA 630) on Stainless Steel
- 8. Overhead Stops and Holders:
  - a. US26D (BHMA 626) on Brass or Bronze
- 9. Closers: Surface mounted:
  - a. Sprayed Aluminum Lacquer
- 10. Miscellaneous Hardware:
  - a. US32D (BHMA 630) on Stainless Steel or US26D (BHMA 626) on Brass or Bronze

## PART 3 – EXECUTION

### 3.01 EXAMINATION:

- A. Examine doors, frames, and related items for conditions that would prevent the proper application of finish hardware. Do not proceed until defects are corrected.
- B. Field verify existing doors, frames, hardware, and conditions prior to scheduling hardware.

### 3.02 INSTALLATION:

- A. Install finish hardware in accordance with reviewed hardware schedule and manufacturer's printed instructions. Prefit hardware before finish is applied. Remove and

reinstall after finish is completed. Install hardware so that parts operate smoothly, close tightly and do not rattle.

- B. Installation of hardware shall comply with NFPA 80 and NFPA 101 requirements.
- C. Set units level, plumb and true to line and location. Adjust and reinforce attachment to substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant, forming tight seal between threshold and surface to which set. Securely and permanently anchor thresholds, using countersunk non-ferrous screws to match color of thresholds (stainless steel screws at aluminum thresholds).
- F. Lead Protection: Lead wrap hardware penetrating lead-lined doors. Levers and roses to be lead lined. Apply kick and armor plates with 3M adhesive #1357, as recommended by 3M Co., on lead-lined doors.

### 3.03 FIELD QUALITY CONTROL:

- A. After installation has been completed, a qualified person from the hardware supplier is to check the Project to determine proper application of finish hardware according to schedule. Also check operation and adjustment of all hardware items.
- B. Installer shall deliver to owner, upon completion, one set of installation and maintenance instructions and specialty tools for all hardware items.

### 3.04 ADJUSTING AND CLEANING:

- A. At completion, hardware shall be left clean and free from disfigurement. Make adjustment to door closers and other items of hardware. Where hardware is found defective repair or replace or otherwise correct as directed.
- B. Adjust door closers to meet opening force requirements of Uniform Federal Accessibility Standards.
- C. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- D. Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of space or area, return to work during week prior to acceptance or occupancy, and make/ check adjustments of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors.



- E. Final Adjustment: Installer shall return six months after substantial completion to make final adjustments of all hardware items.
- F. Installer shall instruct Owner's personnel in proper adjustment and maintenance of door hardware and hardware finishes.
- G. Clean adjacent surfaces soiled by hardware installation.

3.05 PROTECTION:

- A. Provide for proper protection of items of hardware until Owner accepts Project as complete.

3.06 HARDWARE GROUPS AND SUFFIXES:

- A. The following schedule of hardware groups shall be considered a guide only, and the supplier is cautioned to refer to general conditions, special conditions, and the preamble to this section. It shall be the hardware supplier's responsibility to furnish all required hardware.
- B. Refer to the door schedule for special hardware notes, applications, and/or requirements.

3.07 HARDWARE GROUPS:

- A. GROUP 10: Exterior single egress with exit device allowing entry.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	3 each	
b.	Lockset	1 each	Entrance Function – F08.
c.	Exit Device	1 each	8813 ET. [F08 - Key locks or unlocks lever.]
d.	Stop/Hold-Open Closer	1 each	
e.	Threshold	1 each	
f.	Weatherstripping	1 set	
g.	Sweep	1 each	
h.	Rain Drip	1 each	

B. GROUP 20: Exterior single egress with lockset.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	3 each	
b.	Lockset	1 each	Entrance Function – F09. Latch bolt retracted by either side unless outside trim is locked by key inside. Key outside retracts latch bolt when outside trim is locked.
c.	Stop/Hold-Open Closer	1 each	
d.	Threshold	1 each	
e.	Weatherstripping	1 set	
f.	Sweep	1 each	
g.	Rain Drip	1 each	

C. GROUP 60: Exterior egress pair with exit devices allowing entry at one leaf.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	6 each	
b.	Lockset	1 each	8813 ET. [F08 – Key locks or unlocks lever.]
c.	Exit Device	1 each	8810. [F01 – No outside operation.]
d.	Exit Device	1 each	8813 ET. [F08 – Key locks or unlocks lever.]
e.	Keyed Removable Mullion	1 each	12-L980 Steel
f.	Stop/Hold-Open Closer	2 each	
g.	Kick Plates	2 each	
h.	Threshold	1 each	
i.	Weatherstripping	2 sets	
j.	Sweeps	2 each	
k.	Rain Drip	1 each	

D. GROUP 110: Interior non-rated single bathrooms.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	3 each	
b.	Privacy	1 each	Passage Function – F22. Latch bolt retracted by either trim. Turn lever automatically locks outside lever. Operating inside trim automatically retracts latch bolt, unlocking outside trim. Outside emergency release unlocks outside trim. Will automatically unlock when door latches.
c.	Stop Arm Closer	1 each	

E. GROUP 150: Interior non-rated single with storeroom function lockset.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	3 each	
b.	Lockset	1 each	Storeroom Function – F07. Latchbolt retracted by trim inside or key outside. Outside trim rigid at all times.
c.	Stop/Hold-Open Closer	1 each	

F. GROUP 165: Interior rated single corridor and stairs with exit device with passage function.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	3 each	
b.	Exit Device	1 each	Passage Function – F01. Latchbolt retracted by either trim.
c.	Stop Arm Closer	1 each	
d.	Kick Plate	1 each	

B. GROUP 170: Interior rated single electrical/utility room with exit device with storeroom function.

1. Hardware:

	Type	Quantity	Comments
a.	Hinges	3 each	
b.	Exit Device	1 each	12-8813 ET. [F03 – Key retracts latchbolt.]
c.	Stop Arm Closer	1 each	
d.	Kick Plate	1 each	

C. GROUP 200: Overhead and Sectional Doors.

1. All Hardware by Overhead and Sectional Door Manufacturers as applicable.

3.08 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 08 81 00  
GLASS AND GLAZING

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. Provide and set glass required to complete glazing as indicated and specified.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

- 1. ANSI Z97.1: Safety Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings

B. ASTM International (ASTM):

- 1. ASTM C920: Standard Specification for Elastomeric Joint Sealants
- 2. ASTM C1036: Specification for Flat Glass
- 3. ASTM C1048: Specification for Heat Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
- 4. ASTM C1172: Specification for Laminated Architectural Flat Glass
- 5. ASTM E119: Standard Test Methods for Fire Tests of Building Construction and Materials
- 6. ASTM E1886: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
- 7. ASTM E1996: Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

C. National Fire Protection Association (NFPA):

- 1. NFPA 80: Standard for Fire Doors and Other Opening Protectives
- 2. NFPA 257: Standard on Fire Test for Window and Glass Block Assemblies

- D. Underwriters Laboratories (UL):
  - 1. UL 9: Standard for Fire Tests of Window Assemblies
  - 2. UL 263: UL Standard for Safety Fire Tests of Building Construction and Materials
- E. U.S. National Archives and Records Administration (NARA):
  - 1. 16 CFR 1201: Safety Standard for Architectural Glazing Materials

#### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Submit manufacturer's specification for glass and glazing materials and working drawings showing methods of glazing installation.
  - 2. Samples:
    - a. Glass samples not less than 6-inch square.
    - b. Three (3) properly labeled samples of each type of glass and glazing material for review.
  - 3. Manufacturer's certification that materials meet or exceed specifications requirements.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Requirements of Regulatory Agencies: Provide glass installation meeting requirements of applicable State and Local codes.
- C. Design Criteria:
  - 1. Interior Glass and Glazing:
    - a. Fire-rated, clear and wireless glazing material for use in locations such as doors, with fire rating requirements ranging from 45 minutes to 2 hours with required hose stream test; for use in interior applications.
    - b. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate

manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 degrees F, and the fire-resistance rating in minutes.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver each pane of glass affixed with manufacturer's labels; do not remove labels prior to installation, inspection, or final acceptance.

1.06 PROJECT CONDITIONS:

- A. Apply glazing compounds on dry surfaces, at temperatures above 40 degrees F.

PART 2 – PRODUCTS

2.01 GLASS MATERIALS:

- A. General:
  - 1. Safety glass conforming to ASTM C1048 and ANSI Z97.1.
  - 2. Glass Thickness:
    - a. Provide glass thickness at 1/4" thick, or as recommended by manufacturer.
    - b. Provide glass in adjacent windows or glazed panels of same thickness unless shown otherwise.

2.02 GLASS TYPES:

- A. Fire-resistive glazing products.
  - 1. Products:
    - a. Basis of Design: Oldcastle Glass, Inc.; Pyroguard or approved equal.
    - b. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

- B. Fire-Protection-Rated Glazing: Glass Type: 45-minute or 90-minute fire-rated glazing; film-faced ceramic glazing or laminated ceramic glazing.
- C. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies.

2.03 ELASTIC GLAZING COMPOUND:

- A. Channel Glazing and Face Glazing Manufacturers:
  - 1. 795 manufactured by Dow.
  - 2. 895 manufactured by Pecora Corporation.
  - 3. Spectrum 2c manufactured by Tremco Manufacturing Co.
  - 4. Or approved equal.

PART 3 – EXECUTION

3.01 INSPECTION:

- A. Check Openings and Glazing Channels Scheduled to Receive Glass: Free of projections, burrs, irregularities, and debris and other defects that would affect glass or plastic and glazing materials.
- B. Inspect glass for edge damage or face imperfections.
- C. Correct defects before glazing.

3.02 PREPARATION:

- A. Examine frames receiving glass or plastic sheet to ensure if clean and dry.
- B. Verify sealants are compatible with glazing materials.
- C. Remove oil and dust from glass and plastic materials by wiping clean immediately prior to installation.
- D. Use solvents to remove protective coatings or film from aluminum surfaces, that neither etches nor mars surfaces.



### 3.03 GLAZING:

#### A. General:

1. Glaze windows in accordance with current specifications for installation of flat glass published by Flat Glass Jobbers Association.
2. Conform to Flat Glass Marketing Association's "Glazing Manual", manufacturer's recommendations and accepted working drawings.
3. Do not glaze when temperature is below 40 degrees F.
4. Glaze doors in closed position.
5. Maintain edge clearance, in accordance with manufacturers recommendation, from perimeter of glass to inside of rabbet.
6. Maintain minimum 1/8-inch clearance between faces of glass and plastic and adjacent stop or bead.
7. If any glass dimension exceeds 50-inches, provide setting blocks at the sill and spacer shims on other edges.
8. Clean and dry glazing rabbets, glass edges, and applied stops before glazing.
9. Glaze windows neatly and evenly.
10. Do not extend glazing tapes and glazing compounds over edges of glazing stops.
11. Do not apply glazing tapes and glazing compounds more than 1/32-inch under edges of glazing stops.

#### B. Vision Panels:

1. Glaze with applied glazing beads and elastic glazing compound.
2. Minimum edge clearance of glass: 1/4-in. all around.
3. Minimum face clearance of glass: 1/8-in. from sash rabbet, all around.
4. Secure glass in place with removable glazing beads and vinyl glazing inserts.
5. Center glass in glazing rabbets.

6. Apply glazing beads to evenly compress inserts between beads and glass to not less than 15 percent.

7. Miter corners of vinyl inserts.

3.04 GLASS REPLACEMENT:

A. Replace broken, scratched, or damaged glass due to faulty materials or installation with new glass, at no additional cost to the Owner.

3.05 PROTECTION:

A. Protect installed glass and plastic against breakage, damage from sandblasting, welding spatter or other sources.

3.06 CLEANING:

A. Clean glass and surrounding surfaces of spatter and blemishes resulting from glazing operations.

B. Prior to final acceptance clean and polish lights inside and outside.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 08 91 00

### LOUVERS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

A. Provide aluminum louvers and vents as indicated and in compliance with Contract Documents.

1. Section Includes:

a. Fixed, acoustical extruded-aluminum louvers.

##### 1.02 REFERENCES:

A. Aluminum Association (AA):

1. M12C22A41: Anodized Plus Finish

B. American Architectural Manufacturers Association (AAMA):

1. 611: Voluntary Specification for Anodized Architectural Aluminum

2. 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

3. 2604: Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

4. 2605: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

C. Air Movement and Control Association Inc. (AMCA):

1. 500-L: Laboratory Methods of Testing Louvers for Rating

2. 511: Certified Ratings Program for Air Control Devices

D. ASTM International (ASTM):

1. A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

2. A653/A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

3. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
  4. B26/B26M: Standard Specification for Aluminum-Alloy Sand Castings
  5. B209/B209M: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  6. B221/B221M: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  7. D822: Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
  8. D1187: Type II – Specification for Asphalt-Base Emulsions (For Metal Surfaces)
  9. D2244: Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates
  10. D4214: Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
  11. E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
  12. E413: Classification for Rating Sound Insulation
  13. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
  14. E966: Standard Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements
  15. E1332: Standard Classification for Determination of Outdoor-Indoor Transmission Class
- E. American Society of Civil Engineers (ASCE):
1. 7: Minimum Design Loads for Buildings and Other Structures - Includes Supplement No. 1
- F. American Welding Society (AWS):
1. D1.2/D1.2M: Structural Welding Code - Aluminum
  2. D1.3: Structural Welding Code - Sheet Steel
  3. D1.6: Structural Welding Code – Stainless Steel

1.03 DEFINITIONS:

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

1.04 PERFORMANCE REQUIREMENTS:

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.
- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- C. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7-16.
  - 1. Design earthquake spectral response acceleration, short period (Sds) for Project is 0.447g.
  - 2. Component Importance Factor is 1.5.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
  - 1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.
- E. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- F. Acoustic Performance: Provide acoustical louvers complying with ratings specified, as demonstrated by testing manufacturer's stock units identical to those specified, except for length and width for airborne sound-transmission loss according to ASTM E90.

1.05 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Product Data: For each type of product indicated.
  - a. For louvers specified to bear AMCA seal, include printed catalog catalogue pages showing specified models with appropriate AMCA Certified Ratings Seals.
2. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - a. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
  - b. Show mullion profiles and locations.
3. Samples: For each type of metal finish required.
4. Delegated-Design Submittal: For louvers indicated to comply with structural and seismic performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Provide signed and sealed Shop Drawings and Certificate of Delegated Design Services, which are prepared by a Registered Professional Engineer licensed in the state of Delaware.
5. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.06 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- C. Welding: Qualify procedures and personnel according to the following:
  1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.07 PROJECT CONDITIONS:

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.08 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. Brace and support units to prevent deformation during delivery.
- C. Factory wrap units with accepted materials to protect finish during delivery and storage.
- D. Handle units with care to prevent bending or scratching.
- E. Shop Assembly for Architectural Screen: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, mechanical attachment and field assembly of units. Pre-assemble units in ship to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Aluminum Extrusions: ASTM B221/B221M, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209/B209M, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Aluminum Castings: ASTM B26/B26M, Alloy 319.
- D. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
  - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
  - 3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
  - 4. For fastening stainless steel, use 300 series stainless-steel fasteners.
  - 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- E. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

## 2.02 FABRICATION, GENERAL:

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
  - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
  - 2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 1. Frame Type: Channel unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.
  - 1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
  - 2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
  - 3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
  - 4. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.



- G. Provide subsills made of same material as louvers or extended sills for recessed louvers.
  - H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.
- 2.03 FIXED, EXTRUDED-ALUMINUM ACOUSTICAL LOUVERS:
- A. Horizontal Blade Louver:
    - 1. Manufacturers:
      - a. Air Balance Inc.; a Mestek company.
      - b. Air Flow Company, Inc.
      - c. Aiolite Company, LLC (The).
      - d. All-Lite Architectural Products.
      - e. American Warming and Ventilating, Inc.; a Mestek company.
      - f. Arrow United Industries; a division of Mestek, Inc.
      - g. Carnes Company, Inc.
      - h. Cesco Products; a division of Mestek, Inc.
      - i. Construction Specialties, Inc.
      - j. Dowco Products Group; Safe-Air of Illinois, Inc.
      - k. Greenheck Fan Corporation.
      - l. Industrial Louvers, Inc.
      - m. Louvers & Dampers, Inc.; a division of Mestek, Inc.
      - n. Metal Form Manufacturing Inc.
      - o. NCA Manufacturing, Inc.
      - p. Nystrom Building Products.
      - q. Reliable Products, Inc.
      - r. Ruskin Company; Tomkins PLC.
      - s. United Enertech Corp.

- t. Vent Products Company, Inc.
  - u. Or approved equal.
2. Louver Depth: 8 inches.
  3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
  4. Mullion Type: Exposed.
  5. Sills: Extruded aluminum, Alloy 6063-T6. Minimum nominal thickness 0.060 inch.
  6. Louver Performance Ratings:
    - a. Free Area: 30 percent, nominal. Not less than 4.8 sq. ft. for 48-inch- wide by 48-inch- high louver.
    - b. Water Penetration: Maximum of 0.01 ounces per square foot (3.1 g/m<sup>2</sup>) of free area at an air flow of 841 feet per minute (4.26m/s) free area velocity when tested for 15 minutes.
    - c. Air Performance: Not more than 0.06-inch wg static pressure drop. Maximum air flow through free area of 841 feet per minute (256 m/m).
  7. Sound Attenuation Performance: Free Field Noise Reduction not less than 16 dB.
  8. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

#### 2.04 LOUVER SCREENS:

- A. General: Provide screen at each exterior louver.
  1. Screen Location for Fixed Louvers: Interior face.
  2. Screening Type: Insect screening.
- B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
  1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
  2. Finish: Same finish as louver frames to which louver screens are attached.
  3. Type: Non-rewirable, U-shaped frames.

D. Louver Screening for Aluminum Louvers:

1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.05 BLANK-OFF PANELS:

A. Insulated, Blank-Off Panels: Laminated panels consisting of insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 1 inch.
2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
3. Insulating Core: extruded-polystyrene foam.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Same finish applied to louvers.
7. Attach blank-off panels with sheet metal screws.

2.06 FINISHES, GENERAL:

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

2.07 ALUMINUM FINISHES:

- A. Finish louvers after assembly.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
  1. Color: As selected by Architect/Engineer from full range of industry colors and color densities.

PART 3 - EXECUTION

3.01 EXAMINATION:

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

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

3.02 PREPARATION:

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION:

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 07 "Joint Sealants" Section for sealants applied during louver installation.

3.04 ADJUSTING AND CLEANING:

- A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the Engineer, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

**DIVISION 09 – FINISHES**

SECTION 09 29 00  
DRYWALL CONSTRUCTION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide metal stud partitions, gypsum wallboard, and joint treatment finish as indicated and specified.

1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
  - 1. C630: Specification for Water-Resistant Gypsum Backing Board.
  - 2. C645: Specification for Nonstructural Steel Framing Members.
  - 3. C665: Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
  - 4. C840: Specification for Application and Finishing Gypsum Board.
  - 5. C1002: Steel Drill Screws for the Application of Gypsum Board.
  - 6. C1047: Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
  - 7. C1396: Standard Specification for Gypsum Board
  - 8. E84: Specification for Surface Burning Characteristics of Building Materials.
- B. Underwriter's Laboratories, Inc. (UL) Publication:
  - 1. UL-05: Fire Resistance Directory.
- C. Gypsum Association (GA) Publication:
  - 1. GA-600: Fire Resistance Design Manual.
- D. Factory Mutual System (FM):
  - 1. FM-02: Specification for Tested Products Guide.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Manufacturer's product data and specifications.
2. Complete list of interior trim to be provided.
3. Submit levels for finishing gypsum board in compliance with specified requirements.
4. Manufacturer's printed installation instructions.
5. Recycled Content Submittals:
  - a. For products having recycled content, documentation indicating specified percentages by weight of postconsumer and preconsumer recycled content.

1.04 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver materials in original packaging with manufacturer's labels indicating brand name and fire rating, legible and intact.
- C. Store materials at the jobsite in original packaging in enclosed shelter providing protection from damage and exposure to the elements.

1.05 ENVIRONMENTAL CONDITIONS:

A. Temperature:

1. Maintain temperature range between 55 and 70 degrees F for 24 hours before, during and after gypsum wallboard and joint treatment application during cold weather.

B. Ventilation:

1. Provide ventilation during the adhesives and joint treatment applications, using temporary air circulators in enclosed areas lacking natural ventilation.
2. Allow additional drying time between coats of joint treatment under slow drying conditions.
3. Protect installed materials from drafts during hot, dry weather.



## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS:

- A. National Gypsum Company.
- B. United States Gypsum.
- C. Georgia Pacific.
- D. Or approved equal.

### 2.02 GYPSUM WALLBOARD:

- A. Gypsum Wallboard: ASTM C1396.
  - 1. Regular: 5/8-in. thick with tapered joints, 48-inches wide.
  - 2. Fire resistant core: Type X, 5/8-in. thick with tapered joints, 48-inches wide.
- B. Water-Resistant and Mold-Resistant Gypsum Backing Board: ASTM C1396/C1396M.
  - 1. Water-resistant: 5/8-in. thick with tapered joints, 48-inches wide.
  - 2. Mold Resistant: ASTM D3273, score of 10.
  - 3. Water-resistant with fire resistant core: 5/8-in. thick with tapered joints, 48-inches wide.
- C. Provide wallboard in maximum lengths to minimize horizontal joints exposed to view in areas.

### 2.03 METAL DRYWALL STUDS:

- A. Metal Furring Channel: Hat-shaped, rigid furring channels in compliant with ASTM C645.
- B. Metal Drywall Studs: ASTM C645, non-load bearing, studs roll-formed CH-sections from 20 gage hot-dip galvanized steel.
- C. Runners: Width to match studs, formed from 25-ga. hot-dip galvanized steel.
- D. Fasteners:
  - 1. Drywall screws: Conform to ASTM C1002 for Type S Buglehead.
    - a. 1-1/8-in. long for 5/8-in. single layer application to steel studs and runners.

- b. 1-5/8-in. long for 5/8-in. double layer application to steel studs and runners.
- 2. Studs to runners: 7/16-in. Type S12 Panhead screws.
- 3. Studs to door frames: 5/8-in. S12 low profile head screws.
- 4. Runners to concrete: 3/16-in. by 1-5/8-in. Acorn Slotted HWH Tapcon fastener.

#### 2.04 JOINT TREATMENT MATERIALS:

- A. General: Comply with ASTM C475.
- B. Joint Tape: Embedding, tape as furnished by the manufacturer of the gypsum board.
- C. Joint Compound: Ready-mixed nonasbestos, vinyl-based formulation as furnished by the manufacturer of the gypsum board.

#### 2.05 TRIM ACCESSORIES:

- A. Control Joints: Hot-dip galvanized conforming to ASTM C1047.

#### 2.06 AUXILIARY MATERIALS:

- A. Sealant: Provided by manufacturer of gypsum wallboard.
- B. Adhesive: As recommended by manufacturer of gypsum wallboard.

### PART 3 - EXECUTION

#### 3.01 STUD ERECTION:

- A. Attach steel runners at ceiling to structural elements.
  - 1. Locate fasteners 2-in. from each end and space 16-in. on centers between.

#### 3.02 GYPSUM WALLBOARD INSTALLATION:

- A. Single-Layer Screw Attachment: ASTM C840.
  - 1. Apply single layer of 5/8-in. thick regular or water-resistant gypsum backing board parallel to studs.
  - 2. Stagger joints on opposite sides of partitions.
  - 3. Space screws 16-in. on centers in field and at joints.

B. Double-Layer Screw Attachment: Where fire-rated gypsum board construction is indicated, provide materials and application methods, including types and spacing of fasteners in accordance with fire ratings indicated.

1. Install base layer of 5/8-in. thick fire-rated gypsum wallboard parallel to studs.
  - a. Space screws 16-in. on centers in field and at joints.
  - b. Stagger joints on opposite sides of partitions.
2. Install finish layer of 5/8-in. thick fire-rated gypsum wallboard parallel to studs.
  - a. Space screws 16-in. on centers at joints and in field, and 12-in. on centers at runners.
  - b. Offset joints from base layer joints.
  - c. Calk perimeter of partitions.

C. Control Joints: Install control joints in accordance with ASTM C840.

1. Control-Joint Locations:
  - a. Ceilings:
    - (1) Install control joints in areas exceeding 2500 sq. ft.
    - (2) Space control joints not more than 50 feet o.c.
    - (3) Install control joints where ceiling framing or furring changes directions.

D. Schedule:

1. Provide 5/8-in. thick regular gypsum wallboard as indicated.
2. Provide 5/8-in. thick fire resistant core gypsum wallboard for fire rated walls and partitions as indicated.
3. Provide 5/8-in. thick water-resistant gypsum backing board with fire resistant core as indicated.

### 3.03 FINISHING GYPSUM BOARD:

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for finish. Promptly remove residual joint compound from adjacent surfaces.

- B. Prefill open joints, (rounded or beveled edges), and damaged surfaces areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  - 1. Level 4: At surfaces that will be exposed to view, unless otherwise indicated.
    - a. Primer and its application to surfaces are specified in Section 09 94 10.
- E. Seal opening around pipes, fixtures and other items projecting through gypsum wallboard. Apply sealant material with exposed surface flush with gypsum wallboard.
- F. Finish metal corner beads and screw depressions with three coats of joint compound allowing proper drying time between coats.
- G. Feather out joints onto panel face and sand smooth.

#### 3.04 PATCHING:

- A. Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive specified finish.

#### 3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 09 51 13

### ACOUSTICAL PANEL CEILINGS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide suspended acoustical ceilings, mechanical suspension system and accessories; as indicated and specified.

##### 1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:

1. B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
2. C423: Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
3. C635: Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
4. C636: Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
5. E84: Test Method for Surface Burning Characteristics of Building Materials.
6. E119: Method of Fire Tests of Building Construction and Materials.
7. E488: Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
8. E1264: Classification for Acoustical Ceiling Products.
9. E1512: Standard Test Methods for Testing Bond Performance of Bonded Anchors.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:

1. Manufacturer's product data and specifications and recommended installation instructions for all items specified.

2. Layout of units and with location of lighting, ventilating units, and other ceiling interruptions. Include the following:
  - a. Method of attaching hangers to building structure, including insert and hanger spacing and fastening details including splicing method for main and cross runners.
  - b. Details of materials, furring and supports for acoustical ceilings.
  - c. Change in level details.
  - d. Access door dimensions, and locations.
  - e. Acoustical unit support at ceiling fixture.
3. Samples:
  - a. Submit three 6-inch square samples of each type of acoustical material to illustrate color and range of appearance.
  - b. Submit three 12-inch long samples of each suspensions system member, moldings, and hangers.
4. Certificates:
  - a. Provide certification of fire endurance rating and flame spread index of fire rating organization.
  - b. Provide certification that materials and systems conform to specifications.
5. Recycled Content Submittal:
  - a. For products having recycled content, documentation indicating the specified percentage by weight of postconsumer and preconsumer recycled content.
6. Provide manufacturer's system performance guarantee against visible sag.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Qualifications of Installer:
  1. Minimum of three project installations of comparable extent as proposed project.

2. Submit written description of material installer, listing name of material manufacturers, qualifications of installation personnel, and years of concurrent contracting experience.

C. Tolerances:

1. Surfaces to receive acoustical treatment: Free from irregularities and level to within 1/4-in. in 12 ft.
2. Deflection:
  - a. Suspension system components, hangers, and fastening devices supporting light fixtures, ceiling grilles, and acoustical units: maximum deflection 1/360 of the span.
  - b. Deflection test: ASTM C635
3. Allowable tolerance of finished acoustical ceiling system: Level within 1/8 in. in 12 ft.

D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Fire-response tests were performed by UL, ITS/Warnock Hersey, or another independent testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
2. Surface-burning characteristics of acoustical panels comply with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver materials in original, unopened, protective packaging, with manufacturer's labels indicating brand name, pattern, size, thickness and fire rating as applicable, legible and intact.
- C. Store materials in original protective packaging to prevent soiling, physical damage or wetting.
- D. Store cartons open at each end to stabilize moisture content and temperature.
- E. Do not begin installation until sufficient materials to complete a room are received.

## 1.06 ENVIRONMENTAL REQUIREMENTS:

- A. Maintain humidity of 65 percent - 75 percent in area where acoustical materials are to be installed, 25 hours before, during, and 25 hours after installation.
- B. Maintain a uniform temperature in the range of 55 deg. F to 70 deg. F prior to and during installation of materials.

## PART 2 - PRODUCTS

### 2.01 ACOUSTICAL PANELS:

- A. Acoustical Mineral Ceiling Tile: Conform to ASTM E 1264, Type III mineral base with painted finish, Form 2, Pattern CE, Class A.
  - 1. 24-in. by 24 -in. by 5/8-in. thick lay-in panels with reveal edge.
- B. Acoustical Mineral Ceiling Tile: Conform to ASTM E 1264, Type X, Form 2, Pattern CE, Class A.
  - 1. 24-in. by 24-in. by 5/8-in. thick high-density moisture resistant lay-in panels with square edge and formed from inorganic mineral fibers in ceramic bond.
- C. Recycled Content: Provide acoustical tiles with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than fifty five (55) percent by weight.
- D. Acoustical Performance Ratings:
  - 1. Light Reflectance Coefficient (LR): Not less than 0.83.
  - 2. Noise Reduction Coefficient (NRC): Not less than 0.50.
  - 3. Ceiling Attenuation Class (CAC): Not less than 35.

### 2.02 SUSPENSION SYSTEM:

- A. Suspension System: Conform to ASTM C635 for exposed-grid and for intermediate-duty systems.



1. Profile: 1 1/2-in. high main and cross tees. Double web design tees with rectangular bulb, formed from commercial quality electro-zinc coated cold rolled steel, 0.024-in. for main tees and 0.016-in. for cross tees.
    - a. Exposed Grid Face for Reveal Ceilings: 9/16-in.
    - b. Exposed Grid Face for Exposed Lay-in.: 15/16-in.
  2. Provide exposed to view surfaces with a factory-applied white baked enamel finish.
  3. Provide wall moldings with 7/8-in. exposed face and with a flange of not less than 15/16-in. and with outside corner caps. Provide inside corner caps where, due to configuration of installation, they are needed to produce a workmanlike appearance. Finish in same manner as suspension system.
- B. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- C. Hanger Wire:
1. Provide 12 gage mild steel galvanized hanger wire for suspended acoustical ceilings soft annealed, mild steel wire.
  2. Capable of supporting a minimum 300-pound ultimate vertical load without failure of supporting material or attachment.
- D. Anchors:
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
    - a. Type: Postinstalled expansion anchors.
    - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 for Class SC 1 service condition.
- E. Seismic Struts: Provide manufacturer's standard compression struts designed to accommodate lateral forces.

## PART 3 - EXECUTION

### 3.01 PREPARATION:

- A. Examine surfaces scheduled to receive suspended acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of work.
- B. Mark access provisions as to size and location before beginning installation.

### 3.02 INSTALLATION:

- A. Install acoustical materials and suspension systems in accordance with ASTM C636, and manufacturer's printed instructions.
  - 1. Deflection of any one component not to exceed  $1/360$  of span.
  - 2. Install additional support, supplemental hangers, or separate support for ceiling lighting fixtures depending on fixture weights.
- B. Appurtenances:
  - 1. Hangers:
    - a. Hanger Wire: Installed as recommended by manufacturer.
    - b. Suspension of hanger wire or other loads from underside of steel decking will not be allowed.
    - c. Install additional hangers at ends of each suspension member and at light fixtures, 6 in. from vertical surfaces.
    - d. Do not splay wires more than 5 in. in a 4 ft. vertical drop.
    - e. Wrap wire a minimum of three times horizontally, turning ends upward.
  - 2. Saddle tie carrying channels to main structure for indirect hung suspension system.
  - 3. Install carrying channels with leveling clips to main structure for indirect hung suspension system.
  - 4. Wall molding:
    - a. Install wall molding at intersection of suspended ceiling and vertical surfaces.
    - b. Miter corners where wall moldings intersect or install corner caps.

- c. Apply continuous ribbon of acoustical adhesive or calking compound on vertical web.
  - d. Attach to vertical surface with mechanical fasteners.
- 5. Install splines in unsupported joints of acoustical tile, providing hairline joints, in a smooth even plane.
  - 6. Install hold-down clips on units except in location of access panels.
  - 7. Install seismic struts in accordance with manufacturer's printed installation instructions.

3.03 CLEANING:

- A. Following installation, clean and leave free from defects, dirty or discolored surfaces of acoustical units. Remove and replace with new units, damaged or improperly installed units, at no additional cost to the Owner.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 09 65 00

### RESILIENT FLOORING BASE AND ACCESSORIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide resilient vinyl base as indicated and specified.

##### 1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
  - 1. F1861: Specification for Wall Base: Rubber, and Vinyl Plastic.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 30 00:
  - 1. Submit manufacturer's product data, specifications printed installation instructions.
  - 2. Submit manufacturer's maintenance instructions.
  - 3. Submit before ordering material, a minimum of three samples of each type and color pattern of resilient base material matching color/pattern indicated.
    - a. Mark samples with name of Contractor, project identification, and area where materials are to be used.
    - b. Install only product's matching approved samples.
  - 4. Recycled Content Submittal:
    - a. For products having recycled content, documentation indicating specified percentages by weight of postconsumer and preconsumer recycled content.
  - 5. Product Data for Adhesives: Manufacturer's product data including printed statement of VOC content.

##### 1.04 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006.

- B. Deliver materials to site in manufacturer's original, unopened containers with labels indicating brand names, colors/patterns, and quality designations legible and intact.
- C. Extra Stock:
  - 1. For replacement and maintenance purposes, furnish, and deliver to Owner's maintenance department, additional base covering materials of each size, color, pattern and type from same runs as actually used on job and in quantities as follows:
    - a. Base material: Not less than 1/10 of total linear feet used.
  - 2. Provide sufficient amount of adhesive materials for proper installation of extra stock.
- D. Store and protect accepted materials in accordance with manufacturer's direction and recommendations.

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Recycled Content: Provide vinyl base with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of one (1) percent by weight.
- B. Vinyl Bases: 1/8-in. thick by 4-in. high set-on type cove base with tapered top and ribbed back, conforming to ASTM F1861, Type TV, Group 1. Provide preformed internal and external corners with 4-in. returns where necessary.
- C. Water-Resistant Type Adhesive: Manufacturer's recommended type for installation of vinyl base on-grade concrete subfloors.
  - 1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Cove Base Adhesives: 50 g/L.
- D. Colors and Patterns indicated in Finish Schedule.

## PART 3 - EXECUTION

### 3.01 INSPECTION OF SURFACES:

- A. Examine substrate for excessive moisture content and unevenness which would prevent proper installation of resilient base material.
- B. Do not proceed with installation until defects have been corrected.

### 3.02 PREPARATION:

- A. Remove dirt, oil, grease, or other foreign matter from surfaces to receive covering materials or bases. If cleaning material is used, rinse carefully after use to remove all traces of it.
- B. Fill cracks less than 1/8-in. wide, and minor holes, crevices and depressions less than 1/8-in. deep with a crack filler as recommended by manufacturer, as required.
- C. Prime subsurfaces if recommended by manufacturer.

### 3.03 INSTALLATION OF VINYL BASES:

- A. Do not apply vinyl base to masonry surfaces until they have dried thoroughly. Cement base to backing material using adhesives and methods recommended by manufacturer of base. Scribe and neatly fit internal corners.

### 3.04 CLEANING, PROTECTION AND WAXING:

- A. On completion of work in building, thoroughly clean resilient base, and apply one coat of wax as recommended by manufacturer. Leave finished surfaces in perfect condition.

### 3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 09 91 10

### SHOP PAINTING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide labor, materials, equipment, and incidentals required for the surface preparation and application of shop primers and finish coats, as specified herein.

##### 1.02 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses, including list of items and surfaces to receive shop painting.

##### 1.03 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver materials to application area in original, unbroken containers, plainly marked with name and analysis of product, manufacturer's name, and shelf life date. Do not store or use contaminated, outdated, prematurely opened, or diluted materials.
- C. Store coated items to prevent damage or dirtying of coatings. Avoid need for special cleaning, and store coated items out of contact with ground or pavement. Place suitable blocking under coated items during storage.
- D. Do not expose surfaces to weather for more than six months before being top coated, or less time if recommended by coating manufacturer.
- E. Protect surfaces not to receive paint coatings during surface preparation, cleaning, and painting.
- F. Protect coatings from damage during shipment and handling by padding, blocking, use canvas or nylon slings, and use care when handling.
- G. At time of delivery of shop painted items to job site, ensure coatings are undamaged and in good condition.

1.04 JOB CONDITIONS:

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied.
2. Do not apply coatings when dust is being generated.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Coatings are divided into the following service types, as determined by conditions:

1. Non-Potable Water:

- a. All ferrous metals not subject to potable water provide one coat with a dry film thickness of 2.5 to 3.0 mils with one of the following or equal:

- (1) #1 Purple Prime made by Tnemec Co.
- (2) Carbozinc 859 by Carboline Co.
- (3) Multiprime EFD Epoxy Fast Day Inhibitive Primer 94-109 made by PPG Protective & Marine Coatings (4.0 – 6.0 DFT).
- (4) Or approved equal.

2. Potable Water:

- a. Ferrous metals submerged or which are subject to splash action in contact with potable water, provide one coat with a dry mil thickness of 3.0 to 3.5 mils of a certified NSF Standard 61 product by one of the following or equal:

- (1) 91 H20 Urethane Zinc Rich Primer made by Tnemec Co.
- (2) Carboguard 561 made by Carboline Co.
- (3) Aquapon High Build Potable Water Epoxy 95-132 Series made by PPG Protective & Marine Coatings (4.0 – 6.0 DFT).
- (4) Or approved equal.



- B. Shop prime with primers guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09 94 10 for use in the field and which are recommended for use together.

### PART 3 - EXECUTION

#### 3.01 APPLICATION:

##### A. Surface Preparation and Priming:

1. Sandblast clean in accordance with SSPC-SP-6, Commercial Grade, immediately prior to priming non-submerged components scheduled for priming, as defined above.
2. Sandblast clean in accordance with SSPC-SP-10, Near White, immediately prior to priming submerged components scheduled for priming, as defined above.
3. Before priming, provide surfaces dry and free of dust, oil, grease and other foreign material.
4. Shop prime in accordance with approved manufacturer's printed recommendations.

- B. Non-primed Surfaces: Apply approved coating in accordance with manufacturer's printed recommendation.

#### 3.02 TOUCH-UP:

- A. Repair or replace damaged or defective coated areas. Resultant shop painting: Paint items as specified.
- B. Remove damaged or defective coatings by specified blast cleaning to meet surface cleaning requirements, just before recoating. When small areas of coating need touch up, surface preparation may be done with suitable power needle gun to match specified blast cleaning.

#### 3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 09 91 13

SPECIL LININGS AND COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide the protective coatings as indicated and specified.

1.02 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00 - Submittals:
  - 1. Submit manufacturer's product data and printed application and safety requirements.
  - 2. Submit manufacturer's color charts.
  - 3. Submit notarized Contractor qualification statement for licensed applicator.

1.03 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Ensure that mixing and installation of protective coating is performed by applicators licensed by the coating manufacturer.
- C. Submit four copies of a notarized statement from the manufacturer's authorized technical representative certifying the Contractor is qualified to apply the protective coating.

1.04 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006.

1.05 SURFACES COATED:

- A. Apply protective coating (PC) to areas indicated in the Finish Schedule and as specified.
  - 1. Coat entire surface areas. Suitably and neatly mask off as necessary. Provide floor areas with a non-skid surface as specified herein.

1.06 MANUFACTURER'S RECOMMENDATIONS:

- A. Conform to manufacturer's printed instructions for surface preparation, use, safety requirements, mixing, application, curing and intercoat precautions for protective

coating. Submit to Engineer, four copies of these printed instructions and manufacturer's product data sheets, 30 days prior to application of coating.

## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Provide only high-grade products of nationally known manufacturer's having an established good reputation in the field. Provide products having a minimum of five years' similar, satisfactory field service and suitable for the intended service. Apply products specified except, when permitted by the Engineer, other acceptable equivalent products may be applied if the Contractor satisfactorily proves that they are equivalent to the specified item in quality, durability, performing the required function, abrasion resistance, chemical resistance, adhesion, efficiency in protecting the substrate from corrosion and deterioration, life expectancy and recoating cycles, solids content by volume, film thickness per coat, mil. feet per gallon, coverage per gallon, total cost of services, ease of application, ease of repairing damaged areas, and other pertinent criteria. In any one coating system, provide compatible coatings. Provide only products of one manufacturer in any one coating system. Touch-up with coatings as originally applied. Provide materials meeting air pollution requirements in the area where they are applied.
- B. Apply materials within the manufacturer's recommended shelf life.
- C. After review, submit list of coating products that will be used on the job, 30 days prior to application of coatings.
- D. Deliver materials to the application area in their original, unopened containers plainly marked with the name and analysis of the product, the producer's name and the shelf-life date. Do not use contaminated, outdated, prematurely opened, or diluted material. Do not modify or extend coatings and only use in accordance with the coating manufacturer's current printed instructions.

### 2.02 CONCRETE WET WELLS (PC)

- A. Manufacturers:
  - 1. Tnemec Company, N. Kansas City, Mo.
  - 2. Carboline Co., St. Louis, MO Sauereisen, Pittsburg, PA.
  - 3. Sauereisen, Pittsburg, PA.
  - 4. Or approved equal.
- B. Surface preparation to be SSPC-SP-7 brush-off blast cleaning standards.

- C. The following list specifies the material requirement for surfacing system. The acceptable products are as following:
1. Tnemec:
    - a. Base Coat: Tnemec Perma-Shield H<sub>2</sub>S Series 434, apply at 1/8-inch minimum.
    - b. Topcoat: Tnemec Perma-Glaze 435 80-100 mils (DFT).
  2. Carboline:
    - a. Base Coat: Carboline 4010 for deep patch repair (greater than ½”), or Carboguard 510 SG apply at ¼” for resurfacing, 1/16” for scratch coat. 80-125 mils scratch coat to fill bug holes and voids on new concrete.
    - b. Topcoat/gelcoat: Plasite 5371 100-125 mils DFT.
  3. Sauereisen:
    - a. Base Coat: Sewergard – Trowelable No. 210T or 210S apply at 1/8-inch.
    - b. Topcoat/gelcoat: Sewegard Spray Applied No. 210GL 100-125 mils DFT.

2.03 ACCESSORIES:

- A. Mortar Mix and fiberglass scrim mesh for 45 degree cants shall be provided as recommended by coating manufacturer.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

- A. Clean surfaces as specified and recommended by the coating manufacturer before coating is started.
- B. Allow new concrete surfaces to cure for at least 28 days.
- C. Open up concrete blow holes by mechanical means to reveal any underlying cavities and fill with the coating manufacturer's recommended, suitable filler-sealer.
- D. Sandblast clean concrete to remove laitance, and remove loose materials, dirt and dust from these areas by vacuum cleaning. Provide approximate, a texture of medium sandpaper for blast-cleaned concrete. Do not use acid etching.

### 3.02 APPLICATION:

- A. Provide surfaces, tools, and materials clean, dry and at the proper temperature in accordance with the manufacturer's recommendations. Conform to manufacturer's instructions with regard to safety requirements prior to and during application of coating system.
- B. The Contractor's attention is directed to the manufacturer's requirements concerning the temperatures to be maintained before, during and following the application of the coatings, and to the need for protection from dirt, dust, and moisture during these periods.
- C. Provide coatings continuous and free of defects and seams. Prior to the installation of equipment, apply the coatings to areas which will be subsequently made inaccessible by the installation of the equipment, supports, and other appurtenances. Blend into the overall coating by spot blasting and overlap spray coating in the manner specified by the manufacturer for making repairs to damaged linings for edges created by coatings applied prior to equipment installation.
- D. Carefully apply coatings to avoid thin spots at edges, corners, joints, and seams. Effectively seal seams and interfaces of concrete within the specified areas.
- E. Neatly mask off and suitably protect from overspray of both the coating materials and sandblasting grit areas and equipment in or adjacent to surface being coated. Following removal of masking materials, carefully examine edges of masked areas and touch up pinholes, holidays, and damaged coatings.
- F. Provide finished coating free of pinholes, holidays, foreign inclusions, and bubbles. Carefully examine coated areas to ensure that these requirements have been complied with. Repair lining in defective areas by spot blasting and re-coating as recommended by the manufacturer.

### 3.03 NONSKID SURFACE AT CONCRETE FILL AREAS:

- A. Evenly and uniformly broadcast a sufficient quantity of 50 to 90 sieve size silica blasting sand on top of the last top coat before it cures, in order to create a nonskid surface.
- B. Sand floor areas for the nonskid surface. After surfaces have cured, vacuum clean excess sand from the areas.

### 3.04 APPLICATOR'S CERTIFICATE:

- A. Submit to the Engineer, four copies of a notarized statement sworn to by an authorized official of the organization that applies each coating system specified herein, on its letterhead, testifying to the following:

1. That immediately before coating, surfaces matched the specified cleaning, were in suitable condition, clean, dry, and free of dust, foreign and unsuitable matter, when coated.
2. Names of the products used and their manufacturer.
3. Shelf-life dates of each container of each product used.
4. That surface preparation and coating use, mixing, application, curing, and intercoat precautions were done in accordance with the current printed recommendations of the coating manufacturer and in accordance with the coating requirements in this section of the specifications.
5. That copies of coating manufacturer's invoices submitted with this statement cover the sale of products used on this job.
6. Actual dry film thickness of the coating after application.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 09 94 10

### FIELD PAINTING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide and apply paints and coatings specified and indicated. Prepare, clean, and finish all existing and new surfaces to be field painted as specified and indicated.
  - 1. The terms “paint” and “coating” used herein include emulsions, enamels, paints, stains, varnishes, sealers, and other coatings, organic or inorganic, whether used as intermediate, or finish coats.
- B. Complete painting and test patches for existing surfaces in accordance with specifications, paint manufacturer's current surface preparation and application instructions and safety requirements. In the event of conflict, the more stringent specifications will apply.
- C. Furnish and apply pipe, valve, and equipment identification legends as specified.
- D. Items Not To Be Field Painted:
  - 1. The following items will not require field painting:
    - a. Section 40 23 19.01 Pipe Supports
      - (1) All pipe supports will be delivered with finish paint and will not require field painting.
    - b. Section 23 30 00: Heating, Ventilation and Air Conditioning Equipment
      - (1) All equipment except piping valves, meters and fittings will be delivered with finish paint and will not require field painting. Painting Subcontractor shall paint piping, valves, meters and fittings as specified herein as indicated on the contract drawings.
      - (2) HVAC ductwork shall not be field painted.
    - c. Stainless steel and CPVC piping, fittings and supports will not be field painted, except that identification of piping with stencil text shall be provided by the work of this section.

## 1.02 REFERENCES:

- A. Society for Protective Coatings (SSPC) Specifications:
- B. SSPC-PA 1: Shop, Field, and Maintenance Painting of Steel.
- C. SSPC-PA-2: Measurement of Dry Coating Thickness with Magnetic Gages.
- D. SSPC-SP 1: Solvent Cleaning.
- E. SSPC-SP 3: Power Tool Cleaning.
- F. SSPC-SP 6: Commercial Blast Cleaning.
- G. SSPC-SP10: Near-White Blast Cleaning.
- H. American National Standards Institute (ANSI):
  - 1. A13.1: Scheme for the Identification of Piping Systems, Designation.
- I. National Sanitation Foundation (NSF)

## 1.03 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Use products of one manufacturer in any one paint coating system with compatible coating materials. Provide same coating product for touch-up as for original coating.
- C. Do not use or retain contaminated, outdated, or diluted materials for painting. Do not use materials from previously opened containers.
- D. Provide paint products having a minimum of five (5) years of service, with no peeling, flaking, chipping, blistering, or fading, under similar service conditions.

## 1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. List of coating products (Paint Schedule) with brand, type and manufacturer including dry film thickness and volatile organic compound (V.O.C.) regulations conforming to these specifications. Refer to Paragraph 2.04.
  - 2. Manufacturer's current printed recommendations and data sheets for each product including performance criteria, surface preparation, application instructions.



3. Product data and pertinent information including results of test patch data indicating compatibility of field applied coatings with shop applied primers including a schedule listing each primer with field applied coatings to be applied over the primer.
4. Color chip samples of materials proposed and matching color of coatings indicated in Finish Schedule.
4. Color chip samples matching colors indicated in Piping Identification Schedule, included in this specification. Submit list of piping to be included under each color.
5. Submit manufacturer's published data showing service record specified in paragraph 1.04 D.
6. Submit letter(s) signed by paint manufacturer certifying that submitted products are suitable for application on the surfaces to be coated and for the service conditions.
7. Submit a Certificate of Compliance for coatings submerged in potable water with National Sanitation Foundation approval.
8. Product data for mil thickness testing equipment including operating instructions.

B. Field Submittals:

1. Submit letter(s), signed by Contractor, stating that existing and new surfaces to be coated are ready for preparation as specified in paragraph 3.01 B.
2. Submit letter(s) signed by Painting Subcontractor, certifying that existing and new surfaces to be coated have been prepared in accordance with paint manufacturer's printed instructions and are ready for field paint application.
3. Approved mil thickness test results, including location, and surface or item for identification.
4. Provide samples of existing paint coatings to paint manufacturer for identification of existing coatings. Submit to the Contractor for Engineer to review the final recommendations of the paint manufacturer for the proper type of coatings that can be applied to existing surfaces. If the specified paint coating for existing surfaces is not acceptable to paint manufacturer, then the painting subcontractor and paint manufacturer shall submit the recommended coating at no additional cost.

1.05 PAINT STORAGE AND MIXING AREAS, AND WASTE DISPOSAL:

- A. Store paints and painter's materials in area or areas designated by the Construction Manager solely for this purpose. Confine mixing, thinning, clean-up and associated operations, and storage of painting debris, to these areas before authorized disposal.

B. Do not use plumbing fixtures, piping or mechanical equipment for mixing or disposal of paint materials.

1. Transport water to paint area by temporary hose or piping.
2. Store waste temporarily in closed, nonflammable containers until final disposal. Keep no rubbish in painter's area longer than 24 hours. Dispose any hazardous materials in accordance with Section 01 11 00 and place all non-hazardous waste in the central trash trailer area.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. General Contractor will provide storage and protection in accordance with Section 011006 and as specified.
- B. Deliver materials to painter's area in original, unbroken, containers with name and analysis of product, manufacturer's name, and shelf life date. Do not use or retain contaminated, outdated, prematurely opened, or diluted materials.
- C. Store coated items and protect coating from damage and foreign matter, by not allowing contact with soil or pavement, exposure to wind-blown particles, or other harmful contacts which necessitate special cleaning. Use blocking during storage.
- D. Protect coated items, whether prime or finish, from damage due to shipping and handling.

1.07 JOB CONDITIONS:

- A. Environmental Requirements:
  1. Comply with manufacturer's printed recommendations as to environmental conditions under which coatings and coating systems can be applied.
  2. Do not apply coatings when dust is being generated.
- B. Protection:
  1. Cover or otherwise protect finish work of other trades and surfaces not being painted concurrently or not to be painted.
  2. Do not paint over nameplates, tagging or other identification devices.

## PART 2 – PRODUCTS

### 2.01 MANUFACTURERS:

- A. Tnemec Co., Inc.
- B. Carboline.
- C. PPG Protective & Marine Coatings, Inc.
- D. The Sherwin-Williams Co
- E. Or approved equal.

### 2.02 MATERIALS – GENERAL:

- A. Products:
  - 1. Recommended by their manufacturer for intended service.
- B. Material Compatibility:
  - 1. Provide block fillers, undercoats and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
  - 2. Provide field applied coatings that are compatible with shop applied primers.

### 2.03 COLORS AND FINISHES:

- A. Interior finish colors: As indicated in Finish Schedule and Pipe Identification Schedule.
- B. Interior finish colors: As selected by Architect/Engineer from manufacturer's full range of colors and as indicated on the Pipe Identification Schedule.
- C. To provide contrast between successive coats, lightly tint each coat to distinguish it from preceding coats.
- D. Unless otherwise indicated for finish paint, use gloss or semi-gloss on metal, and satin finish on masonry and concrete.

### 2.04 COATING TYPES:

- A. Coatings are described in the COATING IDENTIFICATION SCHEDULE by abbreviations, generic type, minimum solids by volume and minimum dry film thickness.

Provide coatings that comply with the volatile organic compounds (VOC) regulations applicable to the project site and in no case to exceed 3.5 lbs/gal.

B. COATING IDENTIFICATION SCHEDULE

ABBR.	GENERIC TYPE	SOLIDS BY VOL. (%)**	DFT THICKNESS (PER COAT) ***	TNEMEC PRODUCT	CARBOLINE PRODUCT	PPG PMC PRODUCT
AGE	Alkyd-Enamel	49	2.0-3.0	23 Enduratone	Carbocrylic 3359 or 3359 DTM	PPG Industrial Alkyd Enamel 7-824 Series
AL	Emulsified Acrylic	43	2.0-3.0	Series 6	Carbocrylic 3350	PPG Pitt-Tech EDF Exterior WB Acrylic Dry Fog 90-812 Series
APE	High Build Acrylic Polyurethane Enamel	60/ 74	3.0-5.0	Series 73 1074	Carbothane 134HG	PPG Amercoat 450H
BF	Cementitious Acrylic Filler	68	100 sq. ft. per gal.	Series 130	Sanitile 100	BF Cementitious PPG Amercoat 965
HSE	High Solids Catalyzed Epoxy	70	6.0-8.0	Series N69	Carboguard 893SG or 691 NSF	PPG Amerlock 2/400 or Amerlock 2 NSF
LTE	Polyamide Epoxy	58	4.0-6.0	Series 161 or N69F	Carboguard 893SG or 691 NSF	PPG Amerlock 2/400 or Amerlock 2 NSF
PE*	Polyamide Epoxy	60	5.0-7.0	Series 161/ or N69F	Carboguard 893SG or 691 NSF	PPG Amerlock 2/400 or Amerlock 2 NSF

PVA	Poly Vinyl-Acrylic-	28	1.0-1.5	Series 51-792	Carbocrylic 120	PPG Speedhide 6-2 Primer
PRW	Pressure washing and cleanup with materials recommended by Paint Manufacturer.					
TY	Polyamide Epoxy	58	2.0-3.0	Series V27 F.C. Typoxy	---	---
ZR	Zinc Rich Primer	63****	3.0-3.5	Omnithane Series 1	Carbozine 859 or Carbozinc 11	PPG Amercoat 68HS or Dimetcote 9

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- \* If application of PE type coating occurs during low temperatures, provide and apply LTE type coating in lieu of PE and substitute throughout in Paint Schedule at end of Section, unless otherwise recommended by coating manufacturer.
  - \*\* Solids by volume based on Tnemec Coatings.
  - \*\*\* Dry film thickness and performance criteria based on Tnemec Coatings. Provide dry film thicknesses for equivalent products as recommended by manufacturer.
  - \*\*\*\* 80% minimum zinc by weight. If intended for bolted connections, provide minimum Coefficient of Friction as recommended by bolt manufacturers.

- C. Description of coating types includes minimum acceptable percent, by volume, of component solids. Brand identification is to establish standard of quality. Products meeting general physical characteristics and performance criteria, are acceptable.
- D. Provide coatings submerged in potable water with National Sanitation Foundation approval.

## 2.05 PIPE, VALVE/EQUIPMENT IDENTIFICATION AND COLOR CODING:

- A. Provide identification of existing and new pipes, valves, pumps, tanks and similar vessels by color as specified in the Pipe Identification Schedule and with name of contents, directional flow arrows and other required legend.
  - 1. For new pipe systems, use stenciled letters and arrows or self-adhesive labels or tapes located at intervals no greater than 20 ft. apart on straight runs except that stainless steel piping at intervals shall be no greater than 15 ft. apart on straight runs. Mark each valve, branch, wye change in direction and each side of floor and wall penetrations.
    - a. Labels or tapes shall be moisture and U.V. resistant.

- B. Provide legend of size, character and location conforming to ANSI A13.1 for stenciled letters or labels.
- C. Refer to notes at end of Pipe Identification Schedule for further clarifications.

## PART 3 - EXECUTION

### 3.01 INSPECTION:

- A. Examine existing and new surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence, or quality of work.
- B. Do not proceed with surface preparation or coating application until after submitting to the Contractor for Architect/Engineer to review a letter signed by the Contractor, stating that new surfaces to be painted are in acceptable condition for preparation and painting according to the Painting Subcontractor and in accordance with paint manufacturer's printed instructions.
- C. Do not proceed with coating application until after submitting to the Contractor for Architect/Engineer to review a letter signed by paint manufacturer certifying that submitted products are suitable for application in accordance with paint manufacturer's printed instructions.

### 3.02 PREPARATION:

- A. Basic Steps:
  - 1. Prepare and paint existing and new surfaces in heated enclosure unless the ambient weather conditions ensure still, dry air above 50 degree F temperature, and humidity above manufacturer's printed recommended level. Do not apply paints to surfaces in direct sunlight. Conform to manufacturer's printed instructions for safety requirements.
  - 2. Coordinate cleaning and painting operations to eliminate contamination of one by the other.
  - 3. Maintain coating materials at manufacturer's recommended mixing and application temperatures for not less than 24 hours before use. Have clean containers, spray equipment, applicators and accessory items ready for use before decanting or mixing paint materials.
  - 4. Coordinate materials to be applied with previous coatings on affected surfaces. Obtain, in all cases, manufacturer's written directions, and follow them strictly, except where otherwise specified.

5. Coordinate preparation and material compatibility requirements with the work specified in Sections 09 91 10, 22 30 00 and 23 30 00.
- B. Before any paint application, clean existing and new surfaces to be coated of dust, dirt, grease, white rust, paint unsuitable for top coating, efflorescence, oil, moisture, foreign matter or similar conditions detrimental to coating bond and durability.
1. Following cleaning, apply preparatory treatment in strict accordance with manufacturer's written instructions.
  2. Fill imperfections and holes in surfaces to be painted with material recommended by paint manufacturer.
- C. Metals to Receive Paint Finishes:
1. Prepare ferrous metals, including field welds and unprimed shop welds, without shop prime coats as follows:
    - a. Near White blast cleaned (SSPC-SP-10), for submerged components.
    - b. Commercial blast cleaned (SSPC-SP-6), for non-submerged components.
    - c. Use needle gun for field welds and shop welds which occur in narrow, unprimed areas in an otherwise shop primed surface, followed by SSPC-SP1-solvent wipe.
  2. Clean previously shop primed ferrous metals in accordance with manufacturers printed recommendations prior to field painting.
  3. Non-ferrous and galvanized metal surfaces scheduled for paint finish:
    - a. Clean in accordance with manufacturers recommendations prior to field painting (SSPC-SP-1 including power washing).
    - b. Brush blast all exterior and interior exposures above constant 35% relative humidity or treat with Oakite LTS or equal etching solution. Brush blasted galvanized metal surfaces to receive a uniform profile of .75-1.25 mils.
    - c. For interior galvanized and non-ferrous metals not exposed to wet environments apply in accordance with manufacturers written instructions.
- D. Concrete to Receive Paint Finishes:

1. Clean thoroughly of form oil, release agents, dirt, dust, grease, paint, loose material and foreign matter. Remove laitance, roughen smooth surfaces by brush sand blasting, remove fins and projections, fill voids and honeycombs with material recommended by paint manufacturer.
2. Prime after concrete has dried in strict accordance with manufacturer's printed instructions.
3. Concrete in Immersion: Brush blast all new surfaces to receive coating to achieve profile of 2.0-4.0 mils. Previously coated surfaces shall be inspected and evaluated prior to commencing work.

E. Concrete unit masonry for paint finishes:

1. Clean thoroughly by brushing, scraping and sanding or grinding slick areas. Remove loose or projecting mortar, solvent wash oil, grease, paint spots before applying block filler.

F. Provide higher degree of cleaning for acceptable equivalent paint products when paint manufacturer recommends in his printed surface preparation recommendations.

G. Delay painting of areas which will be damaged by heat from welding, until welding is complete. Reclean and recoat substrate as specified for original coats, when coated areas have been damaged by welding or have not been painted to allow welding.

H. PVC Pipe:

1. Sand all surfaces with 60-80 grit paper to provide profile to adhere coatings.

3.03 TOUCH-UP:

- A. Before applying field coat, touch-up abraided areas of shop coats with paint of the same type. Apply an entire coat to abraided area. Touch-up coats are in addition to, and not a substitute for first field coat. Clean deteriorated surfaces as specified herein and in accordance with manufacturer's recommendations before applying touch-up coat.
- B. Equipment, motors, pumps, instrumentation panels, electrical switchgear, and similar items with shop coats, paint filler, enamel or other treatment customary with manufacturer; after installation, touch-up scratches and blemishes before applying field coats.

3.04 APPLICATION:

- A. Refer to Paint Schedule at end of this specification for coating requirements. Provide additional prime, undercoat, and finish coats as specified, indicated, and recommended by coating manufacturer's printed instructions.



B. Conditions:

1. Do not apply paints or other finish to wet or damp surfaces, except in accordance with instructions of manufacturer. Do not apply exterior paint during cold, rainy, or frosty weather, or when temperature is likely to drop to freezing. Do not apply paints to surfaces in direct sunlight.
2. Paint surfaces which have been cleaned, pretreated, or otherwise prepared for painting with first field coat as soon as practicable after such preparation has been completed, but in any event prior to deterioration of prepared surface.
3. Coat blast cleaned metal surfaces in accordance with SSPC guidelines, before any rusting or other deterioration or contamination of the surface occurs. Do not coat blast cleaned surfaces later than 8 hours after cleaning.

C. Methods:

1. Spraying with apparatus may be substituted for brush application of paints in locations approved for spraying.
2. Prepare surfaces, mix and apply paint materials in strict accordance with manufacturer's printed instructions and recommendations. Control temperature of materials upon mixing and application, surface temperature and condition, thinning and modifying.
3. Protect surfaces to be coated, before, during and after application.

D. Workmanship:

1. Apply coating materials to meet manufacturer's spreading rate and dry film thickness recommendations. Dry film thicknesses specified are constant for brush, spray, roller or other form of application.
  - a. Control thinning in accordance with V.O.C. regulations for spray use and to manufacturer's printed instructions, and produce specified dry film thickness on level surfaces, interior and exterior angles.
2. Apply paints and coatings using painters continuously employed in the painting profession for no less than five (5) years, brushed or rolled out carefully to a smooth, even coating without runs or sags. Curing time in accordance with manufacturers printed instructions.
3. Finish surfaces: Uniform in finish and color, and free from flash spots and brush marks.

### 3.05 PROTECTION AND CLEAN-UP:

- A. Protect existing and new surfaces to be painted or coated under this Section as follows:
  - 1. Arrange for preparation and coating activities to be performed in areas and during times when no continuous traffic and no dust generating activity will be present.
  - 2. During time between preparation and coating, protect work from dust and dirt with dropcloth. Do not allow contact with surfaces in this time period.
  - 3. During painting activity, clearly mark the area being used by painters to prevent interference with painting being applied as specified.
  - 4. After painting, clearly barricade painted surfaces with cones, plastic barrier tape, or other visible barrier. Locate "WET PAINT" signs near painted surfaces. Do not remove barriers and signs until paint surface dries throughout entire film thickness.
- B. Remove or completely mask existing and new accessory items, finish hardware, lighting fixtures, escutcheon plates, trim and similar finish items not to be painted before painting adjacent surfaces. Carefully replace and reposition upon completion of adjacent painting and cleaning work.
- C. Upon completion of the work, clean up paint spots, oil, and stains from floors, glass, hardware, and similar finished items and remove tape.

### 3.06 SCHEDULE OF PAINTING:

- A. Coordinate and schedule the various cleaning, touch-up and finishing operations. Transmit and coordinate the transmission of materials data, color selections and coating system methods between the coating applicators. Do not exceed exposure and recoat time limits.
- B. All process valves paint RED, unless noted otherwise.

PIPE IDENTIFICATION COLOR SCHEDULE  
VALVES, PIPE

Pipe System	Legend Symbol	Paint Color	Letters and Arrows	Stencil Text
Dewatering	DW	Black	White	Dewatering
Drain	D	Black	White	Drain
Natural Gas	NG	Yellow	Black	Natural Gas
Potable Water Supply (Cold or Hot)	W1 or HW1	Light Blue	White	Potable Water (cold) – (hot)
Sump Pump Discharge	PD	Black	White	Sump Pump Discharge
Storm Water	SW	Safety Green	White	Storm Water

1. The color stenciled text and directional arrow designation required for chemical piping located inside containment trays shall be applied to the containment trays and not the chemical piping. Provide and place a 2-inch color band (4-in. bands for the color yellow) extending around the complete perimeter of the tray on each side of the stencil text and directional arrow designation.
2. Legend symbols listed above in Pipe Identification schedule shall also be added in parenthesis to the end of all stencil text designations indicated.
3. Paint all process valves RED, unless noted otherwise.

PIPE IDENTIFICATION COLOR SCHEDULE  
VALVES, BLOWERS, PIPE, PUMPS, TANKS

Pipe System	Legend Symbol	Paint Color	Letters and Arrows	Stencil Text
Fuel Oil (Return/Supply)	FOR/S	Orange w/Brown Band	Brown	Fuel Oil
Plumbing				
Potable Water Supply (Cold or Hot)	W1 or HW1	Light Blue	White	Potable Water (cold) – (hot)
Sump Pump Discharge	PD	Black	White	Sump Pump Discharge

PAINT SCHEDULE

Item No.	Surface or Item	Field Coats		
		1 <sup>st</sup>	2 <sup>nd</sup>	Final
1	Interior concrete indicated in finish schedule to be painted	PE	-	PE
2	Interior concrete masonry units indicated in finish schedule to be painted	BF	PE	PE
3	Interior galvanized hollow metal doors, frames and windows and interior shop painted structural steel, interior shop painted monorails and supports, miscellaneous ferrous metal-work, ferrous piping, ferrous parts of operating devices, valve handles and supports, interior surfaces of roll-up door frames and light gage steel trusses	PE	-	PE
4	Exterior shop painted structural steel, exterior galvanized structural steel, lintel angles, ferrous piping, ferrous parts of operating devices and supports, guard posts, bollards and exterior surfaces of roll-up door frames	PE	PE	APE
5	Emulsified asphalt-coated ferrous piping	PE	-	PE
6	Items with factory finish	Touch-up with materials supplied by manufacturer		

7	Shop painted ferrous metals, galvanized metals and equipment submerged	PE	HSE	HSE
8	Interior shop painted ferrous metals, galvanized metals and equipment non-submerged and subject to splashing	PE	HSE	HSE
9	Exterior shop painted ferrous metals, galvanized metals and equipment non-submerged and subject to splashing	PE	HSE	APE
10	Concrete in immersion	HSE		HSE
11	CPVC and PVC piping	PE	-	PE

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Notes:

1. If prime coat has been exposed for more than 6 months, Painting Subcontractor will provide test patches to insure adhesion of field-applied coatings. Test patches in accordance with paint manufacturer's instructions.
2. Provide patching compound for existing and new concrete surfaces before beginning field painting, in accordance with Paint Manufacturer's recommendations. Patch existing concrete masonry unit walls immediately after demolition has been completed and areas have been cleaned.
3. Repaint all existing piping which is modified (existing piping which is partially demolished or to which new piping and equipment will be connected) for the services listed in the Pipe Identification Schedule. Piping, valves, supports, and accessories are to be repainted. Floors, walls, and ceiling surfaces are also to be repainted.
4. Conform to paint manufacturer's written instructions with regard to surface preparation and compatibility of new paint coatings over existing paint coatings. Painting Subcontractor shall take samples of existing paint coatings and coordinate with paint manufacturer and identify the generic type existing. Final recommendations of the paint manufacturer shall be given to the Painting Subcontractor in writing for the proper generic type coating that can be applied to the existing surfaces. If the specified paint coating for existing surfaces is not acceptable by paint manufacturer, then the Painting Subcontractor shall submit the recommended coating and at no additional cost. Paint coating submitted shall have the performance criteria for the intended purpose of that existing item/surface with regard to corrosion-resistance, self-priming, and ease of application.

3.07 FINAL TOUCH-UP:

- A. Prior to final completion and acceptance, examine painted and finished surfaces and retouch or refinish areas to leave touched-up areas with same appearance as and even with the surrounding finish specified.
- B. After doors have been fitted and hung, refinish edges, tops and bottoms.

3.08 TESTING:

- A. Conduct field testing in the presence of the Construction Manager for specified mil thickness in accordance with SSPC-PA-2.
- B. Test results shall meet requirements of SSPC-PA-2. Failure of test results shall require that surfaces be repainted until approved results of testing have been obtained for the specified mil thickness.

3.09 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## **DIVISION 10 – SPECIALTIES**

## SECTION 10 14 00

### SIGNAGE

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

A. Provide signage as indicated and in compliance with Contract Documents.

1. Section Includes:

- a. Room-identification signs.
- b. Field-applied, vinyl-character signs.
- c. Dimensional letters and numbers.

##### 1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):

1. 611: Voluntary Specification for Anodized Architectural Aluminum
2. 2603: Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

B. American National Standards Institute (ANSI):

1. A117.1: Accessible and Usable Buildings and Facilities.

C. ASTM International (ASTM):

1. A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. A529/A529M: Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
3. A572: Specification for Steel Plate.
4. A653/A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
5. A666: Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.



6. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
7. A879/A879M: Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
8. A1008/A1008M: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
9. B36/B36M: Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar
10. B152/B152M: Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
11. B209/B209M: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
12. B221/B221M: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
13. B584: Standard Specification for Copper Alloy Sand Castings for General Applications
14. C1349: Standard Specification for Architectural Flat Glass Clad Polycarbonate
15. D1187: Type II – Specification for Asphalt-Base Emulsions (For Metal Surfaces).
16. D4802: Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet

D. Federal Regulations:

1. 40 CFR 59, Subpart D: National Volatile Organic Compound Emission Standards for Architectural Coatings

E. National Electrical Manufacturers Association (NEMA):

1. LD3: High-Pressure Decorative Laminates.

F. The Society for Protective Coatings (SSPC):

1. Paint 20: Zinc-Rich Coating Type I Inorganic and Type II Organic

1.03 DEFINITIONS:

- A. Accessible: In accordance with the accessibility standard.

- B. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.04 COORDINATION:

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.05 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00.
- B. Product Data: For each type of product.
- C. Shop Drawings: For panel signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
  - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
  - 4. Show locations of electrical service connections.
  - 5. Include diagrams for power, signal, and control wiring.
- D. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
  - 1. Include representative Samples of available typestyles and graphic symbols.
- E. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Room-Identification Signs: Full-size Sample
  - 2. Field-Applied, Vinyl-Character Signs: Full-size Sample of characters on glass.
  - 3. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
  - 4. Exposed Accessories: Full-size Sample of each accessory type.

- F. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.
  - G. Delegated-Design Submittal: For signs indicated in "Performance Requirements" Article.
    - 1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.
    - 2. Provide signed and sealed Shop Drawings and Certificate of Delegated Design Services, which are prepared by a Registered Professional Engineer licensed in the state of New Jersey.
  - H. Qualification Data: For Installer and manufacturer.
  - I. Sample Warranty: For special warranty.
  - J. Maintenance Data: For signs to include in maintenance manuals.
- 1.06 QUALITY ASSURANCE:
- A. Comply with the requirements specified in Section 01 43 00.
  - B. Installer Qualifications: Manufacturer of products.
- 1.07 DELIVERY STORAGE AND HANDLING:
- A. Comply with the requirements specified in Section 011006.
  - B. Package signs, labeled in name groups.
  - C. Store adhesive attachment tape at ambient room temperatures.
- 1.08 PROJECT/SITE CONDITIONS:
- A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.
  - B. Do not install signs when ambient temperature is lower than recommended by manufacturer.
  - C. Maintain this minimum during and after installation of signs.
- 1.09 WARRANTY:
- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Deterioration of finishes beyond normal weathering.
  - b. Deterioration of embedded graphic image.
  - c. Separation or delamination of sheet materials and components.
2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.01 SIGNS:

#### A. General:

1. Provide signs as specified and indicated and of the types and characteristics specified in PART 4 - Sign Schedule.
2. For wall and fence-mounted signs, provide power-driven fasteners for concrete, toggle bolts and through-bolts for masonry, stainless steel machine carriage bolts for steel, lag bolts and screws for wood and gypsum wallboard, and 316 stainless steel wire for chain-link fence.

#### B. Provide materials in accordance with the following:

1. Provide signs that are shop assembled, and ready for installation upon delivery. Predrill or punch holes for screws or bolts.
2. Galvanizing shall be by hot-dip process after fabrication, and in accordance with ASTM A 123.
3. Aluminum Alloy: Provide aluminum alloy products fabricated in accordance with ASTM B 209. Aluminum sheet shall be at least 16 gauge, 0.09 inch thick.
4. Steel: Provide steel products fabricated in accordance with ASTM A 36.
5. Provide pressure sensitive vinyl for graphics in compliance with MS MIL-M-43719, minimum 0.005 in. film thickness. Film shall include a precoated pressure sensitive adhesive backing.
6. Acrylic Sheet: Provide acrylic sheet fabricated in accordance with ASTM D 702, Type III.

C. Aluminum Signs:

1. Provide aluminum signs and components from a single manufacturer.
2. Sign Posts: Provide 2-7/8-in. outside diameter steel pipe with 0.2-in. wall thickness and with provisions for fastening sign panels with concealed fasteners. Provide caps for each post.
  - a. Provide posts with one coat of zinc-chromate primer, in accordance with Section 09 94 10. Do not coat portion of post to be embedded in concrete.
3. Sign Panels: Provide aluminum panels and interlocking components able to interlock with posts with concealed fasteners. Provide panels fabricated with a minimum of 0.090 inch aluminum.
4. Finishes: Provide reflective traffic signs finished with either semi-gloss baked enamel or two-component acrylic polyurethane approved by the Architect/Engineer.
5. For aluminum signs mounted on posts, provide 4000 psi concrete footings, in accordance with Section 03 30 00.
6. Provide signs with pressure sensitive precision cut vinyl letters.
7. Provide aluminum signs for regulating traffic and parking of the characteristics specified in PART 4 - Sign Schedule.
8. Provide anchors and fastener materials compatible with material to which applied, and matching in color and finish.

D. Fiberglass Signs:

1. Provide fiberglass signs and mounting components from a single manufacturer.
2. Provide signs fabricated of 0.125-in. acrylic sodified polyester resin reinforced with chopped strands of fiberglass, and with photographic silkscreen graphics printed on the substrate and embedded into the fiberglass sheets.
3. Provide fiberglass signs for identifying or giving direction to buildings, facilities, rooms, galleries, and process areas, and for identifying hazardous areas, as specified and indicated.
4. Provide fiberglass signs of the characteristics specified in PART 4 - Sign Schedule.

- E. Provide vinyl NFPA four-color hazard labels with adhesive backing for all chemical containers identifying hazard levels of contents.

## 2.02 INTERIOR SIGNAGE:

- A. General: Foam tape attachment.
- B. Work Spaces: High-pressure laminate engraving stock with face and core plies in contrasting colors as selected by Architect/Engineer from manufacturer's full range. Fabricate signs with edges mechanically and smoothly finished. Manufacturer's standard process for producing copy complying with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 braille. Produce precisely formed characters with square cut edges free from burrs and cut marks.
  - 1. Allow for 30 characters per sign. Provide two signs. Meet directly with Owner to schedule text.

## 2.03 TAGS:

- A. For all equipment and items specified in Division 22, 23, 26, 28, 31, 32, 33, 40, 41, and 43, provide tags with the applicable and corresponding nomenclature label.
  - 1. Include and provide tags as indicated on the drawings.
- B. For equipment, provide corrosion-resistant, 0.125-in. thick plastic tags with equipment nomenclature, in white 1/2-in. lettering, engraved in black enamel background, with a minimum of 1/8-in. border around the engraved print, and with extra length to provide for fastening device. For wire and cable, provide black adhesive backed mylar tape with white nomenclature pre-printed on the tape in a letter size no greater than one outside diameter of the cable.
- C. Provide materials specified below for attaching tags to equipment in accordance with paragraph 2.03D - Tagging Schedule:
  - 1. Provide 1/8-in. by 3/8-in., Type 316 stainless steel machine screws.
  - 2. Provide one-piece self-locking nylon tag fasteners.
    - a. Provide nylon fasteners to attach tags only on non-moving parts of stationary equipment.
    - b. Fasteners longer than 8-in. are not acceptable.
    - c. Provide no more than one fastener per tag.
  - 3. Provide 5-mil solvent-activated permanent adhesive.

4. For valve operator chains provide 2” heavy duty rust proof key rings, mounted through the hole in tag and around the chain such that the chain moves freely through the ring during operation.

D. Tagging Schedule:

TAGGING SCHEDULE\*

<u>Equipment</u>	<u>Method of attaching tags</u>
1. Moving equipment including but not limited to; cranes, hoists, elevators and longitudinal and cross collectors	Drill surface and use machine screws
2. Stationary equipment and structural/architectural items	Drill and use machine screws for steel and concrete screws for concrete; or use nylon tag fasteners or adhesives
3. Wiring and Cable	Adhesive-backed mylar tape

\*Note: If the equipment does not fall in the above three categories consult Architect/Engineer for tag location.

2.04 BURIED UTILITY WARNING AND IDENTIFICATION TAPE:

- A. Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument.
- B. Provide tape in rolls, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification to read CAUTION BURIED (APPROPRIATE NAME) PIPING BELOW. Provide permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.05 DIMENSIONAL LETTERS AND NUMBERS:

- A. Manufacturers:
  1. American Graphic, Inc.
  2. A.R.K. Ramos.

3. ASI Sign Systems, Inc.
  4. Charleston Industries, Inc.
  5. Gemini, Inc.
  6. Grimco, Inc.
  7. Innerface Sign Systems, Inc.
  8. Kaltech Industries Group, Inc.
  9. Metal Arts; Div of L&H Mfg.
  10. Mohawk Sign Systems.
  11. Signature Sign Signs, Inc
  12. Mills Manufacturing, Inc.
  13. The Southwell Company.
  14. Or Approved Equal.
- B. Cast Characters: Form individual letters and numbers by casting. Produce characters with smooth, flat faces, sharp corners, and precisely formed lines and profiles, free from pits, scale, sand holes, or other defects. Cast lugs into back of characters and tap to receive threaded mounting studs. Comply with requirements indicated for finish, style, and size.
1. Metal: Aluminum

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchor inserts are correctly sized and located to accommodate signs.
- D. Verify that electrical service is correctly sized and located to accommodate signs.



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

### 3.02 INSTALLATION:

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Notify Construction Manager in writing of sign installation at least twenty-one (21) days in advance. Construction Manager will assign exact location for each sign.
2. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
3. Install signs so they do not protrude or obstruct according to the accessibility standard.
4. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
5. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Room-Identification Signs: Install in locations on walls according to accessibility standard.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
  - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
  - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
  - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the

stud ends in holes. Temporarily support sign in position until adhesive fully sets.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
  4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
  5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
  6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
  7. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips 0.250 inch away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
  8. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.
  9. Shim-Plate Mounting: Provide 1/8-inch thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach signs to plate using adhesive method specified above.
- D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.

3.03 ADJUSTING AND CLEANING:

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

3.05 SCHEDULES:

- A. See Schedule 10 14 00-1.

**SCHEDULE 10 14 00-1  
SIGN SCHEDULE**

<b>LOCATION AND QUANTITY OF SIGNS</b>	<b>ADA (Y/N)</b>	<b>SIGN TYPE</b>	<b>OVERALL SIZE (in.)</b>	<b>LETTERING TEXT</b>	<b>LETTER SIZE (in.)</b>	<b>COLOR COLOUR OF WORDING</b>	<b>COLOR COLOUR OF BACKING</b>	<b>ADDITIONAL GRAPHICS</b>
1. At switchgear and generator, two signs per unit	N	Fiberglass	18 x 4	DANGER HIGH VOLTAGE	4 4	White Black	Red White	
2. Area/room identification signs, on each side of door indicating area/room to be entered	N	Laminated acrylic	7 x 11	AREA NAME	1/2	White	Red	
3. Fire extinguisher, one per extinguisher	N	Note 3	Note 3	FIRE EXTINGUISHER (WITH ARROW)	2	White	Red	
4. Exit signs, quantity = 4, at locations per Architect/Engineer	N	Fiberglass/ Plastic	10 x 14	EXIT (WITH ARROW)	2	White	Red	
5. Under overhead hoists and bridge crane, one sign at each end of crane track, at eye level	N	Fiberglass	8 x 16	DANGER HOIST OVERHEAD	1-1/2 1/2	Red Black	White White	
6. At generator, one sign	N	Aluminum	10 x 7	WARNING HEARING PROTECTION MUST BE WORN WHEN OPERATING THIS EQUIPMENT (WITH FIGURE)	2	Black	White	
7. At exterior entrance of building	N	Aluminum Individual Letters		(Building name as indicated on elevation)	4	Clear Anodized Aluminum		

**NOTES:**

- For lettering Text specified in brackets ( { } ), provide signs with contents of brackets replaced with actual unit, facility, roadway, or building name indicated.
- For signs without overall size listed, provide signs to fit lettering with 1-1/2-inch margin.
- Fire extinguisher signs shall be self-adhesive arrows pointing to the fire extinguisher.
- Symbols and signs shall be self-adhesive vinyl, screen printed with UV resistant inks. No mechanical fasteners will be allowed. Color of letters and backgrounds to be selected by the Architect/Engineer.

END OF SECTION



## SECTION 10 28 00

### TOILET AND BATH ACCESSORIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide toilet and bath accessories as indicated and specified.

##### 1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:

1. A 153/A 153M: Zinc Coating (Hot-Dip) on Iron and Steel Hardware
2. A 653/A 653M: Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. A 666: Annealed or Cold-Worked for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
4. A 1008/A 1008M: Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
5. C 1036: Flat Glass.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:

1. Manufacturer's data and specifications and other product data required to demonstrate compliance with the specified requirements.
2. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use room designations indicated on Drawings.

##### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.

- B. Materials, devices, equipment and apparatus of a patented or of a special nature of manufacture shall be prepared, applied, or installed in strict accordance with the manufacturer's directions.
- C. Work of this Section shall be executed in strict accordance with Drawings, and approved Shop Drawings.
- D. Provide all holes, connections, and fastenings for and to work of other trades abutting, adjoining or intersecting work of this Section.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.

1.06 COORDINATION:

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.07 WARRANTY:

- A. General: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace mirrors that develop visible silver spoilage defects within 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, 0.0359-inch minimum nominal thickness.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.

- D. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
- E. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.
- G. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of three keys to Owner's representative.

## 2.02 TOILET AND BATH ACCESSORIES:

### A. Manufacturers:

- 1. Bobrick Washroom Equipment
- 2. American Specialties, Inc.
- 3. Bradley Corporation
- 4. Or approved equal.

### B. Toilet Tissue Dispenser:

- 1. Basis-of-Design Product: Model B-4288; Bobrick Washroom Equipment, Inc.
- 2. Type: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
- 3. Mounting: Surface mounted with concealed anchorage.
- 4. Material: Stainless steel.
- 5. Operation: Noncontrol delivery with standard spindle.
- 6. Capacity: Designed for two, 4-1/2- or 5-inch- diameter-core tissue rolls.

### C. Combination Towel Dispenser/Waste Receptacle:

- 1. Basis-of-Design Product: Model B-3699; Bobrick Washroom Equipment, Inc.
- 2. Type: Surface mounted for masonry type wall.



3. Towel-Dispenser Capacity: 350 C-fold or 475 multifold paper towels.
  4. Waste-Receptacle Capacity: 2 gal.
  5. Accessories: Vinyl, reusable waste-receptacle liner, tumbler locksets, and removable front panel at waste receptacle for cleaning ease.
- D. Accessories: Vinyl, reusable waste-receptacle liner, tumbler locksets, and removable front panel at waste receptacle for cleaning ease.
- E. Liquid-Soap Dispenser:
1. Basis-of-Design Product: Model B-8226; Bobrick Washroom Equipment, Inc.
  2. Mounting: Deck mounted on vanity.
  3. Capacity: 34 fl. oz.
  4. Materials: Chrome-plated, high-impact resistant ABS escutcheon with bright polished finish and concealed locking mechanism; high-impact-resistant plastic body and shank; antibacterial-soap-resistant plastic cylinder valve with stainless steel spring and u-packing seal and duckbills; and shatter-resistant polyethylene container.
  5. Stainless-Steel Soap Valve: Designed for dispensing soap in liquid form.
  6. Lockset: Tumbler type.
  7. Refill Indicator: Window type.
- F. Mirror Unit:
1. Basis-of-Design Product: Model B-165 Series; Bobrick Washroom Equipment, Inc.
  2. Frame: Stainless-steel channel.
  3. Size: As indicated on Drawings.

## 2.03 FABRICATION:

- A. General: Materials shall be free from defects impairing strength, durability or appearance.
- B. Sections and shapes shall be rolled, formed, drawn or extruded as required for respective functions.

- C. Molded work shall have sharply defined profile and shall be clean and straight. Plain work shall be leveled, straight and surfaces true and smooth. Edges, angles, and corners shall be square, clean and sharp, unless otherwise detailed.
- D. Fastenings, exposed metal fastenings, and accessories, unless Underwriters prohibit for safety, shall be of same materials, texture, color and finish as the base metal to which applied.
- E. Molds, trim, frames and other metalwork shall be proper dimensions to receive masonry block and tile, plaster, ceramic tile, or other scheduled finishes.

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.
- C. Toilet Accessories:
  - 1. Provide one mirror over each lavatory, in accordance with manufacturer's instructions.
  - 2. Provide one toilet paper holder for each water closet.
  - 3. Provide one combination towel dispenser/waste receptacle for each toilet room.
  - 4. Install one soap dispenser for each lavatory.

### 3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 10 40 00

SAFETY, FIRST AID, AND FIRE FIGHTING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide first aid and fire fighting equipment as indicated and specified.

1.02 REFERENCES:

- A. American National Standards Institute (ANSI):
  - 1. S3.1: Permissible Ambient Noise During Audiometric Testing, Criteria for.
- B. U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH).
- C. U.S. Department of Labor, Mine Safety and Health Administration (MSHA).

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Submit manufacturer's product data, catalogs and brochures for all items specified.
  - 2. Submit manufacturer's installation instructions.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.
- B. Deliver equipment in manufacturer's original unopened and undamaged packages.
- C. Clearly identify manufacturer, brand name, contents, stock number and order number on each package. Damaged packages that may affect conditions of contents are not acceptable.
- D. Store in original packaging under protective cover and protect from damage. Stack containers in accordance with manufacturer's recommendations.

- E. Handle equipment in manner to prevent damage to products and finishes.

## PART 2 - PRODUCTS

### 2.01 EQUIPMENT:

#### A. First-Aid Equipment:

##### 1. Manufacturers:

- a. Mine Safety Appliances Co., Pittsburgh, PA.
- b. North Health Care Inc., Rockford, IL.
- c. Otis Clapp & Son, Inc., Boston, MA.
- d. Or approved equal.

- 2. Pack first-aid material in sturdy steel cabinet designed for industrial plant use containing wide variety of American Medical Association approved material for virtually any first-aid need capable of serving up to 25 people. Arrange materials for ready access-ibility, clearly marked for each group of dressings, arranged to be located instantly and removed easily. Include first-aid manual and contents sheet.
- 3. Include brackets or clips for wall mounting permitting easy movability, and stop hinges for cabinet lid permitting lid to be used as a shelf when open.

#### B. Fire Extinguishers:

##### 1. Manufacturers:

- a. Sierra Fire Equip. Co., Los Angeles, CA.
- b. General Fire Extinguisher Corp., Northbrook, IL.
- c. J.L. Industries Inc., Bloomington, MN.
- d. Or approved equal.

- 2. Provide the following types of fire extinguishers consisting of 10 pound, minimum stored- pressure, extinguishers with trigger-type valves, hand grips, and with a short hose and diffuser horn.

- a. Types:

(1) Type 2 Multi-Purpose (Class A, B and C)

C. Fire-Protection Brackets:

1. Mounting Brackets:

a. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

(1) Color: Red.

b. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.

(1) Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

(a) Orientation: Vertical.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install wall mounting brackets and clips at heights and locations indicated or specified. Attach equipment in accordance with manufacturer's printed recommendations.
- B. Correct defects and defective equipment promptly at no additional compensation to the Owner.

3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 10 70 00  
BUILDING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide building specialties as indicated and specified.

1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
  - 1. A123: Specification for Zinc (Hot-Dip galvanized) Coatings on Iron and Steel Products.
  - 2. A153: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. Aluminum Association Standards for Anodic Finishes.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Submit product data and specifications for all items specified.
  - 2. Submit for review completely detailed drawings of items specified, included printed installation instructions for each manufacturer.
  - 3. Indicate on shop drawings, coatings or other corrosion protection applied at the shop or in the field.
- B. Show alloys, tempers and finishes, if any, on shop drawings for aluminum work.
- C. Submit color charts and finishes specified.

1.04 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Galvanize items indicated or specified in accordance with ASTM A123 or ASTM A153, as appropriate.

### 2.02 SPLASH BLOCKS:

- A. Provide precast concrete splash blocks 18 in. x 24 in. by 4 in. thick with sloping, displayed drainage recess cast in top surface, and reinforced with 4 in. by 4 in. 10/10 welded wire mesh.

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Install each building specialty item in accordance with that applicable manufacturer's printed instructions and approved shop drawings and as specified herein.

### 3.02 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

**DIVISION 22 – PLUMBING**



SECTION 22 00 00  
PLUMBING SYSTEMS

PART 1 - GENERAL

1.00 DESCRIPTION:

- A. Provide new plumbing systems where indicated, complete and ready for operation.
- B. The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete and operable systems in accordance with this Section of these Specifications, the Drawings, and the codes and standards listed herein.
- C. Coordinate with the Local Water Department as to any Local restrictions or requirements relative to backflow prevention devices.

1.01 REFERENCES

- A. Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.
- B. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. Air-Conditioning And Refrigeration Institute (ARI):
  - 1. [1010](#): Self-Contained, Mechanically Refrigerated Drinking-WaterCoolers
- D. American National Standards Institute (ANSI):
  - 1. [Z21.22](#): Relief Valves for Hot Water Supply Systems
  - 2. [Z358.1](#): Emergency Eyewash and Shower Equipment
- E. American Society Of Heating, Refrigerating And Air-Conditioning Engineers (ASHRAE):
  - 1. [90.1](#): Energy Standard for Buildings Except Low-Rose Residential Buildings
- F. American Society of Mechanical Engineers (ASME):
  - 1. [A112.6.1M](#): Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use

2. [A112.18.1M](#): Plumbing Fixture Fittings
3. [A112.19.1M](#): Enameled Cast Iron Plumbing Fixtures
4. [A112.19.2M](#): Vitreous China Plumbing Fixtures
5. [A112.19.5](#): Trim for Water-Closet Bowls, Tanks and Urinals
6. [A112.21.1M](#): Floor Drains
7. [A112.21.2M](#): Roof Drains
8. [A112.36.2M](#): Cleanouts
9. [B16.1](#): Cast Iron Pipe Flanges and Flanged Fittings
10. [B16.12](#): Cast Iron Threaded Drainage Fittings
11. [B16.18](#): Cast Copper Alloy Solder Joint Pressure Fittings
12. [B16.22](#): Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
13. [B16.23](#): Cast Copper Alloy Solder Joint Draining Fittings - DWV
14. [B16.24](#): Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500
15. [B16.29](#): Wrought Copper and Wrought Copper Alloy Solder Joint Draining Fittings – DWV
16. [B40.1](#): Gauges - Pressure Indicating Dial Type
17. [BPV VIII](#): Rules for Construction of Pressure Vessels, Division I

G. American Society of Sanitary Engineering (ASSE):

1. [1013](#): Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers
2. [1014](#): Hand-Held Showers
3. [1017](#): Temperature Actuated Mixing Valves for Hot Water Distribution Systems
4. [1018](#): Trap Seal Primer Valves - Potable, Water Supplied
5. [1071](#): Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
6. [1072](#): Barrier Type Floor Drain Trap Seal Devices

- H. American Society for Testing Materials (ASTM):
1. [A74](#): Cast Iron Soil Pipe and Fittings
  2. [B32](#): Solder Metal
  3. [B42](#): Seamless Copper Pipe, Standard Sizes
  4. [B88](#): Seamless Copper Water Tube
  5. [B306](#): Copper Drainage Tube (DWV)
  6. [B584](#): Copper Alloy Sand Castings for General Applications
  7. [C564](#): Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  8. [D2000](#): Rubber Products in Automotive Applications
  9. [F441](#): Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- I. Cast Iron Soil Pipe Institute (CISPI):
1. [301](#): Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications
  2. [310](#): Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
  3. [HSN-85](#): Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings
- J. Foundation For Cross-Connection Control And Hydraulic Research (FCCCHR):
1. [FCCCHR List](#): List of Approved Backflow Prevention Assemblies
- K. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
1. [SP-58](#): Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation
  2. [SP-80](#): Bronze Gate, Globe, Angle and Check Valves
  3. [SP-110](#): Ball Valves Threaded, Socket Welding, Solder Joints, Grooved and Flared Ends
- L. National Sanitation Foundation (NSF):
1. [14](#): Plastic Piping System Components and Related Materials

2. [61](#): Drinking Water System Components
3. [372](#): Drinking Water System Components – Lead Content

M. Plumbing and Drainage Institute (PDI):

1. [WH 201](#): Water Hammer Arresters

N. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. [SMACNA Seismic Restraint Unit](#): Seismic Restraint Manual: Guidelines for Mechanical Systems

O. Underwriters Laboratories (UL):

1. [174](#): Household Electric Storage Tank Water Heaters
2. [795](#): Commercial-Industrial Gas Heating Equipment
3. [1453](#): Electric Booster and Commercial Storage Tank Water Heaters

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Product Data - Annotate descriptive data to show the specific manufacturer, model, type, size, capacity, curves, wiring diagrams, options, etc. of each item. Where products are available with Energy Star labeling, they shall be provided.
  - a. Pipe and fittings
  - b. Cleanouts
  - c. Drains
  - d. Valves
  - e. Strainers
  - f. Pressure gages
  - g. Thermometers
  - h. Water hammer arresters
  - i. Backflow preventers
  - j. Expansion tanks

- k. Electric trap primers
  - l. Pipe hangers and supports
  - m. Access panels
  - n. Plumbing fixtures
  - o. Water heaters
  - p. Sump pumps
2. Certification - Submit documentation certifying completion of the following items in compliance with this Section.
- a. Tests
  - b. Flushing
  - c. Disinfection
3. Test Reports - prepare as specified in Part 3 of this Section
- a. Pressure tests
  - b. Backflow preventer tests
  - c. Functional testing
4. Operation and Maintenance Manuals - Prepare manuals in accordance with Section 017823.
- a. Valves
  - b. Backflow preventers
  - c. Plumbing fixtures
  - d. Water heaters
  - e. Sump Pumps
5. Closeout Submittals
- a. Record Drawings - Prepare as specified in Part 1 of this Section.

1.03 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified herein.

- B. Consideration shall be given only to products of manufacturers who demonstrate successful experience in manufacture, operation, and servicing equipment of type, size, performance, and reliability equal to that specified. Equipment and components shall be the product of a single manufacturer insofar as possible.
- C. Provide equipment such that all parts are designed for continuous and uninterrupted service, and such that lubrication, adjustment, or replacement of parts is possible without manufacturer's assistance. Corresponding parts of multiple units shall be interchangeable.
- D. Comply with requirements of authority having jurisdiction for submittal, approvals, materials, installation, inspections, and testing.
- E. Tests shall be conducted in presence of authorities having jurisdiction. Subcontractor shall notify the authorities having jurisdiction and Engineer minimum five days prior to performing tests
- F. Alternate Equipment and Arrangement:
  - 1. If any equipment submitted for acceptance requires arrangement differing from that indicated or specified, prepare and submit for review, detailed structural, mechanical and electrical drawings, and equipment lists showing all necessary changes and all special features of equipment proposed. Changes are at no additional cost to the Owner.

1.04 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 011006 and as specified herein.
- B. Shipping:
  - 1. All equipment and material shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance. Equipment and material warranties shall not be voided by actions of the Subcontractor.
  - 2. Ship equipment and material complete except where partial disassembly is required by transportation regulations or for protection of components.
- C. Receiving:
  - 1. All equipment and material shall be delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
  - 2. Inspect for damage and correctness, and inventory items, upon delivery to site.
  - 3. Store equipment and material protected for the weather, humidity and temperature variations, dirt and dust or other contaminants. Store and safeguard in accordance with manufacturer's recommendations.

1.05 COOPERATION AND COORDINATION WITH OTHER TRADES:

- A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit, and installed properly.
- B. Furnish to all other trades advance information on location and size of all concrete pads, chases, frames, boxes, pits, sleeves, and openings needed for the Work, and also furnish layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.
- C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.
- D. With the acceptance of the Engineer and without additional cost to the Owner, make reasonable modifications in Work specified under this Section required to coordinate with normal structural interference's, or for proper execution of specified work.
- E. If work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section of the at no additional cost to the Owner.
- F. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section and be responsible for repairing any damages caused by such work without any additional cost to the Owner.
- G. Follow Drawings in layout work. Check drawings of, and coordinate with, other trades to verify special provisions, installation requirements and spaces in which Work provided under this Section will be installed. Maintain maximum headroom or space conditions at all points. Where headroom or space conditions appear inadequate, notify the Engineer before proceeding.
- H. Attend regular coordination and job progress meetings required.

1.06 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION:

- A. Inserts and anchor bolts shall be furnished under this Section and installed under Section 03 30 00. Prepare a schedule showing location, size and function of all required inserts and anchor bolts and deliver schedule to representative of the installing trade.
- B. For new construction, pipe sleeves shall be furnished under this Section and installed by the trade whose finished interior surfaces will be penetrated. Prepare a schedule showing location, size and function of all required pipe sleeves and deliver schedule to representatives of all installing trades. For existing construction, pipe sleeves shall be furnished and installed under this Section.
- C. Prefabricated flashing for plumbing vents shall be furnished under this Section and installed under Section 07 60 00.

- 1.07 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION:
- A. Water meters and remote reading systems shall be installed under this Section and furnished by the Local Water Department. Type and size of meter shall be as indicated.
- 1.08 ELECTRICAL WORK:
- A. All electrical apparatus and control devices associated with systems installed and/or modified under this Section shall be furnished and mounted under this Section. All power wiring, conduit and connections to electrical apparatus will be furnished and installed by Division 26. All control wiring, conduit and connections to electrical apparatus and control devices will be furnished and installed by Division 26.
  - B. Wiring shall be run in conduit specified in Division 26.
- 1.09 CODES, PERMITS AND FEES:
- A. Except for additional requirements as specified or indicated under the Work of this Section, materials, workmanship and equipment shall conform to the governing edition of the following regulations, and agency requirements.
    - 1. State and Local Building Codes, including but not limited to, the Delaware Plumbing Code, the Delaware Energy Conservation Code, and Delaware Building Code.
    - 2. Delaware Department of Natural Resources and Environmental Control
    - 3. Local Fire Department
    - 4. Local Public Utilities Commission
    - 5. Occupational Safety and Health Administration (OSHA)
    - 6. Any other local codes or requirements of Authorities Having Jurisdiction.
  - B. Pay for all fees and give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from Authorities Having Jurisdiction. Deliver all certificates of inspection to the Authorities Having Jurisdiction. No work shall be covered before examination and approval by Authorities Having Jurisdiction. Replace imperfect or condemned work to conform to inspectional requirements, satisfactory to the Owner, Engineer and Authorities Having Jurisdiction without additional cost to the Owner. If Work is covered before inspection and acceptance, pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.
- 1.10 RECORD DRAWINGS:
- A. Record Drawings shall be provided as specified herein.



- B. As work progresses and for the duration of the Contract, maintain a complete and separate set of prints of Drawings at the job site at all times. On a daily basis, record work completed and all changes from original Drawings clearly and accurately, including work installed as a modification or addition to the original design such as change orders, instructions issued by the Engineer, or conditions encountered in the field.
- C. Record Drawings shall show as-built condition of pipe routing and sizes, valve locations, details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation. Remove all superseded data to show the completed work. Accurately indicate the location, size, type, and elevation of new buried piping and their relationship to existing buried piping.
- D. The Record Drawings will be used as a guide for determining the progress of the Work installed. They shall be inspected on a regular basis and shall be corrected immediately if found inaccurate or incomplete. Requisitions for payment will not be acted upon until the Record Drawings are accurate and up to date.
- E. At completion of Work prepare a complete set of cad-drafted record drawings on bond paper showing all systems as actually installed. The Contract Drawing electronic CAD files will be made available for the HVAC Subcontractor's use to serve as backgrounds for the record drawings. Provide all drawings necessary to show the required record information. Submit cad-drafted prints to the Engineer for comments as to compliance with this Section. Make all modifications so noted by the Engineer.
- F. Certify the accuracy of the Record Drawings. Record Drawings shall become the property of the Owner.
- G. When required by jurisdiction, submit the record set for approval by the Authority Having Jurisdiction in a form acceptable to the jurisdiction.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Where applicable, all products requiring approval by the State of Delaware shall be so approved. Where product types are available with Energy Star labeling, they shall be provided.
- B. All potable water piping components shall comply with NSF 61 test standards via third-party testing and certification. Potable water piping components under the jurisdiction of the Federal Reduction of Lead in Drinking Water Act shall comply with NSF 372 test standards via third-party testing and certification.

2.02 DRAIN, WASTE AND VENT (DWV) PIPING:

A. Fittings shall be long radius fittings, except fittings in vent piping may be short radius fittings. Minimum size piping shall be 2 inch for buried piping and 1-1/2 inch for aboveground piping unless otherwise indicated.

B. Buried Piping:

1. Cast-Iron Hub and Spigot Pipe and Fittings:

a. ASTM A74 with ASTM C564 or CISPI HSN-85 rubber compression gasket joints, service weight.

C. Aboveground Piping:

1. Cast-Iron Hubless Pipe and Fittings for Piping 1-1/2 inch and Larger:

a. CISPI 301, with CISPI 310 couplings composed of rubber sleeves and corrugated stainless steel bands and tightening devices.

2. Copper Tubing for Piping 1-1/4 inch and Smaller:

a. ASTM B306, with ANSI B16.23, ASME B16.29, or ASME B16.32 solder joint fittings using ASTM B32, 95-5 tin-antimony or Grade Sn96 tin-silver solder, and flux containing not more than 0.2 percent lead.

3. Sump Pump Discharge Piping:

a. Polyvinyl Chloride (PVC) System, ASTM D2665, Schedule 80. Piping shall have PVC socket fittings conforming to ASTM D2467. All joints shall be solvent cemented and conforming to ASTM D2564.

b. Sump Pump Discharge Piping Valves:

(1) Check Valves

(a) CPVC construction, full port ball type check valve, capable of mounting in horizontal or vertical position; elastomer seal; true union ends with socket connections.

(2) Ball Valves

(a) CPVC construction, trunnion design with upper and lower supports to retain ball under pressure; dual sliding seats with triple O-rings for balance and maximum leak protection; heavy-duty, large diameter shaft; double shaft O-rings; PTFE shaft bearing and seats; true union ends with socket connections.

- (b) b. MSS SP-110, full port design, series 300 stainless steel construction, wetted components made from lead-free stainless steel, plastic, or other non-leaching material, NPT threaded connections, minimum 35 to 120 degrees F operating range, 175 psig minimum rated working pressure. Valves shall have lever handles, stainless steel ball and PTFE seats and seals. Watts Model S-FBV-1 or approved equal.

D. Cleanouts:

1. ASME A112.36.2M; provide threaded bronze cleanout plugs.
2. Floor Cleanouts:
  - a. Provide coated cast-iron or ductile-iron floor cleanout with anchor flange; threaded outlet; adjustable height polished bronze, nickel bronze, stainless steel, or chromium-plated copper alloy top and scoriated floor plate with "CO" cast in the plate; and countersunk screws for installing floor plate flush with finished floor.
3. Wall Cleanouts:
  - a. Provide threaded bronze cleanout plugs and polished stainless steel or chromium-plated copper alloy cover plate and secure to cleanout plug with countersunk stainless steel screw.

E. Drains:

1. Coated cast-iron or ductile-iron drains with membrane clamp rings for use with membrane waterproofing.
2. Floor Drains:
  - a. ASME A112.21.1M, cast iron or ductile iron body with acid-resisting epoxy coating, double drainage flange with weep holes, non-puncturing flashing collar, 3/4 inch trap primer connection, and bottom outlet of size indicated.
  - b. Finished Spaces: Floor drains shall have threaded adjustable round top with nickel bronze strainer, nominal 6 inch diameter.
  - c. Process Building Spaces: Floor drains shall have round top with heavy-duty loose-set slotted grate, nominal 8 inch diameter.
  - d. Provide minimum 4 inch deep seal P-traps for each floor drain.
3. Roof Drains:
4. Barrier Trap Seal Device:

- a. ASSE 1072, barrier type floor drain trap seal protection device designed to admit water entering floor drain and prevent sewer gas from exiting floor drain. Provide flapper valve at each floor drain not equipped with an automatic trap primer device.

F. Backwater Valves:

- 1. Ball float type, cast iron body with corrosion resistant coating, plastic ball float with copper alloy bushing and replaceable neoprene seat.

2.03 DOMESTIC WATER PIPING AND SERVICE WATER PIPING:

A. Buried and Embedded Piping:

1. Copper Tubing for Piping 2 inch and Smaller:

- a. ASTM B88, Type K, soft annealed copper tubing with ASME B16.50 brazed joint fittings. Provide minimum number of joints in buried copper tubing.

- (1) Joints shall be brazed. Brazing filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2. Copper Tubing for Piping 2-1/2 inch and 3 Inch

- a. ASTM B88, Type K, hard drawn copper tubing with ASME B16.50 braze joint fittings; or with ASME B16.26 flared joint fittings. Provide minimum number of joints in buried copper tubing.

- (1) Joints shall be brazed. Brazing filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

3. Ductile-Iron Piping for piping 4 inch and Larger

- a. AWWA C151 ductile-iron pipe, outside coated, AWWA C104 cement mortar lined, AWWA C111 rubber gasket joints, and AWWA C110 fittings. Provide concrete thrust blocks at the elbow where the buried piping turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Aboveground piping shall have flanged end connections conforming to AWWA C115 for flanged pipe and AWWA C110 for flanged fittings.

4. Trap Primer Piping:

- a. ASTM F 876/877, NSF 14 and 61, cross-linked polyethylene tubing with oxygen diffusion barrier, minimum 150 psig and minimum 75 degree F rated

compression fitting or mechanical insert fitting joints. Provide minimum number of joints in buried and/or embedded tubing.

B. Aboveground Piping:

1. Copper Tubing:

- a. ASTM B88, Type L, hard drawn copper tubing with ANSI B16.18 or ASME16.22 solder joint fitting. Provide ASTM B42 copper pipe nipples with threaded end connections. Provide ASTM B32, 95-5 tin-antimony solder, or provide Plumbing Code approved lead-free solder.

C. Valves:

1. Provide valves suitable for minimum 125 psig and minimum 180 degrees F hot water. Valves shall have threaded end connections with a union on all but one side of the valve, or solder end connections for connections between bronze valves and copper tubing.
2. Check Valves:
  - a. MSS SP-80, Class 125, copper alloy, integral seat, PTFE disc, swing check.
3. Ball Valves:
  - a. MSS SP-110, full port design, copper alloy. Valves shall have lever handles, stainless steel ball and PTFE seats and seals.
4. Trap Primer Valves:
  - a. ASSE 1018 automatic trap primers; all bronze body with integral vacuum breaker, non-liming internal operating assembly, and gasketed bronze cover; plain finish.
5. Safety Relief Valves:
  - a. Combination Pressure and Temperature Relief Valves: ANSI Z21.22, copper alloy body, automatic reseating, test lever, and BTU/Hour discharge capacity in excess of protected heating equipment BTU/Hour rated output.
  - b. Pressure Relief Valves: ANSI Z21.22, copper alloy body, automatic reseating with test lever.
6. Vacuum Relief Valve (for Water Heater):
  - a. ANSI Z21.22 rated and CSA certified, copper alloy body with an integral protective cover, 15 psig WSP. Valve may be vertical or horizontal mounting type.

7. Mixing Valves:

- a. General: Factory assembled and tested, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an acceptable type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Valves shall have 125 psig minimum rated inlet pressure.
- b. Emergency Eyewash/Shower Mixing Valves: ASSE 1071, ANSI Z358.1. Mixing valve shall control and maintain the temperature of the tempered water to plus/minus 3 degrees F. Unit shall be self-contained and include a thermostatic water mixing valve with adjustable high temperature limit stop factory set for 90 degrees F, union angle checkstops on the inlets, top or bottom inlets and top outlet, bypass inlet, wall mounting bracket, and all piping and fittings for a complete unit. Unit shall be able to be set to the correct temperature for the specific contaminant but locked in place to prevent changing of the temperature by accident; unit shall be factory set for 85 degrees F outlet temperature. Unit shall be able to flow a minimum of 3 gpm at 30 psig. Unit shall close down upon failure of cold water supply and include cold water bypass capable of 20 gpm at 30 psig upon failure of hot water supply. Unit shall have temperature override protection via a redundant thermostatic control valve on the outlet that opens on temperature rise above 90 degrees F to introduce cold water and maintain tepid flow.
  - (1) Valves shall have integral wall support and cast lever handle. Valves shall have rough bronze finish.
- c. All Other Mixing Valves: ASSE 1017; adjustable high temperature limit stop factory set for 120 degrees F. Mixing valves shall maintain water temperature within 5 degrees F of any setting. Unit shall be able to flow a minimum of 1.0 gpm at 30 psig.
  - (1) Valves shall have integral wall support and cast lever handle. Valves shall have rough bronze finish.

8. Water Pressure Reducing Valves:

- a. ASSE 1003; non-sticking rolling diaphragm design; copper alloy body, replaceable stainless steel seat and elastomer disc, union connection, and integral stainless steel strainer; pressure gauge tapping; minimum 35 to 150 degree F (2 to 66 degrees C) operating temperature, 150 psi minimum rated inlet pressure, 25 to 75 psig adjustable outlet pressure. Parts shall be serviceable without removing the valve from the line.

- b. Valves shall be rated for minimum 0 gpm to maximum flow indicated.

D. Water Meters:

1. General: NSF 61 certified, minimum 150 psig rated operating pressure and 35 to 100 degree F operating temperature, with registration measuring in U.S. gallons or cubic feet as required by the local water authority. Meter cases shall be no-lead copper alloy. Provide direct reading register at each meter. Meters shall be designed for easy removal of all interior parts without disturbing the connections to the pipeline. The manufacturer, model, and serial number shall be marked permanently on both meter casings and registers. Size and direction of flow through the meter shall be marked permanently on all meters. Provide remote reading registration system.
2. Meters 3/4-Inch to 1-1/2-Inch Size: AWWA C700, positive displacement type with nutating disc, magnetic drive, and sealed register. No oscillating-piston style meters will be accepted.
3. Meters 2-Inch to 6-Inch Size: AWWA C702, compound meters consisting of a combination of a main-line meter of the turbine type for measuring high rates of flow and a disc type meter for measuring low rates of flow. Turbine meter shall be in-line, horizontal-axis, high-velocity type with AWWA Class II turbine measuring element. Disc meter shall be positive displacement type with nutating disc and magnetic drive. No oscillating-piston style meters will be accepted. The compound meter shall have an automatic valve mechanism for diverting low rates of flow through the bypass meter. Both metering devices with sealed registers shall be contained in the same case.
4. Registers: Registers shall provide at least six-digit visual registration. The measuring units shall be printed on the face of the register. The register shall have a full test sweep hand or dial. All registers shall be removable without disassembly of the meter or depressurizing the service line. The register shall be free of openings to protect the internal electronics of the register. Lens covers shall be made of polycarbonate or other suitable engineering polymer for indoor installations and mineral glass for underground pit installations.

E. Strainers:

1. Wye Strainers: Strainers shall have blow-off outlet with pipe nipple and ball valve with discharge pipe nipple, copper alloy body. Provide series 300 stainless steel 40 mesh screen.
2. Plate Strainers: AWWA C702, for use upstream of water meters. Strainers shall have top access without blow-down port. Cases shall be ductile iron with internal polymer coating, or copper alloy. Strainer plates shall be series 300 stainless steel or copper alloy.

F. Pressure Gauges:

1. Pressure gauges shall be ASME B40.1, non-liquid filled, 1 percent accuracy or better, with bronze bourdon tube and steel or brass case, as manufactured by U.S. Gauge American, Mueller, Trerice, Ashcroft or equal.
  2. Gauges shall have a minimum 3 inch diameter face. Dial gradations reading in "PSIG" shall be such that the normal operating pressure of the system installed shall be indicated in middle 1/3 of the scale range.
- G. Gauges shall be equipped with a ball valve shutoff and snubber. An outlet tee, at least 1/4-inch size, plugged for the installation of the inspector's gauge shall be located between each valve and gauge.
- H. Thermometers:
1. Bi-metal dial type thermometers with stainless steel case, stem, and fixed thread connection; minimum 3 inch diameter dial with glass face gasketed within the case; accuracy within 2 percent of scale range. Dial gradation reading in "Degrees Fahrenheit" shall be such that the normal operating temperature is in middle 1/3 of scale range.
- I. Water Hammer Arresters:
1. PDI WH 201, hydropneumatic cushion with stainless steel bellows.
- J. Backflow Preventers:
1. Provide reduced pressure principle backflow preventer with ball valve on both ends. Backflow preventers shall have replaceable seats and discs, iron body with internal polymer coating or bronze body, rated for minimum 35 to 150 degrees F and 175 psig. Reduced pressure principle backflow preventers shall be tested and certified under ASSE 1013 and be provided with test cocks and drainage air gap fitting.
- K. Expansion Tanks:
1. NSF 61; diaphragm type expansion tanks designed for use in potable water systems; butyl diaphragm, polypropylene liner, welded steel shell; constructed, tested hydrostatically and certified in accordance with ASME BPVC SEC VIII D1. Tank shall be equipped with all necessary fittings including stainless steel system connection and welded air charge fitting with plastic cap. Tank and fittings shall have 125 psig minimum working pressure and 180 degrees F minimum operating temperature.
  2. Tanks shall be factory pre-charged and field-adjusted to match incoming water pressure.
- L. Electric Trap Primers:



1. Trap primer valve and control all housed in moisture proof enclosure complete with UL listed electrical assembly consisting of circuit breaker, switch, and timer solenoid valve designed to operate on 120 VAC, single phase power. Unit shall be rated for minimum range of 32 to 120 degrees F and 20 to 125 psig, minimum 2 ounces water at 20 psig per trap served. Inlet and outlet piping connections shall be 1/2-inch NPT.

- a. Provide distribution unit to serve up to four (4) traps where required.

M. Hose:

1. Kink resistant reinforced rubber hose, corrosion resistant metal couplings, minimum 5 year warranty; size and length as indicated.

2.04 PIPE HANGERS AND SUPPORTS:

- A. Provide MSS SP-58 type as indicated with adjustable type steel support rods.
- B. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel with drilled hole on centerline and double nut and flat washer. Attach to wood framed structures using wood screws designed for use with threaded rod adapters, or through-bolted with double nut and flat washer. Attach to concrete with Type 18 insert or drilled expansion anchor.
- C. Provide Type 40 insulation protection shields for insulated piping.
- D. Hangers, supports, insulation shields, rods and fasteners shall be Type 316 stainless steel. Hangers and supports in contact with bare copper tubing shall be PVC coated.

2.05 SUPPLEMENTARY STEEL AND CHANNELS:

- A. Provide all supplementary steel and factory fabricated channels required for proper installation, mounting and support of all equipment and systems provided under this Section.
- B. Channels and supplementary steel shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for the specific loading on the system installed herein.
- C. All supplementary steel shall be Type 316 stainless steel welded assemblies. Channels shall be Type 316 stainless steel.

2.06 PIPE SLEEVES:

- A. Sleeves in Masonry and Concrete Walls, Floors, and Flat Roofs: Standard weight ductile-iron or cast-iron pipe sleeves, except shall be schedule 40 Type 316 stainless

steel where penetrating into the wetwell and other corrosive areas. Sleeves available from the manufacturer of mechanically adjustable segmented elastomeric seals shall be permitted subject to acceptance by the Engineer.

- B. Sleeves in Non-Masonry or Non-Concrete Walls, Floors, and Roofs: Type 316 stainless steel sheet, 26 gage minimum thickness.
- C. Mechanically Adjustable Segmented Elastomeric Seals: Seals shall have EPDM seal elements and Type 316 stainless steel hardware.

#### 2.07 PIPE ESCUTCHEONS:

- A. General: Provide pipe escutcheons as specified herein at all pipe penetrations in finished spaces where penetration is exposed to view. Inside diameter shall closely fit pipe outside diameter. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, wall, or ceilings; and pipe sleeve extension, if any. Escutcheons shall be held in place by internal spring tension or set screws.
- B. Provide pipe escutcheons in finished spaces. Pipe escutcheons shall be of stainless steel, or chrome-plated brass, solid or split hinged.

#### 2.08 DRIP PANS:

- A. In cooperation with the Electrical Subcontractor confirm the final location of all new electrical equipment to be installed in the vicinity of new and existing plumbing piping. All new overhead plumbing piping shall be no closer than 3 feet from a vertical line to electrical equipment including, but not limited to, electric motors, controllers, switchboards, panelboards, and similar equipment. Piping shall not be permitted in Electrical Rooms and stairwells.
- B. Where the installation of new and existing plumbing systems piping does not comply with the requirements of the foregoing paragraph, where feasible the piping shall be relocated. Where not feasible, provide drip pans as specified below, except as otherwise indicated on the Drawings.
- C. Provide drip pans fabricated from 14 gauge series 300 stainless steel sheet and with edges turned up 2-1/2-inches. Reinforce top edge, either by structural angles or by rolling top over 1/4-inch rod made of same material as drip pan sheet metal. Provide hole and 1 inch threaded half coupling for low point drain. Provide hanging brackets of sufficient quantity made of same material as drip pan sheet metal for connecting threaded rods used for suspended drip pans. All joints shall be welded watertight.
- D. Locate drip pans under piping passing over or within 3 feet horizontally of material and equipment defined above, and elsewhere as indicated. Hang from structure with rods and building attachments, fasten rods to brackets on sides of drip pan. Carefully pitch to the drip pan low point for drainage. Brace to prevent sagging or swaying. Drip pans shall be installed within 12 inches below piping.

- E. Provide 1 inch schedule 40 PVC drain line from each drip pan and terminate 6 inches above the floor at nearest floor drain.

2.09 ACCESS PANELS:

- A. Access panels shall give access to each valve and cleanout in concealed spaces above non removable (hard) suspended ceilings, behind walls, and to all other concealed parts of the system. Access panels shall be located where indicated on the Drawings, or where otherwise require accessibility for the proper inspection, operation and maintenance of the system.
- B. Access panels in walls shall be Milcor Type M, 16 inch by 16 inch minimum, as manufactured by Inryco, Inc., or equal. Door shall be constructed of 18 gage galvanized steel with frame constructed of minimum 16 gage galvanized steel. Casing bead shall be galvanized steel. Hinges shall be steel concealed spring type with steel pin. Locks shall be flush, screwdriver operated, with metal cam. Prime coat shall be factory applied rust-inhibitive light grey paint. Provide masonry anchors.

2.10 PLUMBING FIXTURES:

- A. Fixtures shall be as indicated in the Plumbing Fixture Schedule on the Drawings and as specified herein.
- B. Provide control-stop valves in each supply to each fixture. The finish of fittings, accessories, and supplies exposed to view shall be chromium-plated per ASME A112.18.1M. Provide special roughing-in for wheelchair fixtures.
- C. Electric Alarm System for Emergency Shower and Eye Wash Units:
  - 1. Provide packaged UL listed alarm systems in quantities and locations indicated. Each system shall be factory assembled and tested and include horn/light assembly, flow switch, and interconnecting wiring. Each horn/light assembly shall be weatherproof and consist of an amber flashing light with shatter-resistant lens; horn with externally adjustable loudness (80 to 100 dB or similar at 10 feet) and horn silencing switch; and support hardware designed for mounting on vertical pipe or wall as indicated. Waterflow switch unit shall include double pole double throw switch (remote signal auxiliary contact) in waterproof enclosure complete with IPS pipe tee for installation in 1-1/4 inch water supply line to emergency wash units. Flow switch shall be designed to activate at 2.4 gpm and deactivate at 2.0 gpm. System shall have 120 VAC single phase power connection in junction box, and 5 foot flexible NEMA 4X cord and receptacle connecting horn/light assembly to flow switch unit. Entire system shall be designed for waterproof service with NEMA Type 4X enclosures.

2.11 STORAGE TANK ELECTRIC DOMESTIC WATER HEATERS:

- A. Provide tappings for hot and cold water, pressure temperature relief, and drain. All units shall be factory wired.

- B. UL 174, listed electric water heaters with heat input, recovery, storage capacity, and power characteristics as indicated, removable medium watt density single or dual heating element with zinc-plated copper sheath and high temperature cut-off switch with manual reset, 150 psig rated working pressure glass-lined welded steel tank, foam-insulated with standby heat loss conforming to ASHRAE 90.1, baked enamel finished steel sheet jacket, replaceable anodes, adjustable range thermostat for each heating element to allow hot water settings between 110 and 160 degrees F minimum.

## 2.12 SUMP PUMPS (SUBMERSIBLE TYPE):

- A. UL listed, factory assembled and tested submersible type pumps for submerged operation in water up to maximum 120 degrees F or higher and capable of passing maximum 1/2-inch spherical solids. Pump shall be complete with cast-iron casing with corrosion resistant finish, cast iron or bronze impeller, stainless steel shaft, carbon/ceramic mechanical seals, sealed heavy-duty ball bearings, water-cooled hermetically-sealed motor, built-in automatic reset thermal protection, stainless steel lift handle, and waterproof three-conductor cables and grounded plugs. Pumps shall have single or double mechanical seal design.
- B. Provide adjustable/variable level float switches complete with waterproof three-conductor cable and grounded plug. Plug shall be designed for piggybacking into pump grounded plug. Float shall have plastic encased variable level switch designed for use in minimum 18 inch diameter sump. Variable level control switch shall be normally open when hanging down vertically above sump liquid level, and close when it reaches a few degrees above the horizontal position.
- C. Select the pump so that the operating point is in the middle one half of the characteristic performance curve for the pump to be furnished.
- D. Sump Pump Control Panel:
  - 1. Provide a UL listed Sump Pump Control Panel rated for a single 480VAC/3 phase/60 Hz power connection with integral step down transformers as required. The Sump Pump Control Panel shall provide 480VAC power for the pump.
  - 2. Provide motor starter for the sump pump integral to the control panel.
  - 3. Provide dedicated Hand/Off/Auto selector switches for the pump.
  - 4. All switches, buttons, and lights to be 35 mm LEDs. Provide dry contacts for remote indication and LED indicating lights for the following:
    - a. Pump Running – Green
    - b. Pump Off – Red
    - c. Pump Fault – Amber

- d. General Fault - Amber
  - e. Level Alarm High – Amber
5. All wires inside the panel to land at terminal blocks. Wiring directly between devices is not acceptable. Use one side of the terminal block for local terminations and the other for remote. All wires to be tagged at each end and shall match the shop drawings.
  6. Provide device power from the Sump Pump Control Panel for all instruments and equipment associated with the sump system.
  7. Provide panel complete with high water alarm light, high water alarm horn with alarm test and horn silence switch, 115 VAC auxiliary dry high level alarm contacts, general fault contacts, and NEMA 4X thermoplastic enclosure.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

- A. Installation, workmanship, inspection, and testing shall be in accordance with the specified Plumbing Code, Energy Conservation Code, and Building Code with the additions specified herein. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of new piping and existing piping affected by the Work thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other acceptable methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position. When fixtures require both hot water and cold water supplies, provide the hot water supply to the left of the cold water supply. Plastic piping shall not penetrate fire walls or fire floors and shall be not be closer than 6 inches to the penetration. Copper tube extracted joints shall not be permitted.
- B. Piping shall not be permitted in Electrical Rooms and stairwells.
- C. Piping and other apparatus shall not be installed in such a manner so as to interfere with the full swing of doors, movement of personnel and equipment, and access to other equipment.
- D. Install aboveground pressurized piping to permit draining of all sections of each piping systems without traps. Pitch piping back to system low points. Provide drain valves at all piping low points.
- E. Make provisions for pipe expansion and contraction with suitable anchors and offsets, expansion joints, or expansion loops. Install piping to allow freedom of movement in all planes without imposing undue stress on any section of the main piping, branch piping, equipment and structure.

F. Buried Piping:

1. Excavation, backfill and surface restoration for buried piping shall be provided by the General Contractor in accordance with Section 31 23 00.

G. Threaded Connections:

1. Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread paste, pipe cement and oil, or PTFE powder and oil; apply only on male threads. Provide exposed ferrous pipe threads with one coat of primer applied to a minimum dry film thickness of 1.0 mil. Do not thread metal pipe into plastic piping.

H. Soldered Connections:

1. Soldering shall be performed in accordance with best soldering practice. Before soldering copper tubing joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Provide suitable flux for use with solder. Surplus soldering material shall be removed at all joints. Piping shall be supported prior to soldering and not be sprung or forced.
2. For solder end valves, remove stems and washers and other items subject to damage by heat during installation. Reassemble valve after soldering is complete. Valves without heat sensitive parts do not require disassembly but shall be fully opened during soldering.

I. Pipe Hangers and Supports:

1. Selection, application and installation of piping hangers and supports shall conform with MSS SP-58, unless otherwise indicated.
2. Furnish and install safe and substantial means of support for all parts of the piping system. Attach all pipes securely to the structure in correct alignment and pitch, to prevent vibration and to effectively care for expansion and construction.
3. All piping shall be hung to true alignment, using appropriate hanger arrangements. Wire and strap hangers shall not be permitted. Hangers shall be located so that piping and hangers will be 6 inches clear from other piping, hangers, conduits, lighting fixtures, equipment, ceiling suspension systems, ductwork and other obstructions. Where insulation or other covering is provided, minimum clearance shall take into account such covering.
4. Supplementary steel and channels shall be firmly connected to the building construction in a manner accepted by the Engineer, or as otherwise shown on the Drawings. Equipment and piping shall not be supported from metal decking or plaster ceilings.

5. Rod Sizes, MSS SP-58.
6. Piping to Receive Insulation
  - a. Provide temporary wood spacers between the insulation protection shield and the pipe in order to properly slope the piping and to establish final elevations. Temporary wood spacers shall be of the same thickness as the insulation to be provided under Section 22 07 00.
7. Maximum Spacing Between Supports
  - a. Support piping within one foot on either side of in-line pumps, flanged valves, and changes in direction. Support within 2 feet of wall penetrations.
  - a. Vertical Piping: Support piping at each floor, but at not more than 10 foot intervals, with pipe riser clamps or offset pipe clamps. Pipe shall be supported not more than 2 feet from end of risers.
  - b. Horizontal Piping: Support cast-iron piping at 5 foot intervals, except for pipe exceeding 5 foot length, provide supports at intervals equal to the pipe length but not exceeding 10 feet. For all piping, locate supports within one foot of each change of direction, and within 18 inches of joints for straight runs. Support plastic piping at 4 foot intervals and support plastic piping at each change of direction. Support straight runs of copper tubing as follows:

Nominal Pipe Size (inches)	One and under	1-1/4	1-1/2	2	2-1/2	3	4	5	6
Copper Tube	5	7	8	8	9	10	12	13	14

8. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while supporting the load.
9. Pipe hangers, inserts and supports shall conform to MSS SP-58, except as specified as follows:
  - a. Types 5, 12, and 26 shall not be used.
  - b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.
  - c. Type 19 and 23 C-clamps shall be torqued per MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

- d. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.
- e. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
- f. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.
- g. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

J. Seismic Bracing Requirements:

- 1. Piping and equipment shall be supported and braced to resist seismic loads where required by the specified Building Code. Provide seismic restraints in accordance with the SMACNA Seismic Restraint Unit.

K. Pipe Through-Penetrations:

- 1. Furnish pipe sleeves where piping passes through walls, floors, roofs, and partitions. Sleeves will be installed, and secured in proper position and location during construction by the trade whose element will be penetrated. Such trades include concrete, masonry, and dry wall and/or plaster in the case of framed construction. Core drilling of masonry and concrete may be provided by this Section in lieu of pipe sleeves when cavities in the core-drilled holes are completely grouted smooth and round. Furnish sleeves of sufficient length to pass through entire thickness of walls, floors, roofs, and partitions.
- 2. Pipe Penetrations Through Building Interior Construction: Provide not less than ½ inch space between exterior of piping or pipe insulation and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. For non-fire rated assemblies, seal at both ends of the sleeve or core-drilled hole with silicone. Seal both ends of penetrations through fire rated assemblies to maintain fire resistive integrity with UL listed fill, void, or cavity material.



3. Pipe Penetrations Through Building Exterior Construction: Provide a mechanically adjustable segmented elastomeric seal, with sleeve sized as recommended by seal manufacturer.
4. Extend sleeves in floor slabs 2 inches above the finished floor, except sleeves are not required where drain, waste and vent piping passes through concrete floor slabs located on grade. Sleeves through walls shall terminate flush with the finished surface on either side of the wall.

L. Cross Connection and Interconnections:

1. No equipment, devices or piping shall be installed which will provide a cross or interconnection between a domestic water supply and a drainage, soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the domestic water supply system.

3.02 FIELD QUALITY CONTROL:

A. Prior to initial operation, test each new system for compliance with Drawings, Specifications and accepted submittals. As part of inspection, perform inspections, tests and purging in compliance with the specified requirements. Have systems accepted by the Engineer before concealing.

B. Test Procedures and Reports:

1. Prepare and submit procedures, material and equipment for all specified tests to the Engineer for acceptance prior to the planned tests. Material and equipment used in testing shall be subject to inspection by the Engineer.
2. Provide all material and labor required for testing. Instruments, test equipment, and test personnel required to properly conduct all tests shall be provided. The Owner will furnish water, fuel and electricity for the tests.
3. Instruments used in tests shall have been calibrated within the 6-month period preceding the tests.
4. Repair defects disclosed by tests or, if required by the Engineer, replace defective work with new work without additional cost. If any deficiencies are revealed during test, such deficiencies shall be corrected in compliance with contract requirements and the tests re-conducted at no additional cost.
5. Leaks found during tests shall be repaired by replacing pipe and/or fittings and the system retested. Caulking of joints shall not be permitted.
6. Test reports shall include accepted test procedures, test results, deficiencies identified, and recommended corrective actions. Provide a complete explanation including supporting documentation detailing the design deficiencies. State that

no deficiencies are evident if that is the case. When tests have been completed and corrections made, submit signed and dated test reports.

C. Tests:

1. Domestic Water Piping and Service Water Piping Pressure Tests: Before applying insulation, and before the installation of fixtures, cap ends of each system and hydrostatically test each piping system at not less than 125 psig for a period of time sufficient for inspection of every joint in the system but in no case less than 2 hours. During the pressure test, there shall be no leakage or reduction in pressure.
2. Drain, Waste and Vent Piping Pressure Tests: Before the installation of fixtures, provide Drainage and Vent Water Test or Air Test in compliance with the specified Plumbing Code. Each test shall be for a period of time sufficient for inspection of every joint in the system but in no case less than 30 minutes. During the pressure test, there shall be no drop in water level or air pressure.
  - a. After plumbing fixtures have been set and their traps filled with water, subject the entire sanitary system to a Drainage and Vent Final Test in compliance with the specified Plumbing Code. The entire system shall be proven absolutely tight under such test.
3. Backflow Preventer Tests: Backflow preventers shall be tested by a locally approved and certified backflow assembly tester. A copy of the test report shall be provided to the Engineer and Owner prior to placing the domestic water system into operation, or no later than 5 days after the test.
4. Functional Testing: All control devices and signaling devices shall be tested individually to demonstrate proper operation. Test all control system functions to demonstrate proper operation in accordance with the specified control sequences.

D. Flushing:

1. After completion of testing and before placing in operation, flush all new and existing piping of all foreign matter. Use the permanent water service at its maximum available pressure as the source of flushing water. Remove integral strainer screens, aerators, shower heads, vacuum breakers, and other devices susceptible to clogging prior to flushing and re-install upon completion. Flush piping through each fixture outlet, strainer blowdown and equipment drain valve. Discharge used water to sanitary sewer. Remove and provide new screens in new and existing strainers after flushing is completed. System shall be drained prior to final filling.

3.03 MANUFACTURERS INSTRUCTIONS:

- A. Obtain instructions from the manufacturer for the proper method of installation and connection of the equipment that is to be installed. Obtain all information that is necessary to facilitate the Work and to complete the project.

3.04 DISINFECTION:

- A. Disinfect the new water piping and existing water piping affected by the Work in accordance with the specified Plumbing Code with the additions specified herein. Fill piping systems with chlorine solution and allow solution to stand. Following the required standing time, flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 ppm, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new and existing water piping, analyzed by a certified laboratory, and submit results prior to the new and existing water piping being placed into service.

3.05 PAINTING:

- A. Field painting of above ground plumbing piping shall be provided by the Painting Subcontractor in accordance with Section 09 91 00. The following shall be painted:
  - 1. New, uninsulated metallic pipe, fittings and valves in aboveground, exposed locations and above suspended ceilings.
- B. Do not apply paint until piping tests have been completed and system accepted by the Engineer.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 22 07 00  
PLUMBING INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide new field-applied insulation where indicated.
- B. The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete systems in accordance with this Section of these Specifications, the Drawings, and the codes and standards listed herein.

1.02 REFERENCES:

- A. Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.
- B. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. American Society for Testing Materials (ASTM):
  - 1. [A167](#): Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
  - 2. [A240](#): Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications
  - 3. [C195](#): Mineral Fiber Thermal Insulating Cement
  - 4. [C533](#): Calcium Silicate Block and Pipe Thermal Insulation
  - 5. [C547](#): Mineral Fiber Pipe Insulation
  - 6. [C552](#): Cellular Glass Thermal Insulation
  - 7. [C553](#): Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
  - 8. [C916](#): Adhesives for Duct Thermal Insulation
  - 9. [C1136](#): Flexible, Low Permeance Vapor Retarders for Thermal Insulation

10. [E 84](#): Surface Burning Characteristics of Building Materials

D. National Fire Protection Association (NFPA):

1. [255](#): Method of Test of Surface Burning Characteristics of Building Materials

E. Underwriters Laboratories (UL):

1. [723](#): Test for Surface Burning Characteristics of Building Materials

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Product Data - Annotate descriptive data to show the specific manufacturer, material and specifications, thicknesses, etc. of each item.

a. Piping insulation and jackets

b. Adhesives, sealants, and coating compounds

c. Accessory materials

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 01 10 06 and as specified herein.

B. Shipping:

1. All material shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance and maintain material warranties.

C. Receiving:

1. All material shall be delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.

2. Inspect for damage and correctness, and inventory items, upon delivery to site.

3. Store and safeguard material in accordance with manufacturer's recommendations.

4. Store material protected from the weather, humidity and temperature variations, dirt and dust or other contaminants.

1.06 COOPERATION AND COORDINATION WITH OTHER TRADES:

- A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit, and installed properly when and as directed.
- B. Furnish to all other trades advance layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.
- C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.
- D. With the approval of the Engineer and without additional cost to the Owner, make reasonable modifications in Work specified under this Section required to coordinate with normal structural interference's, or for proper execution of specified work.
- E. If Work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section at no additional cost to the Owner.
- F. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section of the Specifications and be responsible for repairing any damages caused by such work without any additional cost to the Owner.
- G. Attend regular coordination and job progress meetings required.

1.07 CODES, PERMITS AND FEES:

- A. Except for additional requirements as specified or indicated under the Work of this Section, materials, workmanship and equipment shall conform with the governing edition of the following regulations, and agency requirements.
  - 1. State and Local Building Codes, including but not limited to, Delaware Energy Conservation Code.
  - 2. Delaware Department of Natural Resources and Environmental Control Local Fire Department
  - 3. Occupational Safety and Health Administration (OSHA)
  - 4. Any other local codes or requirements of Authorities Having Jurisdiction.
- B. Pay for all fees and give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from Authorities Having Jurisdiction. Deliver all certificates of inspection to the Authorities Having Jurisdiction. No work shall be covered before examination and approval by Authorities Having Jurisdiction. Replace imperfect or condemned work to conform to inspectional requirements, satisfactory to

the Owner, Engineer and Authorities Having Jurisdiction without extra cost to the Owner. If Work is covered before inspection and approval, pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

#### A. Packaging and Labeling:

1. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to project site shall have manufacturer's stamp or label attached giving name of manufacturer, brand and description of material. Insulation materials shall be asbestos-free.

#### B. Surface Burning Characteristics:

1. Materials shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50, when tested in accordance with NFPA 255, ASTM E84 or UL 723. Insulation materials located exterior to the building perimeter are not required to be fire-rated.

#### C. Recycled Materials:

1. Provide thermal insulation containing recycled materials to the extent practicable, provided that the materials meet all other requirements of this Section. The minimum recycled material content of the following insulation types are:
  - a. Rock Wool: 75 percent slag of weight
  - b. Fiberglass: 20 to 25 percent glass cullet by weight

### 2.02 PIPING INSULATION

- A. Insulation material shall conform to Table 22 07 00-1. Mineral fiber insulation shall be minimum 3.5 pounds per cubic foot density, minimum 500 degrees F rated, and maximum 0.24 R-factor at 75 degrees F. Insulation thickness shall be as listed in Table 22 07 00-2. Insulate all piping listed in these tables. Where piping is located in unheated spaces such as ceiling spaces and crawl spaces or outdoors, provide insulation thickness one inch greater than indicated in Table 22 07 00-2. Insulation exterior shall be factory cleanable, grease resistant, non-flaking and non-peeling.

#### B. Fittings Insulation:

1. Factory premolded insulation inserts for pipe fittings, flanges and valves shaped to fit the specific fitting to be insulated. Inserts shall be of same material as the straight pipe. Inserts shall be of same thickness as the straight pipe insulation.

C. Piping Insulation Jackets:

1. PVC Jackets:

- a. ASTM D1784 polyvinyl chloride (PVC) jackets, minimum 20 mil thick, factory pre-molded PVC fitting covers, UV-resistant, gloss white finish.

2. Stainless Steel Jackets:

- a. ASTM A167 or ASTM A240; Type 316, minimum thickness of 33 gage, smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2-inch. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges. Covers shall be same thickness and materials as jackets on adjacent piping.

2.03 ADHESIVES, SEALANTS, AND COATING COMPOUNDS:

- A. Insulation and Vapor Barrier Adhesive: ASTM C916, Type I adhesive for securing insulation to metal surfaces and for vapor barrier lap only in building interior.
- B. Mineral Fiber Insulation Cement: ASTM C195.
- C. Vapor Barrier Coating: Provide in accordance with insulation manufacturers' recommendations.
- D. Weatherproof Coating: For outside applications, provide in accordance with insulation and jacket manufacturer's recommendations

2.04 ACCESSORY MATERIALS:

- A. Staples: ASTM A167, Type 304 or 316 stainless steel outside-clinch type.
- B. Insulation Bands: 1/2-inch wide; 26 gage Type 316 stainless steel.
- C. Vapor Barrier Materials: ASTM C1136. Resistant to flame, moisture penetration, and mold growth, color white.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Do not insulate the following:
  - 1. Unions
  - 2. ASME stamps



3. Cleanouts or handholes
4. Manufacturer's nameplates
5. Chrome plated pipes
6. Flexible connectors

### 3.02 PIPING INSULATION:

#### A. Insulation (Except Cellular Glass and Calcium Silicate Insulation):

1. Place sections of insulation around pipe and joints tightly butted into place. Draw jacket tight and smooth. Secure jacket with fire resistant adhesive, factory-applied self-sealing lap, or stainless steel outward clinching staples spaced not over 4 inches on center and 1/2-inch minimum from edge of lap. Cover circumferential joints with butt strips, not less than 3 inches wide, of material identical to jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches. Adhesive used to secure butt strip shall be same as that used to secure jacket laps. Apply staples to both edges of butt strips.
2. Vapor Barrier Jacket: When a vapor barrier jacket is required, as indicated in Table 22 07 00-1, on ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, provide a vapor barrier coating, unless pipe insulation is supplied with factory-applied self-seal lap. Apply vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, stapling, and coating as specified for butt strips. Extend patch not less than 1-1/2 inches past the break in both directions. At penetrations by pressure gages, thermometers, etc. fill voids with vapor barrier coating. Seal with a brush coat of the same coating.

#### B. Cellular Glass and Calcium Silicate Insulation:

1. Provide in accordance with manufacturer's printed instructions.

#### C. Piping Insulation Jackets:

1. Polyvinyl Chloride (PVC) Jackets:
  - a. Provide PVC jacketing system to cover all straight pipe runs, pipe fittings, flanges and valves of services to be insulated except as noted herein. Do not provide PVC jacketing where exposed to weather. Provide PVC jacketing only in ambient temperatures below 150 degrees F. Do not provide PVC jacketing at insulated pipe through-penetrations.
  - b. Secure jacketing with jacket manufacturer's solvent welding adhesive to seal all lap joints in the system. For services where vapor barrier is required,

provide vapor retarder mastic compatible with PVC as recommended by the jacket manufacturer applied over all lap joints in the jacketing system.

- c. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 2 inches at longitudinal and circumferential joints. Overlap longitudinal joints of horizontal piping down to shed water. On vertical piping, the circumferential seams of the jacket shall overlap the upper edge of the jacket below. Seal ends of all insulated piping with vapor retarder mastic as recommended by the jacket manufacturer.

## 2. Stainless Steel Jackets:

- a. Provide stainless steel jacketing system to cover all straight pipe runs, pipe fittings, flanges and valves of services to be insulated where exposed to weather or exposed to ambient temperatures 150 degrees F and above. Provide stainless steel jacketing at insulated pipe through-penetrations.
- b. Provide insulation bands to secure jackets to insulation. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges. For services where vapor barrier is required, provide vapor retarder mastic as recommended by the jacket manufacturer applied over all lap joints in the jacketing system.
- c. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 2 inches at longitudinal and circumferential joints and secure with insulation bands at not more than 9 inch centers with no less than 3 bands per jacket section. Overlap longitudinal joints of horizontal piping down to shed water. On vertical piping, the circumferential seams of the jacket shall overlap the upper edge of the jacket below. Seal ends of all insulated piping with vapor retarder mastic as recommended by the jacket manufacturer.

## D. Hangers and Anchors:

1. Pipe insulation shall be continuous through pipe hangers. Where pipe is supported by insulation, provide Type 316 stainless steel insulation protection shields.
2. Where shields are used on pipes 2 inches and larger, provide insulation inserts at points of hangers and supports. Insulation inserts shall be of calcium silicate or cellular glass, all minimum 15 pounds per square inch compressive strength, of the same thickness as adjacent insulation. Insulation inserts shall cover bottom half of pipe circumference and be not less in length than the protection shield. Vapor-barrier facing of insert shall be of same material as facing on adjacent insulation. Seal inserts into insulation with vapor barrier coating or weatherproof coating as applicable.
3. Where anchors are secured to piping carrying medium less than 60 degrees F that is to be insulated, insulate anchors same as piping for a distance not less than four

times the insulation thickness to prevent condensation. Vapor seal insulation around anchors.

E. Through-Penetrations:

1. Where interior wall is penetrated, extend a stainless steel jacket 2 inches out on either side of wall and secure on each end with an insulation band. Where floor is penetrated, extend a stainless steel jacket 2 inches out from bottom of the floor slab to a point 10 inches above floor with one insulation band at the floor and one not more than 1 inch from end of stainless steel jacket. Where exterior wall is penetrated, extend stainless steel jacket through sleeve to a point 2 inches beyond interior surface of wall and secure on each end with an insulation band.
2. Provide insulation inserts beneath the stainless steel jacket. Insulation inserts shall be of calcium silicate, cellular glass, molded mineral fiber, rigid foam or other approved material, all minimum 15 psi compressive strength, of the same thickness as adjacent insulation. Insulation inserts shall cover full pipe circumference and be not less in length than the stainless steel jacket. Vapor-barrier facing of insert shall be of same material as facing on adjacent insulation. Seal inserts into insulation with vapor barrier coating.

F. Flanges, Unions, Valves and Fittings for Piping:

1. Factory fabricated removable and reusable insulation inserts shall be used. When nesting size insulation is used, overlap 2 inches or one pipe diameter, whichever is larger. Use insulating cement to fill voids. On pipe sizes larger than 2-1/2 inches, elbows insulated using insulation segments shall not have less than three segments per elbow. Place and join segments with manufacturer's recommended water-vapor resistant, fire retardant adhesive appropriate for the temperature limit of the service. Overlap tape seams one inch. Total dry film thickness shall be not less than 1/16-inch. Unions are not to be insulated; taper insulation to union at a 45 degree angle.
2. PVC Fitting Covers: Install factory premolded one-piece PVC fitting covers over insulation.
3. Stainless Steel Fitting Covers: Install factory-fabricated one-piece fitting covers over insulation. Secure covers with no less than 3 insulation bands per cover.

G. Piping Exposed to Weather:

1. Stainless Steel Jackets: Provide over insulation. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 2 inches at longitudinal and circumferential joints and secure with insulation bands at not more than 9 inch centers with no less than 3 bands per jacket section. Overlap longitudinal joints of horizontal piping down to shed water. On vertical piping, the circumferential seams of the jacket shall overlap the upper edge of the jacket below. Cover circumferential strips with butt joints, not less than 4 inches wide, of material

identical to the jacket material. Seal joints with a coating recommended by insulation manufacturer for weatherproofing.

Flanges, Unions, Valves, Fittings, and Accessories: Insulate and finish as specified hereinbefore for applicable service. Apply two coats of an emulsion type weatherproof mastic for hot service and vapor barrier mastic for cold service recommended by insulation manufacturer. Embed glass tape in the first coat. Overlap tape not less than one inch and the adjoining metal jacket not less than 2 inches.

3.03 FIELD QUALITY CONTROL:

- A. Except as otherwise permitted herein, Mechanical systems shall be cleaned and tested prior to application of insulation. Obtain Engineer's approval of systems before applying field insulation. Visually inspect to ensure that insulation materials provided conform to Specifications. Inspect installation of insulation for compliance with requirements.
  - 1. Piping systems shall not be insulated before pressure testing and related inspections.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

**TABLE 22 07 00-1  
INSULATION MATERIAL FOR PIPING**

<b>Service</b>	<b>Material</b>	<b>Spec</b>	<b>Type</b>	<b>Class</b>	<b>Vapor Barrier Required</b>
Plumbing Domestic Hot Water Piping (Maximum 200 degrees°F)	Mineral Fiber	ASTM C547		1	No
Plumbing Domestic Cold Water Piping and Service Water Piping	Mineral Fiber	ASTM C547		1	Yes
Water Cooler Drain Piping (to sewer tie in)	Mineral Fiber	ASTM C547		1	Yes
Roof Drain Bodies and Horizontal Piping	Mineral Fiber	ASTM C547		1	Yes

**TABLE 22 07 00-2  
PIPING INSULATION THICKNESS (INCHES)**

Service	Material	Tube and Pipe Size (Inches)	
		1/4 to 1-1/4	1 1/2 to 6
Plumbing Domestic Hot Water Piping (Maximum 200°F)	Mineral Fiber	1	1-1/2
Plumbing Domestic Cold Water Piping and Service Water Piping	Mineral Fiber	1/2	3/4
Water Cooler Drain Piping (to Sewer Tie-In)	Mineral Fiber	1/2	3/4

END OF SECTION

**DIVISION 23 – HEATING, VENTILATING, AND AIR  
CONDITIONING**

## SECTION 23 00 00

### HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide new heating, ventilating and air conditioning systems as indicated, complete and ready for operation.
- B. The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete and operable systems in accordance with this section of the Specifications, the Drawings, and the codes and standards listed herein.
- C. The HVAC Subcontractor shall provide, set up, and maintain all derricks, hoisting machinery, and shall do all hoisting required for his Work.
- D. The HVAC Subcontractor shall furnish, install, and maintain all scaffolding, staging and planking for his Work.
  - 1. Scaffold shall have solid backs and floors to prevent dropping materials therefrom to the floor or ground.
- E. Temporary Electricity: The HVAC Subcontractor shall furnish all extension cords, sockets, motors, and accessories required for his Work.

##### 1.02 REFERENCES

- A. Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.
- B. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. Associated Air Balance Council (AABC)
  - 1. AABC MN-1: National Standards for Total System Balance
  - 2. AABC MN-2: Test and Balance Procedures
- D. Air Conditioning, Heating and Refrigeration Institute (AHRI):



1. 210/240: Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
  2. 270: Sound Rating of Outdoor Unitary Equipment
  3. 340/360: Standard for Commercial and Industrial Unitary Air-Conditioning Equipment and Heat Pump Equipment
  4. 350: Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
  5. 430: Central-Station Air-Handling Units
  6. 440: Room Fan-Coils
  7. 880: Air Terminals
- E. Air Movement and Control Association International (AMCA):
1. 99: Standards Handbook
  2. 210: Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
  3. 500: Laboratory Methods of Testing Louvers for Rating
- F. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
1. 15: Safety Standard for Refrigeration Systems
  2. 33: Method of Testing Forced Circulation Air Cooling and Air Heating Coils
  3. 34: Designation and Safety Classification of Refrigerants
  4. 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
  5. 68: Laboratory Method of Testing to Determine the Sound Power in a Duct
  6. 90.1: Energy Standard for Buildings Except Low-Rose Residential Buildings
- G. American Society of Mechanical Engineers (ASME):
1. B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)
  2. B16.4: Cast Iron Threaded Fittings
  3. B16.5: Pipe Flanges and Flanged Fittings
  4. B16.9: Factory-Made Wrought Steel Butt- Welding Fittings

5. B16.11: Forged Fittings, Socket-Welding and Threaded
6. B16.15: Cast Copper Alloy Threaded Fittings
7. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings
8. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges
9. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
10. B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500
11. B16.39: Malleable iron Threaded pipe Unions
12. B16.50: Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
13. B18.2.1: Square and Hex Bolts and Screws (Inch Series)
14. B18.2.2: Square and Hex Nuts (Inch Series)
15. B31.1: Power Piping
16. B31.3: Process Piping
17. B31.5: Refrigeration Piping and Heat Transfer Components
18. B31.9: Building Services Piping
19. B40.1: Pressure Gauges and Gauge Attachments
20. BPVC SEC VIII D1 Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

H. American Society For Testing and Materials International (ASTM):

1. A36: Carbon Structural Steel
2. A123: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
3. A167: Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
4. A193: Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
5. A194/A194M: Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both

6. A307: Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength
7. A653: Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
8. A924: General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
9. B88: Seamless Copper Water Tube
10. B117: Operating Salt Spray (Fog) Apparatus
11. B209: Aluminum and Aluminum-Alloy Sheet and Plate
12. B280: Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
13. B395: Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
14. C177: State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
15. C533: Cellulosic Fiber Insulating Board
16. C411: Hot-Surface Performance of High-Temperature Thermal Insulation
17. C423: Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
18. D402: Standard Test Method For Distillation Cut-Back Asphaltic (Bituminous) Products
19. D520: Zinc Dust Pigment
20. D1384: Test Method for Corrosion Test for Engine Coolants in Glassware
21. D1654: Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
22. D1785: PolyVinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
23. D2466: PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
24. E84: Surface Burning Characteristics of Building Materials
25. E96: Water Vapor Transmission of Materials
26. F104: Standard Classification System for Nonmetallic Gasket Materials

27. G21: Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- I. American Welding Society (AWS):
1. A5.8/A5.8M: Filler Metals for Brazing and Braze Welding
  2. BRH: Brazing Handbook
- J. Copper Development Association (CDA):
1. A4015: Copper Tube Handbook
- K. Manufacturers Standardization Society Of The Valve And Fittings Industry (MSS):
1. SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
  2. SP-110: Ball Valves Threaded, Socket Welding, Solder Joints, Grooved and Flared Ends
- L. National Association of Corrosion Engineers (NACE)
1. SSPC SP-5: White Metal Blast Cleaning
- M. National Electrical Manufacturers Association (NEMA):
1. ICS 2: Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
  2. ICS 6: Enclosures
  3. MG 1: Motors and Generators
- N. National Environmental Balancing Bureau (NEBB)
1. NEBB TABES: Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
- O. National Fire Protection Association (NFPA):
1. 70: National Electrical Code
  2. 90A: Installation of Air Conditioning and Ventilating Systems
  3. 90B: Installation of warm Air Heating and Air-Conditioning Systems
  4. 211: Chimneys, Fireplaces, Vents, And Solid Fuel–Burning Appliances

- P. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
1. HVAC Duct Const Stds: HVAC Duct Construction Standards - Metal and Flexible
  2. HVAC Install Fire Damper: Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
  3. Seismic Restraint Mnl: Seismic Restraint Manual: Guidelines for Mechanical Systems

Q. Underwriters Laboratories, Inc. (UL):

1. 94: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
2. 181: Factory-Made Air Ducts and Air Connectors
3. 1995: Heating and Cooling Equipment
4. 441: Gas Vents Safety
5. 508: UL Standard for Safety Industrial Control Equipment
6. 508A: Standard for Industrial Controls Panels
7. 555: Fire Dampers
8. 705: Power Ventilators
9. 723: Test for Surface Burning Characteristics of Building Materials
10. 900: Air Filter Units
11. ECED : Electrical Construction Equipment Directory
12. FRD Fire Resistance Directory

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 and as specified herein:

1. Shop Drawings:
  - a. Ductwork and accessories fabrication and assembly details.
  - b. HVAC control system including:

- (1) Wiring diagrams, sequences of operation, and bill of material listing control device model numbers and keyed to wiring diagrams. Provide title sheet, and legend and abbreviation list.
  - (2) Data sheets for control system components.
2. Product Data - Annotate descriptive data to show the specific manufacturer, model, type, size, capacity, curves, wiring diagrams, options, etc. of each item. Indicate all items to receive coating in accordance with Paragraph entitled "Ductwork Coating" of this Section.
  - a. Pipe and fittings
  - b. Refrigerant piping and accessories
  - c. Hangers and supports
  - d. Air conditioning units
  - e. Air-cooled condensing units
  - f. Electric unit heaters
  - g. Ductwork
  - h. Ductwork accessories
  - i. Diffusers, registers, and grilles
  - j. Fans
  - k. Engine generator exhaust accessories
  - l. HVAC controls
3. Test Reports - prepare as specified in Part 3 of this Section
  - a. Test procedures
  - b. Refrigeration systems tests
  - c. HVAC control system tests
  - d. Testing, adjusting and balancing
4. Certification: Submit documentation certifying completion of the following items in compliance with this Section.
  - a. Manufacturers' services

5. Operation and Maintenance Manuals - Prepare manuals in accordance with Section 017823 – Operation and Maintenance Data.
  - a. Refrigerant piping and accessories
  - b. Air conditioning units
  - c. Air-cooled condensing units
  - d. Electric unit heaters
  - e. Ductwork accessories
  - f. Ductwork coating
  - g. Fans
  - h. HVAC controls
6. Closeout Submittals
  - a. Record Drawings - Prepare as specified in Part 1 of this Section.

#### 1.04 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00 and as specified herein.
- B. Provisions:
  1. Drawings and Specifications direct attention to certain features of equipment, but do not purport to cover all details entering into design and construction of the equipment or appurtenances.
  2. Consideration shall be given only to products of manufacturers who demonstrate successful experience in manufacture, operation, and servicing equipment of type, size, performance, and reliability equal to that specified. Equipment and components shall be the product of a single manufacturer insofar as possible.
  3. Equipment furnished shall fit within the space allocated with adequate clearance for proper operation and maintenance.
- C. Workmanship and Design:
  1. Provide equipment such that all parts are designed for continuous and uninterrupted service, and such that lubrication, adjustment, or replacement of parts is possible without manufacturer's assistance. Corresponding parts of multiple units shall be interchangeable.

2. Install equipment that complies with state, local and federal codes and regulations.

D. Alternate Equipment and Arrangement:

1. If any equipment submitted for acceptance requires arrangement differing from that indicated or specified, HVAC Subcontractor shall prepare and submit for review, detailed structural, mechanical and electrical drawings, and equipment lists showing all necessary changes and all special features of equipment proposed. Changes are at no additional compensation.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Provide in accordance with Section 011006 and as specified herein.

B. Shipping:

1. All equipment and material shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance and to maintain equipment and material warranties.
2. Ship equipment and material complete except where partial disassembly is required by transportation regulations or for protection of components.

C. Receiving:

1. All equipment and material shall be delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
2. Inspect for damage and correctness, and inventory items, upon delivery to site.
3. Store and safeguard equipment and material in accordance with manufacturer's recommendations.
4. Store equipment and material protected from the weather, humidity and temperature variations, dirt and dust or other contaminants.

1.06 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit, and installed promptly.

- B. Furnish to all other trades advance information on location and size of all concrete pads, chases, frames, boxes, sleeves, and openings needed for the Work, and also furnish layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.



- C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.
- D. With the acceptance of the Engineer and without extra cost to the Owner, make reasonable modifications in Work specified under this Section required to coordinate with normal structural interferences, or for proper execution of specified work.
- E. If work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section.
- F. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section and be responsible for repairing any damages caused by such work.
- G. Follow Drawings in layout work. Check drawings of, and coordinate with, other trades to verify special provisions, installation requirements and spaces in which Work provided under this Section of the Specifications will be installed. Maintain maximum headroom or space conditions at all points. Where headroom or space conditions appear inadequate, notify the Engineer before proceeding. In no case shall overhead components be less than 7'-0" above the finished floor.
- H. Attend regular coordination and job progress meetings required.

#### 1.07 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Inserts and anchor bolts shall be furnished under this Section and installed under Section 03 30 00 – Cast-in-Place Concrete. Prepare a schedule showing location, size and function of all required anchoring inserts and deliver schedule to representative of the installing trade.
- B. For new construction, pipe sleeves shall be furnished under this Section and installed by the trade whose finished interior surfaces will be penetrated. Prepare a schedule showing location, size and function of all required pipe sleeves and deliver schedule to representatives of all installing trades. For existing construction, pipe sleeves shall be furnished and installed under this Section.

#### 1.08 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

(NOT USED)

#### 1.09 ELECTRICAL WORK

- A. All power including wiring, conduit and connections to motors and packaged equipment will be furnished and installed by the Electrical Subcontractor under Division 26. Motor starters indicated or specified to be factory-furnished shall be factory wired as an integral part of packaged mechanical equipment. Motor starters that are not integral with the mechanical equipment served will be furnished, mounted

and wired by Division 26. Safety disconnect switches will be furnished, mounted and wired by Division 26

- B. All boiler wiring and conduit between the burner, primary controls, limits, operating controls, and multiple boiler controller shall be furnished and installed under this Section in accordance with the requirements of Division 26. Control circuit for burner shall be taken from the secondary side of a step-down control transformer, installed and wired at the factory. All safety control switching shall be accomplished in the hot ungrounded conductor and through the 24V low voltage wiring supplied by the boiler manufacturer and in accordance with the manufacturer's instructions and recommendations. All power wiring and conduit to boiler – burner units including service switches will be furnished and installed under Division 26.
- C. All HVAC Control Work including control wiring, conduit and connections between damper actuators, manual switches, electric thermostats, damper end switches, and motor starter auxiliary contacts shall be furnished and installed under this Section and shall conform to Division 26 requirements and as specified in this Section. Motor starters shall be equipped with all poles, auxiliary contacts and other devices necessary to permit the interlocking and control sequences required by the HVAC Control Systems; coordinate same with Division 26.
- D. All equipment furnished under this Section requiring motors shall have motors factory furnished and installed by the manufacturer of the equipment served and shall be mounted and aligned so as to run free and true. Provide motors and all associated internal wiring for mechanical equipment as an integral part of the equipment. Motor starters and contactors shall be factory-furnished and wired as an integral part of packaged mechanical equipment where indicated on the Drawings.
- E. Control wiring shall be 120 Volt or less and as specified in this Section. Run control wiring in conduit specified in Division 26.

#### 1.10 CODES, PERMITS AND FEES

- A. Except for additional requirements as specified or indicated under the Work of this Section, materials, workmanship and equipment shall conform to the governing edition of the following regulations, and agency requirements.
  - 1. State Local Building Codes including, but not limited to, the Delaware Building Code, Delaware Electrical Code, Delaware Mechanical Code, Delaware Energy Conservation Code, and Delaware Fire Code.
  - 2. Delaware Department of Natural Resources and Environmental Control Local Fire Department
  - 3. Occupational Safety and Health Authority (OSHA)
  - 4. Any other local codes or requirements of Authorities Having Jurisdiction.

- B. Pay for all fees and give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from Authorities Having Jurisdiction. Deliver all certificates of inspection to the Authorities Having Jurisdiction. No Work shall be covered before examination and approval by Authorities Having Jurisdiction. Replace imperfect or condemned work to conform to inspectional requirements, satisfactory to the Architect, Owner, Engineer and Authorities Having Jurisdiction without extra cost to the Owner. If Work is covered before inspection and acceptance, pay costs of uncovering and reinstalling the covering, whether it meets Contract requirements or not.

#### 1.11 RECORD DRAWINGS

- A. Record drawings shall be provided as specified herein.
- B. As work progresses and for the duration of the Contract, maintain a complete and separate set of prints of drawings at the job site at all times. On a daily basis, record work completed and all changes from original contract drawings clearly and accurately, including work installed as a modification or addition to the original design such as change orders, instructions issued by the Engineer, or conditions encountered in the field.
- C. Record drawings shall show as-built condition of ductwork and pipe routing and sizes, valve locations, details, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of installed equipment. Remove all superseded data to show the completed work.
- D. The record drawings will be used as a guide for determining the progress of the Work installed. They shall be inspected on a regular basis and shall be corrected immediately if found inaccurate or incomplete. Requisitions for payment will not be accepted until the record drawings are accurate and up-to-date.
- E. At completion of Work prepare a complete set of cad-drafted record drawings on bond paper showing all systems as actually installed. The Contract Drawing electronic CAD files will be made available for the HVAC Subcontractor's use to serve as backgrounds for the record drawings. Provide all drawings necessary to show the required record information. Submit cad-drafted prints to the Engineer for comments as to compliance with this Section. Make all modifications so noted by the Engineer.
- F. Certify the accuracy of the record drawings. Record drawings shall become the property of the Owner.
- G. When required by jurisdiction, submit the record set for approval by the Authority Having Jurisdiction in a form acceptable to the jurisdiction.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Branch piping to appliances or equipment shall be at least as large as the inlets thereof.
- B. Provide electrical equipment rated in accordance with the Area Classification Schedule on the Contract electrical drawings.

### 2.02 NAMEPLATES

- A. Major equipment including air conditioning units, air-cooled condensing units, dehumidifiers, electric unit heaters, electric duct heaters, fans, and motors shall have the manufacturer's name, address, model and serial number on a factory-furnished and installed aluminum plate secured to the item of equipment.
- B. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

### 2.03 PIPE AND FITTINGS

- A. Non-Pumped Air Conditioning Condensate Drain Piping: Schedule 40 polyvinyl chloride (PVC) pipe conforming to ASTM D1785. Drain piping shall have Schedule 40 PVC socket fittings conforming to ASTM D2466. All joints between pipe and fittings shall be solvent cemented joints conforming to ASTM D2235 and ASTM D402. Provide protection for PVC piping exposed to weather from ultraviolet radiation.
- B. Unions: FS WW-U-516, solder joint end type, copper alloy.

### 2.04 REFRIGERANT PIPING AND ACCESSORIES

- A. Refrigerant piping shall be type L hard drawn copper tubing cleaned, dehydrated and capped for refrigerant service conforming to ASTM B280. Refrigerant piping shall have wrought copper brazed joint pressure fittings conforming to ASME B16.50. All joints shall be made using a brazing alloy containing silver or using a copper-phosphorous alloy. Brazing filler metal shall have a minimum of 1,100 degrees F melting temperature and shall conform to AWS A5.8/A5.8M, Type BA5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.
- B. Filter dryer in the liquid line shall consist of a steel cylinder filled with a suitable desiccant that will not plug, cake, rust, channel or break down and shall remove both water and acid from the refrigerant. The dryer shall be constructed so that none of the desiccant will pass into the refrigerant lines. The filter dryer shall be the replaceable core type "catch all" as manufactured by either Sporlan or Alco.
- C. Provide all shutoff valves, accessories and appurtenances to provide a complete and properly functioning refrigerant system under all conditions of operation. The complete

refrigerant system shall be designed for use with the refrigerant employed at its maximum operating pressure.

- D. Install all refrigerant piping in accordance with the requirements of ASME Standard B31.5, refrigerant piping; and ASHRAE Standard 15, standard safety code for mechanical refrigeration. All refrigerant piping shall be installed to ensure that all oil returns to the compressor. Suction line piping shall be sized on a pressure drop between the evaporator and compressor equal to an equivalent temperature of not greater than 2 degrees F, with a velocity in the vertical rise of not less than 1,000 fpm. Liquid line piping shall be sized on a pressure drop not to exceed 5 psig. Provide the minimum number of piping joints to limit refrigerant leaks.
- E. Refrigeration system installation shall be in accordance with all state and local codes.

## 2.05 HANGERS AND SUPPORTS

### A. Pipe Hangers:

1. Comply with MSS SP-58. Provide Type 1 or Type 7 as indicated with adjustable type steel support rods.
2. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel with drilled hole on centerline and double nut and flat washer. Attach to concrete with Type 18 insert or drilled expansion anchor.
3. Provide Type 40 insulation protection shields for insulated piping.
4. Hangers, supports, insulation shields, rods and fasteners shall be Type 316 stainless steel. Hangers and supports in contact with bare copper tubing shall be PVC coated carbon steel.

### B. Duct Hangers:

1. Duct hangers shall be in accordance with the "HVAC Duct Construction Standards" published by the Sheetmetal and Air Conditioning Contractors National Association, Incorporated (SMACNA).
2. All hanger rods shall be supported from the building structure same as specified for pipe hangers.
3. Support components in direct contact with ductwork shall be hanger straps with material matching the duct material. Supports, rods and fasteners shall be Type 316 stainless steel. Provide minimum 1/8-inch thick neoprene rubber pads between dissimilar metals.

- C. Where support points are required to avoid other work, provide a system of supplementary steel and/or channels between support points. Provide all necessary supports and cross framing. No part of piping, ductwork, equipment, and the building shall be stressed beyond its normal allowable working strength.

#### 2.06 SUPPLEMENTARY STEEL AND CHANNELS

- A. Unless otherwise indicated on the Structural Drawings, provide all supplementary steel and factory fabricated channels required for proper installation, mounting and support of all equipment, piping and ductwork provided under this Section.
- B. Channels and supplementary steel shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for the specific loading on the system installed herein.
- C. All supplementary steel shall be ASTM A36 factory-formed standard mill finished structural shapes and shall be Type 316 stainless steel. Channels shall be Type 316 stainless steel.

#### 2.07 PIPE SLEEVES

- A. Sleeves in Masonry and Concrete Walls and Floors: Service weight cast iron or standard class ductile iron pipe, except shall be schedule 40 Type 316 stainless steel where penetrating into the wetwell and other corrosive areas. Where sleeves are cast into new concrete, sleeves shall be Type 316 stainless steel pipe, have 2-inch high annular ring water stop continuously welded all around the pipe sleeve.
- B. Sleeves in Non-Masonry or Non-Concrete Walls, Floors, and Roofs: Type 316 stainless steel, minimum 26-gauge thickness.
- C. Mechanically Adjustable Segmented Elastomeric Seals: Seals shall have EPDM seal elements and Type 316 stainless steel hardware.

#### 2.08 DUCT-FREE SPLIT SYSTEM AIR CONDITIONING UNITS:

- A. Provide indoor, direct-expansion, wall-mounted fan coils with matching air-cooled condensing units. Unit shall be complete with cooling-only coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket and mounting hardware.
- B. Cabinet: Cabinet discharge and inlet grilles shall be styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
- C. Fans: Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front.

- D. Coils: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the indoor unit coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. Units shall use capillary tubes or piston refrigerant metering device for refrigerant control.
- E. Motors: Open drip-proof, permanently lubricated ball bearing with inherent overload protection. Indoor unit fan motors shall be 3-speed.
- F. Filters: Indoor unit shall have filter track with factory-supplied cleanable filters.
- G. Controls: Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 64 to 84 degrees F (18 to 52 degree C). The unit shall have the following functions as a minimum.
  - 1. An automatic restart after power failure at the same operating conditions as at failure.
  - 2. A timer function to provide a minimum 24-hour timer cycle for system automatic Start/Stop.
  - 3. Temperature-sensing controls shall sense return-air temperature. Indoor-air high discharge temperature shutdown shall be provided.
  - 4. Indoor coil freeze protection.
  - 5. Auto Stop features shall have integral setback control.
  - 6. Dehumidification mode shall provide room air circulation when no cooling is required.
  - 7. Fan only operation shall provide room air circulation when no cooling is required.
  - 8. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
  - 9. Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during all operating modes.
  - 10. A time delay shall prevent compressor restart in less than 3 minutes.
  - 11. Electrical Requirements: Power and control connections shall have terminal block connections.

## 2.09 AIR-COOLED CONDENSING UNITS:

- A. Provide outdoor-mounted, factory-assembled, single piece, air-cooled condensing unit consisting of an air-conditioning compressor assembly, an air-cooled coil, propeller-type condenser fans, and a control box. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant holding charge, and all accessories indicated. Unit shall have single or multiple independent refrigeration circuits as is furnished standard by the manufacturer. Unit shall discharge cooling air vertically upward. Unit shall be used in a refrigeration circuit matched with a packaged fan coil unit.
- B. Unit shall be rated in accordance with AHRI Standard 210/240 or 365 as applicable. Unit construction shall comply with ANSI/ASHRAE 15 safety code latest revision and comply with NEC. Unit shall be constructed in accordance with UL standards and shall carry the UL label.
- C. Unit Cabinet:
  - 1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a prepainted baked enamel finish. Unit cabinet shall be capable of withstanding 500 hour salt spray exposure per ASTM B117 (scribed specimen).
  - 2. A heavy-gage roll-formed perimeter base rail with forklift slots and lifting holes shall be provided to facilitate rigging. Unit shall have hinged or removable panels for service access to all components.
- D. Fans:
  - 1. Condenser fans shall be direct driven, propeller-type with fan blades statically and dynamically balanced. Condenser fan discharge openings shall be equipped with wire safety guards constructed of coated steel or corrosion resistant metal. Condenser fan and motor shaft shall be corrosion resistant.
- E. Compressors:
  - 1. Compressors shall be of the hermetic scroll type or semi-hermetic reciprocating type and be mounted on vibration isolators. Compressors shall be equipped with overload protection, and factory-installed crankcase heater to control oil dilution. Reciprocating type compressor speed shall not exceed 1,750 rpm and scroll type compressor speed shall not exceed 3,500 rpm. Unloading compressors shall unload using pressure-operated suction cutoff unloading. Provide 5 year extended warranty on compressors.
- F. Condenser Coils:
  - 1. Condenser coils shall be air-cooled and circuited for integral subcooler. Coils shall be constructed of aluminum fins or copper fins mechanically bonded to internally grooved seamless copper tubes which are then cleaned, dehydrated, and



sealed. Condenser coils for semi-hermetic compressor units shall be leak tested at 150 psig and pressure tested at 480 psig, and for hermetic compressor units shall be leak tested at 200 psig and pressure tested at 428 psig.

2. Coils shall be protected by a sheet metal casing to eliminate the need for wind baffles and avoid damage due to the elements and vandalism.

G. Refrigeration Components:

1. Refrigeration circuit components shall include liquid line service valve, suction line service valve, automatically reversible oil pump, a full charge of compressor oil, and a holding charge of refrigerant. Units with semi-hermetic compressors shall have oil-level sight glass and muffler.

H. Controls and Safeties:

1. Minimum control functions shall include:
  - a. Power and control terminal blocks.
  - b. Time delay protection to prevent compressor short-cycling.
  - c. Compressor lockout on auto-reset safety until reset from thermostat.
  - d. Head pressure control to fixed set point between 50 to 55 degrees F ambient temperature by fan cycling. One condenser fan shall be cycled by ambient temperature to maintain proper head pressure.
  - e. Capacity control on the lead compressor shall be by suction cutoff unloaders in response to compressor suction pressure.
2. Minimum safety devices which are equipped with automatic reset (after resetting first at thermostat), shall include:
  - a. High discharge pressure cutout.
  - b. Low suction pressure cutout.
  - c. Compressor high discharge temperature cutout where required.
  - d. Compressor oil pressure switches.
  - e. Condenser fan motors protection against overload or single-phase condition by internal overloads.
  - f. Electrical overload protection through the use of definite-purpose contactors and calibrated, ambient-compensated, magnetic trip circuit breakers.

Circuit breakers shall open all 3 phases in the event of an overload in any one of the phases or a single-phase condition.

I. Electrical Requirements:

1. Unit electrical power shall be single-point connection. Unit control circuit shall contain a 24-volt transformer for unit control

2.10 ELECTRIC UNIT HEATERS

A. Commercial Electric Unit Heaters:

1. Provide commercial, forced-convection-type, electric unit heaters, rated as indicated on the equipment schedules.
2. Provide each unit heater complete with heating element, fan, contactor, and control transformer for 120-volt control.
3. Provide heaters of heavy construction and consisting of heating element with radiating fins.
4. Provide fan motors totally enclosed, oil sealed, and quiet in operation.
5. Provide each unit housed in sheet-steel enclosure equipped with hanger suitable for ceiling or wall mounting as indicated.
6. Include in housing:
  - a. Adjustable vanes or deflectors on front of heater.
  - b. A swivel mounting to permit rotating through at least 180 deg.
7. Provide heaters with thermal cutout, to interrupt current to heater in case of overheating, with provision for hand resetting.
8. Provide industrial-type thermostat with thermometer to control room temperature at each location by closing and opening magnetic contactor. Provide wall mounted thermostat of 2-wire type, adjustable from 40 to 80 deg. F or integral as indicated on the equipment schedule.

B. Corrosion Resistant Electric Unit Heaters:

1. Provide corrosion resistant forced-convection type, electric unit heater, rated as indicated on the equipment schedules.
2. Provide each heater unit complete with heating element, fan, contactor, and control transformer for 120-volt control.

3. Provide fan motors totally enclosed, oil sealed, and quiet in operation.
4. Provide each unit housed in a Series 300 stainless steel NEMA 4X enclosure equipped with hanger suitable for ceiling or wall mounting as indicated.
5. Provide adjustable louver and thermal cutout. Cutout to protect heater from overheating by opening the electric circuit and automatically reenergizing the heater when a safe temperature is reached.
6. Provide NEMA 4X industrial grade, corrosion resistant thermostat, adjustable from 40 to 80 degrees F.

C. Controls:

1. The heater shall be available with a choice of control combinations to provide flexibility of operation in various applications. All units must include a two-position rotary switch for High & Low heat and blower output and a time delay relay to remove residual heat before shut-off. The heater shall include built-in (integral) single pole thermostat (45 to 90 degrees F) or wall mounted as indicated, in the equipment schedule, and a disconnect switch for positive power interruption.

D. Fan and Motor:

1. All motors are to be resilient mounted and have built-in automatic reset thermal overload protection. Motors are to have plug-in electrical connections for ease of service. Motors and blowers are to be mounted as a single assembly with direct-drive connection on a rigid heavy gauge frame to prevent vibration. A blow-through design shall be used to assure quiet operation and maximum cooling for the blower motor.

E. Thermal Protection:

1. A linear high temperature thermal cutout shall be provided for the full length of the heating element.

## 2.11 SHEETMETAL DUCTWORK

- A. Provide all ductwork (ducts, plenums and sleeves) as required for the various air systems. All ductwork shall be aluminum, stainless steel, or galvanized steel sheetmetal ductwork as specified herein and as indicated. All ductwork shall be shop-fabricated.
- B. Aluminum Ductwork: Provide ASTM B 209, alloy 3003-H14 for aluminum sheet, and alloy 6061-T6 or equivalent strength for aluminum connectors and barstock.
- C. Stainless Steel Ductwork: Provide ASTM A 167, 16 gauge, Type 316L stainless steel ductwork.

- D. Galvanized Steel Ductwork: Provide carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 924/ and ASTM A 653, Designation G60. PVC-coat all galvanized steel ductwork in accordance with Paragraph entitled "Ductwork Coating" of this Section.
- E. All ductwork, except where specified otherwise herein, shall be fabricated in accordance with the "HVAC Duct Construction Standards for Metal Ducts" published by the Sheetmetal and Air Conditioning Contractors National Association, Incorporated (SMACNA). Apply SMACNA aluminum thickness adjustment to Pressure Class tables for aluminum ductwork.
1. Rectangular Duct Construction: Provide 2-inch w.g. positive/negative pressure class.
  2. Round Duct Construction: Provide 2-inch w.g. negative pressure class.
  3. All ductwork transverse joints, longitudinal seams, and penetrations shall be sealed in conformance with SMACNA seal classification A.
- F. Ductwork shall be true to the inside dimensions indicated. Cross break all duct panels over 12 inches wide. Support ducts rigidly and securely. Support horizontal ducts not over 8 feet on center. Ductwork shall be straight and smooth on the inside with neatly finished joints.
- G. Elbows narrower than 16 inches shall be full radius elbows with inside radius equal to the dimension of the duct in the plane of the elbow or offset. Elbows wider than 16 inches may be full radius elbows or square elbows with air foil section turning vanes (Duct Manual Figure 2-3) and 6-inch inside radius. Vanes shall be "Runner" type 2, 3 1/4-inches on centers. Install outside vane flush against the outside of the elbow.
- H. Transitions in ductwork shall be made with a 20 degree maximum angle projected from the straight duct side on a diverging transition and a 30 degree maximum angle projected from the straight duct side on a converging transition. Any conditions requiring deviations from the above shall be brought to the attention of the Engineer for acceptance. Duct aspect ratios shall not exceed 4 to 1.
- I. All notches for connecting sections of duct, including longitudinal seam notches, shall not be cut any deeper than 1 7/8-inches to ensure tight corners in 2-inch deep slip joints.
- J. Slips shall be at least two gauges heavier than the ductwork and all joints shall be made in a neat and workmanlike manner and in all cases shall be tight.
- K. All ductwork shall have all transverse joints, longitudinal seams, and penetrations sealed with EC-800 as manufactured by 3M, Hardcast or equal, except sealant for coated ductwork shall be in accordance with the coating manufacturer's recommendation,. Sealing tapes shall not be permitted unless otherwise specified for coated ductwork.

- L. Sheet metal screws shall be stainless steel.

## 2.12 DUCTWORK ACCESSORIES

- A. Duct Flexible Connectors: Provide flexible connectors at fan and unit inlets and outlets. Flexible connectors shall be silicone rubber-coated woven fiberglass fabric with stainless steel edge designed for fastening to adjoining ductwork. Flexible connectors shall be UL listed, maximum 25/50 flame spread/smoke developed rating complying with NFPA 90 A, -40 to 200 degrees F temperature range or wider range, waterproof, mildew resistant, and airtight. Flexible connectors shall be minimum 6-inch wide. Leave 1-inch minimum slack (this means 1/2-inch standing fold). Duct openings shall be lined up on either side of flexible connections. Duro Dyne Thermafab or equal.
- B. Volume Dampers:
  - 1. Provide volume dampers where indicated. All volume dampers shall be shop-fabricated.
  - 2. Dampers shall be manually adjustable single blade and/or multi-blade dampers for rectangular ductwork. Dampers shall be manually adjustable round butterfly dampers for round ductwork.
  - 3. Brackets shall be secured to ductwork with sheet metal screw with locking quadrant arms. Provide 2-inch handle extension for all dampers on externally insulated ductwork.
  - 4. Damper materials shall match the ductwork materials in which installed.
- C. Fire Dampers:
  - 1. Provide stainless steel fire dampers.
  - 2. Provide horizontal and vertical UL labeled, dynamic type fire dampers with rating to suit the barrier penetrated. Assembly shall be of the fully enclosed type with duct collars and dampers that consists of formed steel blades with 100 percent interlocking joints to form a continuous steel curtain when closed. Assembly shall be suitable for horizontal and vertical air flow. Dampers shall meet NFPA 90A requirements.
  - 3. Provide 16-gauge galvanized steel duct sleeves for dampers in ducts with maximum height dimension of 24 inches and maximum width dimension of 36 inches, and 14-gauge sleeves for larger ducts. Depth of sleeve shall be sufficient to install perimeter angles attached to the sleeve on both sides of the wall or floor opening as required by UL-555. Sleeves and housings shall be constructed and installed in accordance with SMACNA HVAC Install Fire Damper, Case 2 or Case 3 of Figure 5 and Case 2 or Case 3 of Figure 6. Connection of duct to the fire damper sleeve or housing shall be rigid and sealed air tight.

4. Fire dampers shall be designed and constructed so that the blade stack in the open damper position is completely outside of the air stream.
5. Where duct pass through fire walls or partitions, the spaces around the duct sleeves shall have the necessary clearance for expansion in conformance with the UL approval. Installation shall conform to all UL-555 requirements.

D. Sheet Metal Access Doors:

1. Provide access doors of the proper size and at all locations in ductwork necessary to service fire dampers, control devices, fan bearings and to service all systems.
2. Access doors shall have foam gasketing, fixed hinges and compression type latches as furnished by Ventlock, Duro-Dyne or equal. Access doors for insulated ducts shall be insulated with minimum 1-inch thick coated duct liner.
3. Access door materials shall match the ductwork materials in which installed.
4. Where sizes of duct access doors are not indicated, provide sizes in accordance with the following table. The edge of duct access doors nearest to the device which it serves shall be within 12 inches of such device. Install access doors in long side of duct in accessible location. Where dimension of short side of duct is 14 inches or greater, access doors may be located in duct short side subject to accessibility requirements of the specifications.

<b>Dimension of Long Side of Duct Inches</b>	<b>Duct Access Door Size Inches</b>
8	6x6
10	8x8
12	10x10
14 or greater	12x12

2.13 REGISTERS AND GRILLES

- A. Provide factory-furnished registers and grilles of material, styles, borders and sizes indicated. Exterior and exposed edges shall be rolled, or otherwise stiffened and rounded. Provide silicone sponge-rubber gasket between flanges and duct. Registers and grilles material of construction shall match the adjoining aluminum or stainless steel ductwork.
- B. Manufacturer certified sound pressure level rating of inlets and outlets shall conform with NC 30 maximum.
- C. Supply registers shall be adjustable double-deflection supply registers.
- D. Exhaust grilles shall have a set of fixed face bars or vanes.

## 2.14 CENTRIFUGAL SIDEWALL FANS:

### A. General:

1. UL 705. Fan shall be a spun aluminum, wall mounted, belt driven, centrifugal exhaust ventilator. Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance. Select fan for maximum efficiency, minimum noise, and stability during all modes of system operation. Unit shall bear an engraved aluminum nameplate. Lifting lugs shall be provided to help prevent damage from improper lifting.

### B. Casing:

1. Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded flange for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two piece end cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor, bearings and drive shall be isolated from the unit structure with rubber vibration isolators.

### C. Wheel:

1. Wheel shall have centrifugal backward inclined blades, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be statically and dynamically balanced in accordance with AMCA Standards.

### D. Belt Drives:

1. Provide belt drive. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for minimum 130 percent of the installed motor horsepower.

### E. Bearings:

1. Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged fan speed.

### F. Motor:

1. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the indicated voltage, phase and enclosure. Motor and power transmission components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream.

G. Coating:

1. Provide coating where and as indicated. All surfaces of metal components exposed to air inside and out shall have a coating, spray-applied. Coating thickness shall be as recommended by the coating manufacturer. Surfaces shall be prepared and cleaned in accordance with the coating manufacturer's requirements.

2.15 TUBULAR MIXED FLOW IN-LINE FANS:

- A. U1 705, inline tube axial type with steel mixed flow configured fan wheels statically and dynamically balanced. The housing shall be constructed of continuously welded steel and include integral punched inlet and outlet flanges to prevent air leakage. The housing, bearing support, and motor base shall be constructed of structural members to prevent vibration and rigidly support the shaft, bearings, and motor. Bearings shall be cast iron pillow block, grease lubricated, and self-aligning. Bearings shall be selected for an L(10) life, per ABMA standards, in excess of 200,000 hours. Turned, precision ground and polished steel shafts shall be sized so the first critical speed is at least 25 percent over the maximum operating speed for each level of construction. Steel housings and structural components shall have factory-applied painting system. Fan performance shall be based on tests conducted in accordance with AMCA Standard 210. All fans shall be licensed to bear the AMCA Certified Ratings Seal for Air Performance. All fans shall have AMCA 99 Type B spark resistant construction.

2.16 CENTRIFUGAL CEILING EXHAUST FANS:

- A. UL 705, suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Wheels shall be forward curved type, statically and dynamically balanced. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Motors shall be open drip proof type with permanently lubricated sealed bearings and thermal overload protection. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.

2.17 SQUARE INLINE- FANS

- A. Fan shall be duct-mounted, belt driven centrifugal square inline.
- B. The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18-gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing.



- C. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone.
- D. Motor shall be heavy duty type with permanently lubricated sealed ball bearings.
- E. Bearings shall be heavy duty regreasable ball type in a pillow block cast iron housing selected for a minimum L50 life of 200,000 hours at maximum cataloged operating speed.
- F. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan speed.
- G. Provide coating where and as indicated.

#### 2.18 ENGINE GENERATOR EXHAUST ACCESSORIES:

- A. Muffler: Critical grade, chamber type exhaust muffler, constructed of welded steel and designed for inside horizontal mounting. Eyebolts, lugs, flanges, or other items shall be provided for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.
- B. Flexible Sections and Expansion Joints: A flexible section shall be provided at each engine and an expansion joint at each muffler. Flexible sections and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the single bellows type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at 1,000 degrees F. Expansion and flexible elements shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

#### 2.19 HVAC CONTROLS:

- A. Except where indicated to be an accessory included with the HVAC equipment, furnish and install all actuators, thermostats, sensors, fan speed controllers, relays, transformers, switches, control dampers, wiring and conduit to perform all functions as called for or required. Controls shall be electric and/or electronic type essentially the product of a single manufacturer, Honeywell, Siemens, or approved equal. Controls shall be OPC compliant where connected to Supervisory Control and Data Acquisition (SCADA) System.
  - 1. All devices shall be mercury-free.
- B. Instruction and Adjustment:

1. Upon completion of the Work, the HVAC Controls Subcontractor shall:
  - a. Completely adjust and ready for use all components and equipment provided under this paragraph.
  - b. Furnish manuals covering operation and maintenance of control systems on project for use by Owner's operating personnel.
- C. Motor starters shall be equipped with all poles, auxiliary contacts and other devices necessary to permit the interlocking and control sequences required by the HVAC Control Systems. Coordinate same with Division 16.
- D. NEMA electrical enclosure requirements shall be as indicated on the Drawings and/or as specified in this Section of the Specifications.
- E. Provide components factory ordered for this project. Rebuilt equipment, warehoused equipment, or earlier generation equipment shall not be acceptable. Actuators and other devices shall operate within temperature limit ranges of plus 35 to 150 degrees F.
- F. Actuators:
  1. General: Provide direct-coupled, electric or electronic spring return actuators. Actuators shall function as required within 85 to 110 percent of their power supply rating. Actuators shall fail to their spring return positions on signal or power failure. Actuators shall have visible position indicators. Actuator motor running time shall be less than 90 seconds after a full scale signal input change. Full scale spring return run time shall be less than 30 seconds. Control circuit shall be 120 VAC.
  2. Damper actuators shall be rated for at least 150 percent of the motive power necessary to operate the connected damper. The actuator stroke shall be limited by an adjustable stop in the direction of the return stroke. Actuators shall be provided with mounting and connecting hardware. All damper actuators shall be power open/fail close.
  3. Provide multiple actuators for ganged control dampers.
  4. Provide damper actuators in NEMA 4X enclosures.
- G. Control Dampers:
  1. Control dampers shall be Ruskin CDTI-50 thermally isolated, parallel blade, low leakage dampers or approved equal.
  2. Damper Assembly: Dampers shall conform to SMACNA HVAC Duct Construction Standards. A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall consist of a combination of sections

ganged together. Damper shall be aluminum. Flat blades shall be made rigid by folding the edges. Provide blades with compressible seals at points of contact. Provide channel frames of dampers with jamb seals to minimize air leakage. Dampers shall not leak in excess of 5 cfm per square foot at 4 inches water gage static pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 degrees F to 200 degrees F. Damper blades shall have high density foam insulation encased between metal blade skins. Damper blades shall have thermal break isolating inside and outside blade skins from each other. Dampers shall be rated at not less than 2000 fpm air velocity. Moving parts of operating linkage in contact with each other shall consist of dissimilar materials. Damper axles shall be 0.5 inch minimum plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by non-ferrous dissimilar thrust bearings. Pressure drop through dampers shall not exceed 0.10 inch water gage at 1,000 fpm in the wide-open position. Frames shall not be less than 4 inches wide. Dampers shall be tested in accordance with AMCA 500-D.

3. Operating Links: Operating links external to dampers, such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators or dampers, shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Mating parts shall consist of dissimilar materials. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

H. Electric Thermostats:

1. Thermostats shall be 120 VAC electric type, integral sensing bulb, amperage rating to suit application. Contacts shall be 2-position single-pole double-throw (SPDT) or single-pole single-throw (SPST), hermetically sealed, and wired to identified terminals. Maximum differential shall be 3.5 degrees F. Minimum differential shall be 2.5 degrees F. Thermostats shall be reverse acting or direct acting as required by the control sequence and shall have a minimum range of 40 to 100 degrees F. Thermostats shall have NEMA 4X enclosures.
2. Single stage, Chromolox Model WCRT-100 or approved equal.

I. Miscellaneous Control Devices:

1. Relays: Relays shall be rated at 120 or 24 Vac as applicable, and shall have an enclosed coil. Provide with a light indicator which is lit when the coil is energized and is not lit when the coil is not energized.
2. Transformers: UL 508 and NEMA ST 1 as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for available voltage and secondaries wound for correct control circuit voltage. Transformers shall be

sized so that connected loads equal no more than 80 percent of rated capacity. Disconnect switch with fuse shall be provided on the primary side, and a fuse cutout on the secondary side.

3. Damper End Switches: SPDT switch rated for 120 VAC. Designed for mounting on motor crank arm. Provide NEMA 4X enclosure.
4. Pilot Lights: Device illumination shall be by light-emitting diode (LED) or neon lamp.
5. Manual Switches: Switches shall have operating levers and index plates showing switch positions and names of apparatus controlled or other appropriate designations

#### J. HVAC Control Panels

1. Panel Assembly: Panel shall be fabricated for bottom entry connection for control system electric power, control system wiring, interconnection of control systems, interconnection of starters, and external shutdown devices. Panels shall house relays, transformers and other miscellaneous devices that are not required to be located external to the control panel due to function. Panel shall have an operating temperature rise of not greater than 20 degrees F above an ambient temperature of 100 degrees F.
2. Panel Electrical Requirements: Control panel shall be powered by nominal 120 VAC terminating at panel on terminal blocks. Instrument cases shall be grounded. Interior and exterior panel enclosures shall be grounded.
3. Enclosures: Enclosures for each panel shall be a single door, wall-mounted NEMA 1 factory-painted steel enclosure, with a continuous hinged and gasketed exterior door with a print pocket and interior offset removable metal back panel. Inside finish shall be white enamel.
4. Main Power Switch and Receptacle
  - a. Provide each control panel with a main external power on/off switch and transformer located inside the cabinet. Also provide each panel with a separate 120 VAC duplex receptacle.
5. Mounting and Labeling: Pilot lights and switches shall be mounted on the door. Power conditioners, fuses, and duplex outlets shall be mounted on the interior of the cabinet. Other components housed in the panel shall be mounted on the interior back panel surface of the enclosure.
6. Wiring:
  - a. Electric and electronic device signals entering and leaving the panel shall be wired to identified terminal blocks.

- b. Wiring shall be installed in wiring ducts so that devices can be added or replaced without disturbing existing wiring that is not affected by the change. Wiring to single-loop controllers shall have a 4-inch wiring loop in the horizontal wiring duct at each wiring connection. There shall be no wiring splices within the control panel. Interconnections required for power or signals shall be made on device terminals, if available, or panel terminal blocks, with not more than two wires connected to each terminal.
  - c. Instrument signal grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Wiring shield grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Grounding terminal blocks shall be identified by reference level.
  - d. Wiring connected to controllers shall be identified by function and polarity, e.g., process variable input and remote setpoint input and output.
7. Quality Assurance: The Control Cabinet shall be manufactured and labeled in accordance with UL 508A. Simply supplying UL recognized individual components shall not be sufficient. The assembled control cabinet, as a whole, shall be inspected for proper wiring methods, fusing, etc., and shall be labeled as conforming to UL 508A. Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL). The system shall be manufactured by a nationally recognized Trade Union (I.B.E.W. or similar trade union). Lack of an NRTL certified UL508A wiring methods inspection and label or lack of a Trade Union label shall be grounds for rejection.

K. Control Wiring:

- 1. Control wiring for 24-V circuits shall be 18 AWG minimum and shall be rated for 600-V service.
- 2. Wiring for circuits operating at more than 100 V shall be 14 AWG minimum and shall be rated for 600-V service.
- 3. Run all wiring in conduit. Conduit shall be as specified in Division 26.

L. Nameplates:

- 1. Provide nameplates directly beneath each thermostat and temperature sensor identifying the fan unit controlled. Provide nameplates attached directly to fan units identifying the equipment tag name. Nameplates shall be plastic laminate construction with engraved white lettering and black background. Lettering height shall be minimum one inch. Nameplates shall be secured to wall, ductwork or equipment casing as applicable with stainless steel fasteners. Adhesives shall not be acceptable. Hand lettering or marking shall not be acceptable.

M. Adjustments:

1. Adjust controls and equipment to maintain conditions indicated, to perform the functions indicated, and to operate in the sequence specified.

N. Field Quality Control:

1. Demonstrate compliance of HVAC control systems. Furnish personnel, equipment, instrumentation, and supplies necessary to perform site testing. Calibrate test equipment in accordance with NIST standards. Ensure that tests are performed or supervised by competent employees of the control system installer or the control system manufacturer regularly employed in testing of control systems.
2. Testing shall include field tests and the performance verification test. Field test shall demonstrate proper operation of specific equipment. The performance verification test shall ensure proper execution of sequence of operation.
3. Submit original copies of test results to the Owner's Representative at the conclusion of testing. Tests are subject to supervision and approval by Owner's Representative.
4. Test Reporting: After completion or termination of field tests and again after the performance verification test, identify, determine causes, replace, or repair equipment which fails to meet the specifications; and deliver a written report to the Owner's Representative. The report shall document test results, explain in detail the nature of each failure, and corrective action taken. After delivering the performance verification test report, the HVAC Controls Subcontractor shall convene a test review meeting at the job site to present results and recommendations to the Owner's Representative. As a part of the test review meeting, the HVAC Controls Subcontractor shall demonstrate by performing appropriate portions of field tests or the performance verification test that failures have been corrected. Based on HVAC Controls Subcontractor's report and test review meeting, the Owner's Representative will determine either the restart point or successful completion of testing. Do not commence required retesting until after receipt of notification by the Owner's Representative. At the conclusion of retesting, repeat the assessment.
5. HVAC Controls Subcontractor 's Field Testing: Verify equipment and system operation before system is placed on-line. Include the following tests in field testing.
  - a. System Inspection: Observe HVAC control system in shutdown condition. Check dampers for proper normal positions. Document positions for the performance verification test report.

- b. Actuator Range Adjustment: With the controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position through to the full range stroke position.
6. Field Test Documentation: Before scheduling the performance verification test, provide field test documentation and written certification of completion to Owner's Representative that the installed system has been tested, and is ready to begin the performance verification test. Do not start the performance verification test prior to receiving permission from the Owner's Representative.
7. Performance Verification Test: Conduct the performance verification tests to demonstrate that the control system maintains setpoints and that the system is set up for the correct sequence of operation. Conduct the performance verification test during one week of continuous HVAC and control systems operation and before final acceptance of work. Specifically, the performance verification test shall demonstrate that the HVAC system operates properly through the complete sequence of operation, for specified control sequences. Demonstrate proper control system response for abnormal conditions for which there is a specified system or controls response by simulating these conditions. Demonstrate that hardware interlocks and safety devices work as designed. Demonstrate that the control system performs the correct sequence of control.

## 2.20 CONTROL SEQUENCES:

- A. Control sequences of operation shall be as indicated on the Drawings.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Installation, workmanship, inspection, and testing shall be in accordance with the specified codes with the additions specified herein.
- B. Arrange for permits, inspections, and tests, in accordance with applicable state and local codes, at the HVAC Subcontractor's expense. Verify all measurements at job site.
- C. Avoid interferences with other trades.

### 3.02 MANUFACTURER'S INSTRUCTIONS

- A. Obtain instructions from the manufacturer for the proper method of installation and connection of the equipment that is to be installed. Obtain all information that is necessary to facilitate the Work and to complete the project.
- B. Upon completion of all Work, furnish, in duplicate, certificates of inspection from equipment manufacturers stating that authorized factory engineers have inspected and

tested the operation of their respective equipment and found same to be in satisfactory operating condition.

### 3.03 PIPING INSTALLATION

- A. Determine and establish measurements for piping at job site. Cut pipe to actual dimensions and assemble to prevent residual stress. Use reducing fittings for changes in pipe size. Size changes made with bushings will not be accepted. Run piping parallel to structure lines and conceal in finished spaces.
- B. Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.9. Install piping straight and true to bear evenly on hangers and supports. Keep the interior and ends of piping thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other accepted methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position.
- C. Piping shall not be permitted in electrical rooms without approval of the Engineer.
- D. Piping and other apparatus shall not be installed in such a manner so as to interfere with the full swing of doors, movement of personnel and equipment, and access to other equipment.
- E. Install piping to permit draining of all sections of each piping system without traps.
- F. Make provisions for pipe expansion and contraction with suitable anchors, offsets and expansion loops. Install piping accurately aligned to allow freedom of movement in all planes without imposing buckling, swaying, and undue stress on any section of the piping, equipment and structure.
- G. Pipe Joints:
  - 1. Threaded Joints
    - a. Threaded joints shall be made with tapered threads properly cut and shall be made tight with a stiff mixture of graphite and oil, applied to the male threads only, and in no case to the fittings. Weeping of glycol solution at threaded joints shall not be acceptable.
  - 2. Flanged Joints
    - a. Flanges shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thickness, full-face or self-centering flat ring type. The gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service.



3. Soldered Connections:

- a. Soldering shall be performed in accordance with best soldering practice. Before soldering copper tubing joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Provide suitable flux for use with solder. Surplus soldering material shall be removed at all joints. Piping shall be supported prior to soldering and not be sprung or forced.
- b. For solder end valves, remove stems and washers and other items subject to damage by heat during installation. Reassemble valve after soldering is complete. Valves without heat sensitive parts do not require disassembly but shall be fully opened during soldering.

4. Brazed Connections:

- a. Brazing of copper tubing joints shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be continuously purged with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Piping shall be supported prior to brazing and not be sprung or forced.

H. Equipment Connections:

1. The size of the connections to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.
2. All components shall be installed in accordance with manufacturer's installation instructions.
3. All piping shall be brought to equipment connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping.
4. On components that require draining, HVAC Subcontractor shall provide piping to and discharging into appropriate drains.

I. Pipe Hangers and Supports:

1. Selection, application and installation of piping hangers and supports shall conform with MSS SP-58, unless otherwise indicated.

2. Furnish and install safe and substantial means of support for all parts of the piping system. Attach all pipes securely to the structure in correct alignment and pitch, to prevent vibration and to effectively care for expansion and contraction.
3. All piping shall be hung to true alignment, using appropriate hanger arrangements. Wire and strap hangers shall not be permitted. Hangers shall be located so that piping and hangers shall be 6 inches clear from other piping, hangers, conduits, lighting fixtures, equipment, ceiling suspension systems, ductwork and other obstructions. Where insulation or other covering is provided, minimum clearance shall take into account such covering.
4. Supplementary steel and channels shall be firmly connected to the building construction in a manner accepted by the Engineer, or as otherwise shown on the Drawings. Equipment and piping shall not be supported from metal decking or plaster ceilings.
5. Rod Sizes, MSS SP-58.
6. Piping to Receive Insulation:
  - a. Provide temporary wood spacers between the insulation protection shield and the pipe in order to properly slope the piping and to establish final elevations. Temporary wood spacers shall be of the same thickness as the insulation to be provided under Section 23 07 00 – HVAC Insulation.
7. Maximum Spacing Between Supports:
  - a. Support piping within one foot on either side of valves and changes in direction. Support within 2 feet of wall penetrations.
  - b. Vertical Piping: Support metal piping at each floor, but at not more than 10 foot intervals. Support plastic piping at each floor and at midpoint between floors, but at not more than 5 foot intervals. Support within 2 feet of floor and roof penetrations and within 2 feet of offsets and changes in direction. Support with pipe riser clamps or offset pipe clamps.
  - c. Horizontal Piping: Locate supports within one foot on either side of each change of direction. Otherwise, support plastic piping and copper tubing as follows:

<b>Maximum Spacing (Feet)</b>									
<b>Nominal Pipe Size (Inches)</b>	<b>≤ 1</b>	<b>1 1/4</b>	<b>1 1/2</b>	<b>2</b>	<b>2 1/2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
Plastic Pipe	4	4	4	4	-	-	-	-	-

Maximum Spacing (Feet)									
Nominal Pipe Size (Inches)	≤ 1	1 1/4	1 1/2	2	2 1/2	3	4	5	6
Copper Tube	5	7	8	8	-	-	-	-	-

8. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while supporting the load.
9. Pipe hangers, inserts and supports shall conform to MSS SP-58, except as specified as follows:
  - a. Types 5, 12, and 26 shall not be used.
  - b. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.
  - c. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.
  - d. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.
  - e. Type 24 may be used only on trapeze hanger systems or on fabricated frames.
  - f. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

J. Seismic Bracing Requirements:

1. Piping, ductwork and equipment shall be supported and braced to resist seismic loads and the seismic restraints shall be designed in accordance with SMACNA Seismic Restraint Manual.
2. Conform to the seismic design requirements of the specified Building Code. Site seismic criteria can be found on Drawing 00 S-001 of the Drawings.

K. Pipe Through-Penetrations:

1. Provide pipe sleeves where pipe passes through walls, floors, and ceilings. In new construction, sleeves will be installed, secured in proper position and location during construction by the trade whose element will be penetrated. Such trades

include concrete, masonry, drywall and/or plaster in the case of framed construction. In existing construction, pipe sleeves shall be furnished and installed under this Section. Core drilled holes in masonry and concrete may be provided by this Section in lieu of pipe sleeves, however cored drilled holes in masonry shall have cavities completely grouted smooth under this Section. Furnish sleeves of sufficient length to pass through entire thickness of walls, floors and roofs.

2. Pipe Penetrations through Building Exterior Construction: Provide a mechanically adjustable segmented elastomeric seal, with sleeve sized as recommended by seal manufacturer.
3. Pipe Penetrations through Building Interior Construction: Provide not less than 1 1/2-inch space between exterior of piping or pipe insulation and interior of sleeve or core-drilled hole. Firmly pack space with rock wool insulation.
  - a. For non-fire rated assemblies, seal at both ends of the sleeve or core-drilled hole with silicone.
  - b. Seal both ends of penetrations through fire rated assemblies to maintain fire resistive integrity with UL listed fill, void, or cavity material. Install firestopping assembly in accordance with UL FRD systems, and as recommended by manufacturer. Completely fill voids flush with the surface. Firestopping for filling voids in floors in which smallest dimension of a void is 4 inches or more shall support the floor design load or be protected by a permanent barrier. Damaged, disrupted, or removed firestoppings shall be replaced with new firestoppings as specified in this Section.
4. Extend sleeves in floor slabs 2 inches above the finished floor. Sleeves through walls shall terminate flush with the finished surface on either side of the wall.
5. Seismic-braced pipe
  - a. Proper clearances between penetrating piping and any barrier shall be provided. The penetrations holes shall be sized such that the hole diameter is 2 inches larger for pipe diameters 1-inch nominal to 3-inch nominal, and 4 inches larger for 4-inch and larger nominal diameter pipe.
  - b. All open space around seismically braced through-penetrations shall be protected by a Listed, flexible through-penetration seal system.

L. Refrigeration Piping and Accessories:

1. Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing.

Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written acceptance. Pipes shall be cut square, shall have burrs removed by reaming, and shall be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made. Pipe shall be purged with nitrogen and capped until refrigerant line is charged.

2. Directional Changes
  - a. Changes in direction shall be made with fittings.
3. Functional Requirements:
  - a. All piping shall be pitched down 1/2-inch per 10 feet of pipe toward the compressor to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the Drawings.
4. Filter Dryer:
  - a. A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. The filter dryer shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. The filter dryer shall be installed such that the filter dryer can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Filter dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.
5. Sight Glass:
  - a. A moisture indicating sight glass shall be installed in all refrigerant circuits downstream of all filter dryers.

#### 3.04 DUCTWORK AND EQUIPMENT INSTALLATION

- A. Installation shall be according to THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS unless otherwise specified. Friction beam clamps indicated in THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS shall not be used. Supports shall be attached only to structural framing members. Supports shall not be anchored to metal decking unless a means is provided and accepted for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members,

suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

B. Dust Control:

1. To prevent the accumulation of dust, debris and foreign material during construction, temporary dust control protection shall be provided. The air distribution system shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

C. Ductwork and equipment shall not be installed in such a manner so as to interfere with the full swing of doors, movement of personnel and equipment, and access to other equipment.

D. Hangers and Supports:

1. Furnish and install safe and substantial means of support for all equipment and parts of the ductwork system. Attach all ductwork and equipment securely to the structure.
2. All ductwork and equipment shall be hung to true alignment, using appropriate hanger arrangements. Hangers and supports shall be located so that ductwork and equipment and associated hangers and supports will be minimum 6 inches clear from other piping, hangers, supports, conduits, lighting fixtures, equipment, ceiling suspension systems, and other obstructions. Where insulation or other covering is provided, minimum clearance shall take into account such covering.
3. Supplementary steel and channels shall be firmly connected to the building construction in a manner accepted by the Engineer, or as otherwise shown on the Drawings. Equipment and ductwork shall not be supported from metal decking.
4. Rod Sizes, MSS SP-58.

E. Where dissimilar metals occur between ductwork and dampers, ductwork and hangers, or ductwork and any other mating surfaces, provide minimum 1/8-inch thick neoprene pads between the dissimilar metals. Pads shall provide continuous separation between the ductwork and mating materials. Pads shall provide continuous separation between the ductwork and damper frames to form an airtight seal.

### 3.05 FIELD QUALITY CONTROL

- A. After system installation has been completed and prior to initial operation, inspect piping and ductwork systems for compliance with Drawings, Specifications, and accepted submittals. Perform tests in compliance with the specified Codes with the additions specified herein. Have piping and ductwork accepted by the Engineer before insulating or otherwise concealing.

B. Test Procedures and Reports

1. Prepare and submit procedures, material and equipment for all specified tests to the Engineer for acceptance prior to the planned tests. Material and equipment used in testing shall be subject to inspection by the Engineer.
2. Provide all material, equipment and labor required for testing. Instruments, test equipment, and test personnel required to properly conduct all tests shall be provided. Provide water, fuel, electricity.
3. Repair defects disclosed by tests or, if required by the Engineer, replace defective work with new work without additional cost. If any deficiencies are revealed during test, such deficiencies shall be corrected and the tests reconducted at no additional cost.
4. Test reports shall include accepted test procedures, test results, deficiencies identified, and recommended corrective actions. Provide a complete explanation including supporting documentation detailing the design deficiencies. State that no deficiencies are evident if that is the case. When tests have been completed and corrections made, submit signed and dated test reports.

C. Provide all materials, labor and power required for testing. Instruments, test equipment, and test personnel required to properly conduct all tests shall be provided as well as the necessary electricity, fuel and water.

D. Refrigeration Systems Tests:

1. System Charging and Startup Test: Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with electronic leak detectors, and bubble leak detection, Big Blue or equal.
2. Refrigerant Leakage Test: After all components of the refrigerant system have been installed and the piping connected, the system shall be subjected to a refrigerant leakage test. The refrigerant leakage test shall be done before any refrigerant pipe is insulated or covered. High and low side of the refrigerant system shall be tested with the minimum refrigerant leakage test pressure specified in ASHRAE 15, for the refrigerant employed in the system. System shall be proved tight and free of leaks by allowing the refrigerant leakage test pressure to remain on the system for 24 hours with no drop in pressure. The initial test pressure and surrounding air temperature will be recorded. After the 24 hour hold period, the final system pressure and surrounding air temperature will be recorded. A correction of 0.3 psi shall be allowed for each degree F

change in the initial and final temperature of the surrounding air, plus for an increase and minus for a decrease. The system shall have passed the refrigerant leakage test if the corrected final system pressure is equal to the initial system test pressure. If the pressures are not equal, the leaks shall be located and repaired.

3. Refrigerant Leaks: To repair leaks, the joint shall be taken apart, thoroughly cleaned, and remade as a new joint. Joints repaired by caulking or remelting and adding more brazing material will not be acceptable. After leak repairs have been made, the refrigerant leakage test shall be conducted again.

E. Equipment Adjusting And Cleaning:

1. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer.
2. V-belts and sheaves shall be tested for proper alignment and tension prior to initial operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, and not bouncing.
3. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.
4. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction. At completion of construction, all construction dirt shall be removed from the building. System shall be maintained in this clean condition until final acceptance.

3.06 TESTING, ADJUSTING AND BALANCING (TAB):

A. Prerequisite HVAC Work:

1. Prior to the commencement of TAB field work, HVAC system installation shall be fully complete. Complete check out and debugging of HVAC equipment, ductwork, and controls prior to the commencement of TAB field work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC systems installation, and verifying all adjustable devices are functioning as designed. Checkout and debug the following equipment including factory controls and accessories:
  - a. Air conditioning units
  - b. Electric heaters
  - c. Fans
  - d. HVAC control systems



B. TAB Work:

1. Test, adjust, and balance the air distribution systems listed herein to the state of operation indicated and specified in the Contract Documents. Conduct TAB work, including maintenance and calibration of instruments, and measurements accuracy in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES, except as supplemented and modified by this Section. Provide instruments and consumables required to accomplish the TAB work.
2. TAB the following:
  - a. Standalone belt-driven exhaust fans
  - b. Standalone belt-driven supply fans
  - c. Standalone direct-driven supply fans and exhaust fans (measure and record air flow rate only).

C. TAB Reports:

1. Submit certified TAB Report in the following manner:
  - a. Report format: Bind the report with a waterproof front and back cover. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable. Report field data may be handwritten on the typewritten report forms.
  - b. Static Pressure Systems: Static pressure report data shall include, in addition to NEBB/AABC required data, the following:
    - (1) Report fan inlet and discharge static pressures.
  - c. Instruments: List the types of instruments actually used to measure the TAB data. Include in the listing each instrument's unique identification number, calibration data, and calibration expiration date. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.
  - d. Motors: Supply list of motors with nameplate amperes and readings taken.
  - e. Performance Curves: Include, in the TAB Report, factory fan curves for fans TAB'd on the job.
  - f. Certification: Include the typed name and the dated signature of the person responsible for the TAB Report.

D. Air Distribution Systems:

1. Check to verify that all dampers are free to open and close.
2. Check for correct rotation of all fan motors and adjust as required.
3. Test ports shall be neat round holes with no sharp edges. Provide plastic plugs designed specifically for HVAC balancing test ports.
4. Make any necessary changes in fan speeds to obtain the design air flow rates indicated on the Drawings. Actual flow rates shall be within the accuracy specified in the paragraph entitled "Acceptable Range" of this Paragraph. Use tong ammeter when adjusting fan speeds to avoid overloading motors. Change the size of pulleys, adjustable sheaves and belts as required to obtain proper air delivery.

E. Acceptable Range:

1. Conduct TAB work on specified HVAC systems until measured parameters are within the following permissible tolerances of the design values, that is, the values specified or indicated on the Drawings.
  - a. Supply Fans: -10% to +10%
  - b. Exhaust Fans: -10% to +10%

For spaces ventilated by a combination of both supply fans and exhaust fans, total exhaust air flow rate and associated total supply air make-up flow rate shall be within +/- 10 percent of each other, with exhaust flow being equal to or greater than supply flow.

F. Deficiencies:

1. Strive to meet the intent of this Section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph entitled "Acceptable Range" provide written notice as soon as possible to the Engineer describing the deficiency and recommended correction.
2. Responsibility for correction of installation deficiencies is with the Contractor. If a deficiency is in equipment design, call the Engineer for technical assistance.

G. Marking of Settings:

1. Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices, (eg. fan sheaves, volume dampers, fan speed controllers) so that adjustment can be restored if disturbed at any time. The permanent marking shall indicate the settings on the adjustment devices which result in the data reported on the submitted Certified TAB Report.

H. Test Ports:

1. Ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

3.07 PAINTING

- A. Field touch-up of factory-painted surfaces of components furnished under this Section shall be provided under Section 09 91 00.
- B. Field painting shall not be applied until after installation and testing is complete.

3.08 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 23 07 00  
HVAC INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide new field-applied insulation for new piping and ductwork as indicated.
- B. The Work of this Section shall include all labor, materials, tools, equipment and appurtenances, and performing all operations necessary to furnish and install complete systems in accordance with this Section of these Specifications, the Drawings, and the codes and standards listed herein.

1.02 REFERENCES:

- A. Except as specified herein, the latest edition of the standards listed below form a part of this Specification to the extent referenced in this Section. Where earlier editions of standards are adopted as referenced in applicable codes, those shall govern. The publications are referred to within the text by the basic designation only.
- B. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. American Society For Testing And Materials (ASTM):
  - 1. A167: Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
  - 2. A240: Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications
  - 3. C195: Mineral Fiber Thermal Insulating Cement
  - 4. C533: Calcium Silicate Block and Pipe Thermal Insulation
  - 5. C534: Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
  - 6. C547: Mineral Fiber Pipe Insulation
  - 7. C552: Cellular Glass Thermal Insulation

8. C553: Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
9. C612: Mineral Fiber Block and Board Thermal Insulation
10. C916: Adhesives for Duct Thermal Insulation
11. C1136: Flexible, Low Permeance Vapor Retarders for Thermal Insulation
12. D1784: Rigid Poly(vinyl Chloride) (PVC) Compounds and Chlorinated Poly(vinyl Chloride) (CPVC) Compounds
13. E 84: Surface Burning Characteristics of Building Materials

D. National Fire Protection Association (NFPA):

1. [255](#): Method of Test of Surface Burning Characteristics of Building Materials

E. Underwriters Laboratories (UL):

1. [723](#): Test for Surface Burning Characteristics of Building Materials

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Product Data - Annotate descriptive data to show the specific manufacturer, material and specifications, thicknesses, etc. of each item.
  - a. Piping insulation and jackets
  - b. Duct insulation and jackets
  - c. Adhesives, sealants, and coating compounds
  - d. Accessory materials

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 011006.

B. Shipping:

1. All material shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance and to maintain material warranties.

C. Receiving:

1. All material shall be delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.
2. Inspect for damage and correctness, and inventory items, upon delivery to site.
3. Store and safeguard material in accordance with manufacturer's recommendations.
4. Store material protected from the weather, humidity and temperature variations, dirt and dust or other contaminants.

1.06 COOPERATION AND COORDINATION WITH OTHER TRADES:

- A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit, and installed properly when and as directed.
- B. Furnish to all other trades advance layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.
- C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.
- D. With the approval of the Engineer and without additional cost to the Owner, make reasonable modifications in Work specified under this Section required to coordinate with normal structural interference's, or for proper execution of specified work.
- E. If Work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section at no additional cost to the Owner.
- F. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section and be responsible for repairing any damages caused by such work at no additional cost to the Owner.
- G. Attend regular coordination and job progress meetings required.

## 1.07 CODES PERMITS AND FEES:

- A. Except for additional requirements as specified or indicated under the Work of this Section, materials, workmanship and equipment shall conform with the governing edition of the following regulations, and agency requirements.
  - 1. State Local Building Codes including, but not limited to, the Delaware Building Code, Delaware Energy Conservation Code, and Delaware Fire Code.
  - 2. Delaware Department of Natural Resources and Environmental Control
  - 3. Local Fire Department
  - 4. Occupational Safety and Health Authority (OSHA)
  - 5. Any other local codes or requirements of Authorities Having Jurisdiction.
  - 6. Pay for all fees and give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from Authorities Having Jurisdiction. Deliver all certificates of inspection to the Authorities Having Jurisdiction. No work shall be covered before examination and approval by Authorities Having Jurisdiction. Replace imperfect or condemned work to conform to inspectional requirements, satisfactory to the Owner, Engineer and Authorities Having Jurisdiction without extra cost to the Owner. If Work is covered before inspection and approval, pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Packaging and Labeling:
  - 1. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to project site shall have manufacturer's stamp or label attached giving name of manufacturer, brand and description of material. Insulation materials shall be asbestos-free.
- B. Surface Burning Characteristics:
  - 1. Materials shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50, when tested in accordance with NFPA 255, ASTM E84 or UL 723. Insulation materials located exterior to the building perimeter are not required to be fire-rated.

C. Recycled Materials:

1. Provide thermal insulation containing recycled materials to the extent practicable, provided that the materials meet all other requirements of this Section. The minimum recycled material content of the following insulation types are:
  - a. Rock Wool - 75 percent slag by weight
  - b. Fiberglass - 20 to 25 percent glass cullet by weight

2.02 PIPING INSULATION:

A. Insulation material shall conform to Table 23 07 00-1. Mineral fiber insulation shall be minimum 3.5 pounds per cubic foot density, minimum 500 degrees F rated, and maximum 0.24 R-factor at 75 degrees F. Insulation thickness shall be as listed in Table 23 07 00-2. Insulate all piping listed in these tables. Where piping is located in unheated spaces such as ceiling spaces and crawl spaces or outdoors, provide insulation thickness one inch greater than indicated in Table 23 07 00-2. Insulation exterior shall be factory cleanable, grease resistant, non-flaking and non-peeling.

B. Fittings Insulation:

1. Factory premolded insulation inserts for pipe fittings, flanges and valves shaped to fit the specific fitting to be insulated. Inserts shall be of same material as the straight pipe. Inserts shall be of same thickness as the straight pipe insulation.

C. Piping Insulation Jackets:

1. PVC Jackets:

- a. ASTM D1784 polyvinyl chloride (PVC) jackets, factory premolded PVC fitting covers, UV-resistant, gloss white finish. Provide compatible vapor retarder mastic.

2. Stainless Steel Jackets:

- a. ASTM A167 or ASTM A240; Type 316, minimum thickness of 33 gage, smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2-inch. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges. Covers shall be same thickness and materials as jackets on adjacent piping.

2.03 DUCT INSULATION:

A. Duct Insulation:



1. Provide factory-applied insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier jacket.
2. Rigid Insulation: Rigid mineral fiber in accordance with ASTM C 612, Class 2 (maximum surface temperature 400 degrees F), 3 pound per cubic foot (pcf), 1 inch thick.

B. Duct Insulation Jackets:

1. All-Purpose Jacket:
  - a. Insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.
2. Metal Jackets:
  - a. Stainless Steel Jackets: ASTM A167 or ASTM A240; Type 316, minimum thickness of 33 gage (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface.
  - b. Provide insulation bands.

2.04 ENGINE EXHAUST PIPING AND MUFFLERS INSULATION:

- A. Insulation material and minimum thickness shall comply with Table 23 07 00-3. Fill joints in the block insulation with mineral wool or equivalent insulation cement. For equipment operating at surface temperatures above 600 degrees F, apply block in double layer construction with staggered joints.
- B. Fittings Insulation
  1. Factory premolded insulation inserts for pipe fittings, flanges and valves shaped to fit the specific fitting to be insulated. Inserts shall be of same material as the straight pipe. Inserts shall be of same thickness as the straight pipe insulation.
- C. Stainless Steel Jackets:
  1. ASTM A167 or ASTM A240; Type 304, minimum thickness of 33 gage, smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2-inch. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges. Covers shall be same thickness and materials as jackets on adjacent piping

2.05 ADHESIVES, SEALANTS, AND COATING COMPOUNDS:

- A. Insulation and Vapor Barrier Adhesive: ASTM C916, Type I adhesive for securing insulation to metal surfaces and for vapor barrier lap only in building interior.
- B. Lagging Adhesive: Fire resistant, for pipe and duct insulation.
  - 1. Provide appropriate class recommended by insulation manufacturer for bonding fibrous glass cloth to unfaced fibrous glass insulation; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding fibrous glass tape to joints of fibrous glass board; or for bonding lagging cloth to thermal insulation.
  - 2. Provide appropriate class for attaching fibrous glass insulation to metal surfaces.
- C. Mineral Fiber Insulation Cement: ASTM C195.
- D. Vapor Barrier Coating: Provide in accordance with insulation manufacturers' recommendations.
- E. Flexible Cellular Insulation Adhesive: Air-drying contact adhesive for joining insulation longitudinal seams and butt joints.
- F. Flexible Cellular Insulation Coating: Water-based latex enamel for protective finish, UV and weather resistant. Do not use vinyl lacquer finish or equivalent.

2.06 ACCESSORY MATERIALS:

- A. Staples: ASTM A167, Type 316 stainless steel outside-clinch type.
- B. Insulation Bands: 1/2-inch wide; 26 gage Type 316 stainless steel.
- C. Anchor Pins and Speed Washers: Provide in accordance with insulation manufacturer's recommendations.
- D. Fibrous Glass Cloth and Tape: 20 by 20 maximum size mesh. Tape shall be 4 inch wide rolls. Tape shall be 4.5 ounces per square yard. In lieu of glass cloth and tape, open weave glass membrane may be provided.
- E. Wire: Soft annealed stainless steel, 16 gage.
- F. Vapor Barrier Materials: ASTM C1136. Resistant to flame, moisture penetration, and mold growth, color white.

## PART 3 - EXECUTION

### 3.01 GENERAL:

- A. Do not insulate the following:
  - 1. Unions
  - 2. Nameplates and ASME stamps
  - 3. Cleanouts or handholes
  - 4. Factory preinsulated flexible ductwork
  - 5. Factory preinsulated HVAC equipment
  - 6. Manufacturer's nameplates
  - 7. Flexible connectors (pipe and/or duct)

### 3.02 PIPING INSULATION:

- A. Mineral Fiber Insulation:
  - 1. Place sections of insulation around pipe and joints tightly butted into place. Draw jacket tight and smooth. Secure jacket with fire resistant adhesive, factory-applied self-sealing lap, or stainless steel outward clinching staples spaced not over 4 inches on center and 1/2-inch minimum from edge of lap. Cover circumferential joints with butt strips, not less than 3 inches wide, of material identical to jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches. Adhesive used to secure butt strip shall be same as that used to secure jacket laps. Apply staples to both edges of butt strips.
  - 2. Vapor Barrier Jacket: When a vapor barrier jacket is required, as indicated in Table 23 07 00-1, on ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, provide a vapor barrier coating, unless pipe insulation is supplied with factory-applied self-seal lap. Apply vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, stapling, and coating as specified for butt strips. Extend patch not less than 1-1/2 inches past the break in both directions. At penetrations by pressure gages, thermometers, etc. fill voids with vapor barrier coating. Seal with a brush coat of the same coating.
- B. Flexible Cellular Insulation:

1. Do not use flexible cellular insulation for pipes in fire rated chases and inside fire walls.
2. Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Where pipes penetrate fire walls, provide calcium silicate or cellular glass insulation inserts and metal jackets. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions. Apply two coats of flexible cellular insulation coating to flexible unicellular insulation in outside locations. Do not use vinyl lacquer finish or equivalent.

C. Cellular Glass and Calcium Silicate Insulation:

1. Use cellular glass or calcium silicate insulation for pipes in fire-rated chases and through fire-rated walls.
2. Use cellular glass or calcium silicate insulation inserts at pipe hangers and supports for piping 2-inch and larger.
3. Use calcium silicate insulation for engine exhaust piping and mufflers.
4. Provide in accordance with manufacturer's printed instructions.

D. Piping Insulation Jackets:

1. Polyvinyl Chloride (PVC) Jackets:

- a. Provide PVC jacketing system to cover all straight pipe runs, pipe fittings, flanges and valves of services to be insulated except as noted herein. Do not provide PVC jacketing where exposed to weather. Provide PVC jacketing only in ambient temperatures below 150 degrees F. Do not provide PVC jacketing at insulated pipe through-penetrations.
- b. Secure jacketing with jacket manufacturer's solvent welding adhesive to seal all lap joints in the system. For services where vapor barrier is required, provide vapor retarder mastic compatible with PVC as recommended by the jacket manufacturer applied over all lap joints in the jacketing system.
- c. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 2 inches at longitudinal and circumferential joints. Overlap longitudinal joints of horizontal piping down to shed water. On vertical piping, the circumferential seams of the jacket shall overlap the upper edge of the jacket below. Seal ends of all insulated piping with vapor retarder mastic as recommended by the jacket manufacturer.

2. Metal Jackets:

- a. Provide stainless steel jacketing system to cover all straight pipe runs, pipe fittings, flanges and valves of services to be insulated where exposed to weather or exposed to ambient temperatures 150 degrees F and above. Provide stainless steel jacketing at insulated pipe through-penetrations.
- b. Provide insulation bands to secure jackets to insulation. Provide factory prefabricated stainless steel covers for insulation on fittings, valves, and flanges. For services where vapor barrier is required, provide vapor retarder mastic as recommended by the jacket manufacturer applied over all lap joints in the jacketing system.
- c. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 2 inches at longitudinal and circumferential joints and secure with insulation bands at not more than 9-inch centers with no less than 3 bands per jacket section. Overlap longitudinal joints of horizontal piping down to shed water. On vertical piping, the circumferential seams of the jacket shall overlap the upper edge of the jacket below. Seal ends of all insulated piping with vapor retarder mastic as recommended by the jacket manufacturer.

E. Hangers and Anchors:

1. Pipe insulation shall be continuous through pipe hangers. Where pipe is supported by insulation, provide Type 316 stainless steel insulation protection shields.
2. Where shields are used on pipes 2 inches and larger, provide insulation inserts at points of hangers and supports. Insulation inserts shall be of calcium silicate, cellular glass, or other acceptable material, all minimum 15 psi compressive strength, of the same thickness as adjacent insulation. Insulation inserts shall cover bottom half of pipe circumference and be not less in length than the protection shield. Vapor-barrier facing of insert shall be of same material as facing on adjacent insulation. Seal inserts into insulation with vapor barrier coating or weatherproof coating as applicable.
3. Where anchors are secured to piping carrying medium less than 60 degrees F that is to be insulated, insulate anchors same as piping for a distance not less than four times the insulation thickness to prevent condensation. Vapor seal insulation around anchors.

F. Through-Penetrations:

1. Where interior wall is penetrated, extend a stainless steel jacket minimum 3 inches out on either side of wall and secure on each end with an insulation band. Where

floor is penetrated, extend a stainless steel jacket from a point 3 inches below the floor slab to a point 10 inches above floor with one insulation band at the floor and one not more than one inch from end of metal jacket. Where exterior wall is penetrated, extend stainless steel jacket through sleeve to a point 2 inches beyond interior surface of wall and secure on each end with an insulation band.

2. Provide insulation inserts beneath the metal jacket. Insulation inserts shall be of calcium silicate or cellular glass, or other approved material, all minimum 15 pounds per square inch compressive strength and of the same thickness as adjacent insulation. Insulation inserts shall cover full pipe circumference and be not less in length than the metal jacket. Vapor-barrier facing of insert shall be of same material as facing on adjacent insulation. Seal inserts into insulation with vapor barrier coating.

G. Flanges, Unions, Valves and Fittings for Piping:

1. Factory fabricated removable and reusable insulation inserts shall be used. When nesting size insulation is used, overlap 2 inches or one pipe diameter, whichever is larger. Use insulating cement to fill voids. Place and join segments with manufacturer's recommended water-vapor resistant, fire retardant adhesive appropriate for the temperature limit of the service. Overlap tape seams one inch. Unions are not to be insulated; taper insulation to union at a 45 degree angle.
2. PVC Fitting Covers: Install factory premolded one-piece PVC fitting covers over insulation.
3. Stainless Steel Fitting Covers: Install factory-fabricated one-piece fitting covers over insulation. Secure covers with no less than 3 insulation bands per cover.

H. Piping Exposed to Weather:

1. Stainless Steel Jackets: Provide over insulation. Machine cut jacket to smooth edge of circumferential joints. Overlap jacket not less than 2 inches at longitudinal and circumferential joints and secure with insulation bands at not more than 9 inch centers with no less than 3 bands per jacket section. Overlap longitudinal joints of horizontal piping down to shed water. On vertical piping, the circumferential seams of the jacket shall overlap the upper edge of the jacket below. Cover circumferential strips with butt joints, not less than 4 inches wide, of material identical to the jacket material. Seal joints with a coating recommended by insulation manufacturer for weatherproofing.
2. Flanges, Unions, Valves, Fittings, and Accessories: Insulate and finish as specified hereinbefore for applicable service. Apply two coats of an emulsion type weatherproof mastic for hot service and vapor barrier mastic for cold service recommended by insulation manufacturer. Embed glass tape in the first coat.

Overlap tape not less than one inch and the adjoining metal jacket not less than 2 inches.

### 3.03 DUCTWORK AND ACCESSORIES INSULATION:

- A. Provide rigid type duct insulation. Provide field-applied insulation to exterior of outside air ductwork between the outdoor intake and the control damper, exhaust air ductwork between the outdoor discharge and the control damper, and plenums. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction with damper handles, and other such items. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit.
- B. Rigid Insulation:
  - 1. Secure rigid insulation by impaling over pins or anchors located not more than 3 inches from joint edges of boards, spaced not more than 12 inches on center and secure with washers and clips. Spot weld anchor pins or attach with waterproof adhesive especially designed for use on metal surfaces. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors. Each pin or anchor shall be capable of supporting a 20 pound load. Cut off protruding ends of pins, after clips are sealed with coating compound for indoor work. Coatings shall be reinforced with open weave glass membrane.
- C. Through-Penetrations:
  - 1. Insulation shall be continuous through sleeves, wall and floor openings, except at fire dampers in duct systems. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at manufacturer's recommended coverage per gallon.
- D. Access Doors:
  - 1. On externally insulated ducts, plenums, and casings, bevel insulation around access doors.
- E. Insulation Finishes and Joint Sealing:
  - 1. Fill breaks, punctures, and voids with vapor barrier coating compound for inside work or manufacturer's recommended weatherproof coating for outside work. Vapor seal joints by embedding a single layer of 3-inch wide open weave glass membrane, maximum 20 by 20 mesh per linear inch between two 1/16-inch wet film thickness coats of vapor barrier coating compound. Draw glass fabric smooth and tight with a 1 1/2-inch overlap. At jacket penetrations such as hangers, instrumentation, control devices, and damper operating rods, fill voids in insulation

with vapor barrier coating. Brush a coat of vapor barrier coating where required on ducts. Provide vapor barrier jacket continuous across seams, reinforcements, and projections. Where height of projections is greater than insulation thickness, carry insulation and jacket over projection. For joints for heating only systems, provide insulation with two coats of fire resistant adhesive with glass fabric mesh embedded between coats.

F. Moisture Seal:

1. Provide a vapor (moisture) seal where insulation terminates against metal hangers, anchors and other projections through insulation on surfaces for which a vapor seal is specified. Keep insulation dry during application of finish. Bevel and seal edges of exposed insulation.

3.04 ENGINE EXHAUST PIPING AND MUFFLER INSULATION:

A. Calcium Silicate Insulation:

1. Insulation shall be secured with not less than 3/8-inch width fibrous glass reinforced waterproof tape or Type 316 stainless steel bands spaced not more than 8 inches on center. A stainless steel jacket encasing the insulation shall be provided. The stainless steel jacket shall have a minimum thickness of 0.016 inches, a factory-applied polyethylene and kraft paper moisture barrier on the inside surface. The jacket shall be secured with not less than 1/2-inch wide stainless steel bands, spaced not less than 8 inches on centers. Longitudinal and circumferential seams of the jacket shall be lapped not less than 3 inches. Jackets on horizontal piping shall be installed so that the longitudinal seams are on the bottom side of the pipe. The seams of the jacket for vertical piping shall be placed on the off-weather side of the pipe. On vertical piping, the circumferential seams of the jacket shall overlap so the lower edge of each jacket overlaps the upper edge of the jacket below.

3.05 FIELD QUALITY CONTROL:

- A. Except as otherwise permitted herein, Mechanical systems shall be cleaned and tested prior to application of insulation. Obtain Engineer's approval of systems before applying field insulation. Visually inspect to ensure that insulation materials provided conform to Specifications. Inspect installation of insulation for compliance with requirements.

3.06 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.



TABLE 23 07 00-1 INSULATION MATERIAL FOR PIPING					
Service	Material	Spec	Type	Class	Vapor Barrier Required
Refrigerant Suction Piping (35°F nominal)	Flexible Cellular	ASTM C 534	I		No
A/C Condensate Drain Located Inside Building	Flexible Cellular	ASTM C 534	I		No

TABLE 23 07 00-2 PIPING INSULATION THICKNESS (INCH)						
Service	Material	Tube and Pipe Size				
		1/4 - 1 ¼	1 1/2-3	3 1/2-5	6-10	11-36
Refrigerant Suction Piping (35°F nominal)	Flexible Cellular	0.5	1	1	1	1
Metallic A/C Condensate Drain Located Inside Bldg.	Flexible Cellular	0.5	0.5	0.5	0.5	0.5

TABLE 23 07 00-3

INSULATION AND THICKNESS (INCHES) FOR ENGINE EXHAUST PIPING AND MUFFLERS

		<b>OUTSIDE DIAMETER (INCHES)</b>				
Service & Surface Temperature Range (Degrees F)	Material	1/4 -1-1/4	1 1/2-3	3 1/2-5	6-10	11-36
Generator Exhaust Piping and Muffler	Calcium Silicate ASTM C533 Type I or II	3	3.5	4	4	4

END OF SECTION

**DIVISION 26 – ELECTRICAL**

## SECTION 26 05 10

### ELECTRICAL WORK – GENERAL

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Provide complete and operational systems for both normal and standby electric power systems, normal and emergency lighting systems, grounding systems, and other specified systems, including the installation and wiring of miscellaneous equipment and devices. Perform all Work and testing as indicated and specified to provide operationally ready electrical systems.
1. Provide conduit, wiring and connections for power, motors, motor controllers, control devices, lighting, control panels, instrumentation, and alarms and for equipment furnished by others as indicated on the contract drawings.
  2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction. Perform work at the convenience of the Owner.
  3. Engage the services of an Independent Electrical Testing Firm to perform the field inspections, tests and adjustments specified in Section 26 08 13.
  4. Provide the services of a specialty firm to provide short circuit, coordination study and Arc Flash analysis for the electrical distribution system in accordance with Section 26 05 70.
  5. Install all raceways and equipment to meet the seismic requirements indicated on the contract structural drawings. Raceways supports and equipment anchoring shall be provided as specified in Section 26 05 33.
  6. All electrically powered equipment and devices provided under other specification sections are connected to electrical systems as part of the Electrical Work. Provide all conduits, wiring and wiring terminations as indicated.
  7. Provide all supervision, labor, materials, tools, test instruments or other equipment or services and expenses to test, adjust, set, calibrate, functionally and operationally check all Work and components of the various electrical systems and circuitry throughout the installation.
  8. The Diesel Generator system shall be supplied under Section 26 32 13. Provide all conduit, wiring, terminators, etc. as required for system operation as shown on the contract electrical drawings.

9. The equipment enclosure classification of the facility is indicated on the contract electrical drawings. Provide all equipment, devices and material meeting the requirements for these area classifications unless otherwise noted or specified.
  10. Furnish and install all conduit and wiring between motor operated doors and windows and their control stations.
  11. Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other Divisions of the Specifications.
- B. Provide, set up, and maintain all derricks, hoisting machinery, staging, and planking and perform all hoisting required to complete the Electrical Work.
  - C. Obtain all necessary permits required to complete the work of Section 26 – Electrical Work.
  - D. Submit short circuit and coordination study for review and acceptance prior to submittal of distribution equipment and devices.

#### 1.02 SEQUENCING AND SCHEDULING

- A. Coordinate electrical equipment installation with other building components.
- B. Arrange for chases, slots and openings in the building structures during the progress of construction to allow for the electrical installation.
- C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work.
- E. Coordinate the installation of large equipment prior to closing in the building.
- F. In addition to manufacturer's equipment shop drawings, submit electrical installation work drawings containing the following:
  1. Concealed and buried conduit layouts, shown on floor plans drawn at not less than  $\frac{1}{4}$ -in = 1-ft-0-in scale. The layout shall include locations of process equipment, motor control centers, transformers, panelboards, control panels and equipment, motor, switches, motor starters, large junction or pull boxes, instruments and any other electrical devices connected to concealed or buried conduits.

2. Plans shall be drawn on high quality reproducible, size 36-in. by 24-in. and shall be presented in a neat, professional manner.

### 1.03 REFERENCES

- A. National Electrical Safety Code (NESC)
- B. Occupational Safety and Health Administration (OSHA)
  1. OSHA Part 1910; Subpart S, 1910.308
  2. OSHA Part 1926; Subpart V, 1926.950 through 1926.960
- C. National Fire Protection Association (NFPA)
  1. ANSI/NFPA 70B: Electrical Equipment Maintenance
  2. NFPA 70E: Electrical Safety Requirements for Employer Workplaces
  3. ANSI/NFPA 70: National Electrical Code
  4. ANSI/NFPA 101: Life Safety Code
- D. National Electrical Manufacturers Association (NEMA)
- E. American National Standards Institute (ANSI)
  1. ANSI C2: National Electrical Safety Code
  2. ANSI Z244-1: American National Standard for Personnel Protection
- F. Insulated Cable Consultants Association (ICEA)
- G. Instrument Society of America (ISA)
- H. Underwriters Laboratories, Inc. (UL)
- I. Factory Mutual (FM)
- J. International Electrical Testing Association (NETA) – Acceptance Testing Specification for Electric Power Distribution Equipment and Systems (STD)
- K. Institute of Electrical and Electronics Engineers (IEEE)
- L. Delaware Electrical Code
- M. National Electric Code

N. All inspections and tests shall utilize the following references:

1. Project Design Specifications
2. Project Design Drawings
3. Project Short Circuit, Coordination and Arc Flash Study
4. Manufacturer's shop drawings submittals and instruction manuals applicable to each particular apparatus

#### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00.

1. Shop Drawings and Data: Include manufacturer's drawings, bills of material, panel and equipment layouts, catalog data, schematics diagrams, interconnection diagrams, wiring diagrams and other documentary or descriptive information for each assembly submitted in one package.
  - a. Bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or identification on all other drawings where item appears.
  - b. Submit equipment installation instructions in separate submittals from other shop drawings.
  - c. Mark shop drawings and data submitted showing and annotating only items applicable to this specific contract.
  - d. Make submission of drawings for those components where dimensions of equipment and location of conduit entrances are required to facilitate construction in accordance with the construction schedule.
  - e. Include one-line diagrams, schematic diagrams, wiring diagrams, control sequence diagrams, relay diagrams, and metering. Submit only completed drawings showing all local and remote devices associated with each item. Submit one complete package of shop drawings. Partial submittals will be returned without action.
  - f. Submit time-current characteristic curves for all circuit breakers and fuses.
  - g. Submit instruction manuals for installation, operation, and maintenance of equipment, and parts list. Mark standard publications showing only





- l. Lightning Protection Systems
- m. Control Stations
- n. Enclosures
- o. Control Panels
- p. Safety Switches
- q. Electric Heating Units and Accessories
- r. Mats
- s. Motor Controls
- t. Field Acceptance Test Reports
- u. Record Drawings

#### 1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00.
- B. Install electrical Work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and in accordance with requirements of State and Local Codes.

#### 1.06 INTERFERENCE AND ERRONEOUS LOCATIONS

- A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.
- B. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.
- C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

#### 1.07 SEISMIC REQUIREMENTS

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20 and as specified herein.
- B. All raceways and equipment installed under Division 26 shall utilize earthquake resistant supporting systems as specifically required in each applicable section.

## 1.08 APPROVAL AND MARKING EQUIPMENT

- A. All devices and materials shall be listed and/or labeled by Underwriters Laboratories, Inc., wherever standards have been established by that agency. Where Underwriters Laboratories listing is not available for equipment, submit certified test reports of recognized, independent testing laboratory, approved by the local inspecting authority, indicating that equipment is in conformance with local code requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.
- B. Mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other information on a nameplate.

## 1.09 ELECTRICAL SYSTEM STUDIES

- A. Provide electrical system studies as specified in Section 26 05 70. The specialty firm performing the study shall have no contractual or business ties with the electrical distribution system supplier.
- B. The electrical system protection trip settings resulting from the study shall be provided to the electrical testing firm specified under Section 26 08 13 to adjust and set the electrical system parameters in the field.
- C. The Arc Flash Labels shall be generated by the specialty firm under Section 26 05 70 and installed in the field under Division 26.

## 1.10 ELECTRIC SERVICE

- A. The electrical power system for the facility will be stepped down using one (1) pad mounted transformer to facility operating voltage of 480/277 volt, 3-phase, 4 wire, 60 Hertz.
  - 1. The electrical low voltage distribution system that operates on 208/120 volt, 3-phase, 4 wire, 60 Hertz obtained from the power system by dry-type step down transformer(s).
- B. Contact the following organization for coordinating the incoming power requirements for the project:

Delmarva Power  
Attn: Jocelyn Gilbert  
PO Box 9239  
Newark, DE 19714-9239  
Jocelyn.Gilbert@exeloncorp.com

- 1. The organization identified above will furnish and install:

- a. Pad-mount transformer, including metering equipment.
  - b. Primary cables up to the splice box.
  - c. Connection and terminations of all primary cables at the splice box.
  - d. Metering equipment
2. The following shall be furnished and installed under this division.
- a. Concrete pad for transformer.
  - b. Primary and secondary concrete encased ductlines.
  - c. Primary cable between the splice box and utility transformer and Secondary cables of sufficient length for termination at the transformer.
  - d. Connection and terminations of all secondary cables at the service transformer.
  - e. Grounding at pad.
  - f. Metering equipment
3. The following will be furnished under this division and installed by the organization identified above:
- a. Connection and terminations of primary cable between the splice box and utility transformer
- C. Include an allowance of \$ \_\_\_\_ to cover the cost of power company's charges and fees for providing service. If the total cost of such charges is greater or less than the allowance, a debit or credit of difference in cost will be made to Owner.
1. Perform all work in accordance with power company's requirements and in manner approved by power company.
  2. Notify power company, in writing, within two weeks after the contract award date concerning incoming service requirements.
- D. Electrical Work for low voltage system includes generator, transformers, panelboards, raceways, wiring, fittings, fixtures, receptacles, switches, and other appurtenances for completion and operation of system.

- E. Obtain the available short circuit current at the service connection from the power company. Provide this information to the firm performing the short circuit and coordination study under Section 26 05 70.
- F. Earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for electrical work under this contract shall conform to requirements specified under applicable sections of the Contract for General Construction.
- G. The final, complete installation shall comply with all state and local statutory requirements having jurisdiction. The Contractor shall arrange for all necessary permits, pay all fees and arrange for all required inspections by local authorities. In general, all work shall comply with the requirements of the National Electrical Code, all state and local codes and ordinances.

#### 1.11 COOPERATION AND COORDINATION WITH OTHER TRADES

- A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow efficient completion of the project. Materials and equipment shall be installed as fast as conditions will permit and installed promptly.
- B. Furnish to all other trades advance information on location and size of all concrete pads, chases, frames, boxes, sleeves, and openings needed for the Work, and also furnish layout information and shop drawings necessary to permit other trades affected by the Work to install their work properly coordinated and without delay.
- C. Where there is evidence that Work installed interferes with the work of other Sections, assist in working out space conditions to make satisfactory adjustments.
- D. If work is installed before coordinating with other trades so as to cause interference with the work of such trades, make all necessary changes in Work under this Section.
- E. Protect all materials and work of other trades from damage that may be caused by the Work required under this Section and be responsible for repairing any damages caused by such work.
- F. Follow Drawings in layout work. Check drawings of, and coordinate with, other trades to verify special provisions, installation requirements and spaces in which Work provided under this Section of the Specifications will be installed. Maintain maximum headroom or space conditions at all points. Where headroom or space conditions appear inadequate, notify the Construction Manager and the Architect/Engineer before proceeding.
- G. Prepare and submit for acceptance coordination drawings consisting of 1/4 inch = 1 foot-0 inches scale or larger working plans and sections, clearly showing how this Work is to be installed in relation to the work of other Sections. Coordination drawings shall be

based upon accepted equipment submittals. Prepare backgrounds for coordination drawings for all buildings in this contract, and indicate all process piping where applicable. These coordination drawings shall be used to work out the coordination of all work of all trades as specified in each applicable Section. Show and coordinate the Work of this Section on said coordination drawings.

#### 1.12 HAZARDOUS AREAS

- A. Equipment, materials and installation in areas designated as hazardous shall comply with NEC Articles 500, 501, 502 and 503.
- B. Equipment and materials installed in hazardous areas shall be UL listed for the hazardous area classification.

#### 1.13 CODE, INSPECTION AND FEES

- A. Equipment, materials and installations shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all permits and arrange for all inspections.

#### 1.14 TESTS AND SETTINGS

- A. Test systems and equipment furnished under Division 26 and replace all defective Work and equipment at no additional cost. Refer to the individual equipment sections and Section 26 08 13 for additional specific testing requirements. Employ the services of an Independent Testing Company, other than the manufacturer of the electrical distribution system, to perform the tests specified.
- B. Field testing and commissioning shall be performed in accordance with the latest revisions of NETA Standard ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" and Section 26 08 13.
- C. A typed test report for each component tested shall be submitted. The firm doing the testing shall include, in the report, their opinion whether or not the equipment being tested complies with the specification. Any discrepancies shall be noted in the concluding summary of the report. Test report forms shall be in compliance with NETA standards. Five complete copies shall be provided. Reports shall be signed by the person in charge of the field testing, an officer of the firm performing the tests and an officer of the Contractor.
- D. In addition to the specific testing requirements listed in the individual sections, the following tests and settings shall be performed:

1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for operation.
2. Check the full load current draw of each motor. Check ampere rating of thermal overloads for motors and submit a typed record of the same, including driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.
3. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.
4. Check settings of the motor circuit protectors. Adjust settings to allow the motor to be started when under load conditions.
5. Check motor nameplates for correct phase and voltage.
6. Check rotation of motors prior to testing the driven load.
7. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function as indicated by control schematic and wiring diagrams.
8. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.

#### 1.15 INTERPRETATION OF DRAWINGS

- A. Coordinate the conduit installation with other trades and the actual supplied equipment. Coordinate equipment conduits top and/or bottom entries as required for the equipment installation and as specified and indicated on the contract drawings.
- B. Install each 3-phase circuit in a separate conduit unless otherwise indicated.
- C. Provide and install all conduits and wiring system as indicated on the contract electrical drawings. Conduits shall not be combined unless otherwise indicated on contract electrical drawings.
- D. Conduit shall be installed exposed unless otherwise requested
- E. All fittings and boxes shall be provided for a complete raceway installation.
- F. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installations.

- G. Except where dimensions are shown, the locations of equipment, fixtures, and outlets indicated are approximate only. Obtain information relevant to the placing of electrical Work and in case of any interference with other Work.
- H. Circuit layouts are not intended to show the number of fittings, pull boxes, or other installation details. Furnish all labor and materials to install and place in operation all power, lighting and other electrical systems indicated.
- I. Interconnection descriptions are indicated in their Riser Diagrams as indicated. Provide raceways and conductors, as required by the system manufacturer, for a complete and operating system.
- J. Raceways and conductors for lighting, switches, receptacles, and other miscellaneous low voltage power and signal systems as specified are not indicated. Raceways and conductors shall be provided for lighting, switches and receptacles for a complete and operating system.

#### 1.16 PHASE BALANCING

- A. The contract electrical drawings do not attempt to balance the electrical loads across the phases. Circuits on panelboards shall be field connected to result in evenly balanced loads across all phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 26 05 20.

#### 1.17 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling.
- C. Equipment shall not be physically larger than what is shown on the contract drawings.

#### 1.18 EQUIPMENT IDENTIFICATION

- A. Identify equipment specified under Division 26 with the name of the equipment it serves. Control panels, panelboards, junction or terminal boxes shall have nameplate designations as indicated. Equipment nomenclature and identification system shall be as specified herein.
- B. Nameplates shall be engraved, laminated plastic, 1/16-in. thick by 3/4-in by 2-1/2-in. with 3/16-in. high white letters on a black background.

- C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using a waterproof epoxy adhesive. Two sided foam adhesive tape shall not be used. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

## PART 2 – PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.01 METERING EQUIPMENT

- A. Install metering equipment as follows:
  - 1. Obtain from power company drilling templates, dimensions, and mounting arrangements for metering transformers. Transmit this information to electrical equipment manufacturer for cutting and drilling.
  - 2. Ensure that metering equipment installation shall be in accordance with requirements of power company by submitting drawings, sketches, catalog information and other appropriate material for power company approval.

### 3.02 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Store equipment in compliance with manufacturer's recommendations and as specified herein.
- B. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.
- C. Do not store equipment outdoors.
- D. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

### 3.03 DEFECTIVE OR DAMAGED EQUIPMENT

- A. Damaged equipment shall not be used. Equipment damaged in shipment, storage, installation or through other means shall be replaced without additional cost.
- B. All equipment showing signs of damage shall be rejected regardless of dielectric test results.



- C. All electrical equipment is considered “in storage” regardless of location until first energized. Manufacturer’s recommendations for storage precautions, conditions and care shall be followed.
- D. Equipment that is found to be damaged or failed the field inspection and acceptance tests specified under Section 26 08 13 shall be replaced at no additional cost.

### 3.04 STARTING EQUIPMENT DATA LIST

- A. Obtain data from the equipment supplier shop drawing submittals or equipment nameplates, and prepare a complete tabulation of all motors over 1/3 hp, electric heaters over 1 kW, air conditioning units and starting equipment, to be furnished on the project.
  - 1. Include in tabulation form the following information:
    - a. Name and identification of equipment.
    - b. Manufacturer.
    - c. Horsepower or kilowatt rating.
    - d. Voltage.
    - e. Phase.
    - f. Speed.
    - g. Full load current.
    - h. Locked rotor current or code letter.
    - i. Type of enclosure (open drip-proof, totally enclosed, fan cooled, etc.).
    - j. NEMA size of starter or contactor.
    - k. Overload heater size.
    - l. Type of starter (full-voltage, reduced-voltage, autotransformer, etc.).
    - m. Breaker trip setting or fuse size.
    - n. Voltage of starter operating coil.
  - 2. Final acceptance of the electrical system is contingent upon submittal of the complete motor and equipment tabulation.
  - 3. Arrange tabulation in groups by building location.

4. Furnish six copies of the tabulation to the Construction Manager for Architect/Engineer review when a submission is made.

### 3.05 EQUIPMENT ENCLOSURE

- A. The equipment enclosure classification of the building areas are indicated within the Area Classification Schedule shown on the contract electrical drawings. Provide all equipment, devices, installations and material meeting the requirements of this schedule.

### 3.06 RECORD DRAWINGS

- A. At the completion of the Project, provide two sets of contract drawings that are marked to show the as-installed equipment, devices, conduits, underground duct lines locations, layouts, wiring and any revisions to the contract drawings that occurred during construction. As-built drawings shall be complete and provide a detailed and accurate representation of as installed field conditions of all equipment provided under this contract.

### 3.07 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions. Locate all slots for Electrical Work and form before concrete is poured.
- B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from the equipment vendors and locate the concealed conduit before the slab is poured.
- C. Seal all openings, sleeves, penetrations and slots as specified in Section 26 05 33.

### 3.08 CUTTING AND PATCHING

- A. Arrange installation of all Work such that cutting and patching is not required.
- B. Do not cut joints, beams, girders, columns or any other structural members.

### 3.09 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 05 13

### MEDIUM VOLTAGE CABLE

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Furnish and install all medium voltage cables and accessories, as indicated and specified.
- B. Perform tests on installed cables in accordance with Section 26 08 13.
- C. Provide pulling calculations performed on a commercially available computer program for all medium voltage cables to be installed. Submit as specified prior to installation of all associated raceway system components.

##### 1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Division 26: Electrical

##### 1.03 REFERENCES:

- A. Medium voltage cables shall meet or exceed the specifications and requirements of the latest Insulated Cable Engineers Association (ICEA) and the Association of Edison Illuminating Companies (AEIC) publications, except as modified by this Section.
- B. Ethylene-propylene rubber (EPR) insulated cable shall meet or exceed ICEA S-68-516/NEMA WC-8 and AEIC CS-6.
- C. Cables shall comply with Underwriters Laboratories (UL) Standard 1072.
- D. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the International Electrical Testing Association (NETA Standard ATS) unless otherwise modified by this Section.
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- F. Delaware Electrical Code.

1.04 SUBMITTALS:

- A. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - 1. Failure to include a copy of the marked-up specification sections will result in return of the entire submittal without further review and consideration until the mark-up specification are resubmitted with the entire package.
- B. Submit the following after award:
  - 1. Submit shop drawings and manufacturer's product data for all cables, terminations, lugs, connectors, identification tags, etc. in accordance with the requirements of Section 26 05 10.
  - 2. Submit cable pulling calculations for medium voltage feeders prior to their installations. The pulling calculations shall include the submitted cable manufacturer data with maximum pulling tension and maximum sidewall pressure.
  - 3. Factory and field test reports.

1.05 QUALITY ASSURANCE:

- A. The general construction of the cable and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities.
- B. Upon request, submit a copy of his Quality Assurance Manual detailing the quality control and quality assurance measures in place at this facility.
- C. Cable shall be UL listed as Type MV-105.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

- A. Okonite
- B. Pirelli
- C. Southwire
- D. Or equal.

## 2.02 GENERAL:

- A. The manufacturer's name, the voltage class, type of insulation, thickness of insulation, conductor size, UL listing and date of manufacture shall be printed on the jacket.
- B. Cables shall be suitable for use in partially submerged wet locations, in non-metallic or metallic conduits, underground duct systems, cable trays and direct buried installation.
- C. Cables shall be able to operate continuously at 105 degrees C conductor temperature, with an emergency rating of 130 degrees C and a short circuit rating of 250 degrees C. Emergency overloads shall be possible for period of up to 100 hours. Five 100 hours emergency overload operations within the life time of the cable shall be possible.
- D. Medium voltage cable shall be shielded.
- E. Medium voltage cables shall have the following physical characteristics in accordance with ICEA, AEIC and UL standards:
  - 1. Conductors: Aluminum per ASTM B-609, Class B stranded per B-231.
  - 2. Insulation: Thermosetting ethylene propylene rubber (EPR) compound over an extruded, non-conducting high dielectric stress control layer, with a semi-conducting shield applied directly over the primary insulation. The base elastomer shall have a maximum ethylene content of 72 percent by weight and shall contain no polyethylene. The semiconducting layers and insulation shall be applied using a triple extrusion process.

## 2.03 CABLE RATINGS AND TYPE

- A. Cable type: Single conductor, aluminum, shielded MV-105.
- B. Insulation level: 15 kV – 133 percent, 110 kV BIL.
- C. Operating voltage; 13,200 Volts, 3 Phase, 60 Hz, grounded distribution system.

## 2.04 CABLE SHIELDING SYSTEM

- A. Insulation Shield
  - 1. The insulation shield shall consist of a layer of black semi-conducting material extruded directly over the insulation.

B. Metallic Shield

1. 5 mil copper tape helically applied with a nominal 25 percent overlap.

C. Cable Jacket

1. Provide an overall, moisture, heat, abrasion, UV and ozone resistant jacket over the metallic shield. Jacket material shall be polyvinyl chloride (PVC).

2.05 CABLE ACCESSORIES

A. General

1. Cable termination and splicing material shall be as manufactured by Raychem; 3M Corp.; Elastimold or equal. All material used in terminating and splicing medium voltage cables shall be as recommended by the cable manufacturer. Cables shall be terminated and spliced in accordance with the kit supplier's drawings.
2. Cable terminations shall meet or exceed IEEE Standard 48, Class I requirements.
3. EP insulated cable splices shall be hand wrapped and shall meet or exceed the requirements of ANSI C119.1 and IEEE 404.
4. Cable accessories shall be by one manufacturer to assure adequate installer training and application assistance.
5. The manufacturer shall be able to document a minimum of 5 years successful field experience as well as demonstrating technical life assessment as requested. The manufacturer shall establish and document a Quality Assurance Program implementing suitable procedures and controls for all activities affecting quality. The program shall provide documentation that verifies the quality of production joint kits and traceability back to inspection records, raw material and the original designs and design proof tested joints.

B. Indoor Cable Termination

1. Single conductor shielded cable terminations for indoor applications shall be one piece, track resistant EPDM rubber with top seal and ground strap assemblies.
2. Termination shall have a current rating equal to, or greater than the cable ampacity.

3. Termination shall accommodate any form of cable shielding or construction without the need for special adapters.
4. Acceptable products:
  - a. 3M Corp. Quick Term II, 5620K Series.
  - b. Raychem Corp., HVT Series.
  - c. Elastimold, 35 MTG Series.
  - d. Or equal.

C. Outdoor Cable Terminations

1. Single conductor shielded cable terminations for outdoor protected or exposed locations shall be one piece, track resistant silicone rubber with top seal, rain skirt and ground strap assemblies. Cable compartments of outdoor metal clad switchgear shall be considered as outdoor locations.
2. Termination shall have a current rating equal to, or greater than the cable ampacity.
3. Termination shall accommodate any form of cable shielding or construction without the need for special adapters.
4. Acceptable products:
  - a. 3M Corp. Quick Term II, 5630K Series.
  - b. Raychem Corp., HVT Series.
  - c. Elastimold, 35 MTG Series.
  - d. Or equal.

D. Heat Shrinkable Bus Connection Kits

1. Bus kits shall be capable of insulating bus bars 2-in to 6-in wide and for connection of 1 to 4 cables. Kits shall electrically insulate and environmentally seal the connection and be easily re-enterable.

2. Cable-to-bus bar connection kits shall be rated up to 15 kV class and tested in accordance with ANSI C37.20c, Section 5.2.1.4. Test for Bus Bar Insulation and Section 5.2.9 Flame-Retardant Test for Applied Insulation. Kits shall be manufactured by Raychem Corp.; 3M Corp.; Elastimold; or equal.

E. Medium Voltage Heat-Shrinkable Motor Connection Kits.

1. Motor connection kits shall insulate the motor feeder motor lead connection and allow installation within the motor conduit box.
2. Kits shall environmentally seal the connection and be easily re-enterable. Kits shall be as manufactured by Raychem; 3M Corp.; Elastimold; or equal.

F. Cable end caps shall be heat shrinkable polyolefin, as manufactured by 3M Corp.; Raychem; Elastimold; or equal.

G. Lugs and Connectors

1. Copper lugs and connectors shall be crimped with standard industry tooling. All connections of copper stranded wire in sized No. 6 AWG through 1000 kcmil shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements. Lugs larger than 4/0 AWG shall be two-hole lugs with NEMA spacing. The lugs and connectors shall be rated for operating through 35 kV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

H. Electrical Grounding Braid

1. Conducting metal braid shall be woven from 240 strands of 30 AWG tinned copper wires and be capable of carrying fault current comparable to that of 6 AWG copper wire.

I. Cable Marking Systems

1. A 7-mil, flame retardant, cold and weather-resistant vinyl plastic electrical tape shall be used for phase identification.
2. Cable tags shall be heat stamped nylon secured by polypropylene cable ties.

## 2.06 PULLING COMPOUNDS

- A. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.



- B. Acceptable manufacturers are Ideal Company; Polywater, Inc.; Cable Grip Co. or equal.

## 2.07 SHOP TESTING

- A. Perform manufacturers standard production testing and inspection in accordance with Section 6 of the referenced ICEA standards. If requested by the Authority, the manufacturer shall submit certified proof of compliance with ICEA design and test standards.
- B. Provide certified test reports indicating that the cable has passed the following tests:
  - 1. Partial Corona Discharge Test in accordance with AEIC CS5/6, Section G.
  - 2. Vertical tray flame test in accordance with IEEE 1202.
- C. After completion of the factory tests, individual pulling eyes shall be installed on single or triplexed conductor length of cable. Pulling eyes shall be suitable for maximum allowable pulling tension on the conductors and they shall be sealed against entrance of water.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Determine the cutting lengths, reel arrangements and total lengths of cable required and shall furnish this data to the cable manufacturer as soon as possible to assure on-time delivery of cable.
- B. Make sure of the field engineering services available from the cable manufacturer.

### 3.02 INSTALLATION

- A. Cable Installation
  - 1. When temperature is below 50 degrees F, cable reels shall be stored at 70 degrees F for at least 24 hours before installation.
  - 2. Do not exceed manufacturer's recommendations for maximum pulling tensions, sidewall pressure, and minimum bending radii.
  - 3. Pull cables from direction that requires the least tension.

4. Feed cables into raceway with zero tension and without cable crossover at raceway entrance.
5. Cable splices are not permitted unless approved by the Engineer and the Owner.

B. Terminating

1. The work area shall be kept warm, dry and ventilated during splicing and terminating of the cables.
2. Terminating shall be performed by electricians having at least 80 hours of formal training and a minimum of 5 years field experience in this type of work.
3. Prepare cables in accordance with splice or termination kit manufacturers installation details.
4. Maintain shield continuity around splices. Bond cable shields at each terminal or splice location.
5. Install a neoprene tape wrap around each splice and bonding jumper to provide a watertight environmental seal.
6. Insulate and seal each cable-to-bus termination with heat shrinkable bus connector kits.

C. Electric Arc and Fire Proofing

1. In exposed locations where threat of fire exists or communicated fault can occur, wrap medium voltage cables with one half-lapped layer of arc and fireproofing tape approved by the cable supplier. Tape shall be secured with a two-layer band of glass electrical tape over the last wrap approved by the cable supplier.

D. Marking and Identification

1. Plastic nameplates shall be installed in each pull box and at splice and terminating points. These nameplates shall show the phase and feeder designations and the date when the cable was installed or splice or termination was made. The feeder designation shall be as indicated. Nameplates shall be tied to each cable with self-locking nylon ties.

### 3.03 FIELD TESTING

- A. Perform field testing in accordance with Section 26 08 13 and as specified herein.

- B. Engage the services of a recognized independent testing firm to inspect and test the installed cables prior to energization. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Provide at least two weeks notification prior to scheduling any testing.
- C. Equipment testing and inspection shall be performed in accordance with NETA Standard ATS and shall include the following:
  - 1. Visual and mechanical inspection.
  - 2. Shield continuity test.
  - 3. Insulation resistance test.
  - 4. DC Hipot test per IEEE Standard 400.
- D. Submit certified copies of the test results and leakage plots in accordance with Section 01 33 00 within 5 days of completion of the tests.
- E. Immediately notify the Engineer and do not energize the cables if any of the following conditions occur:
  - 1. Cable damage.
  - 2. Improper installation or grounding.
  - 3. Shield discontinuity or high resistance.
  - 4. Dielectric absorption ratio and polarization index below 1.5.
  - 5. Abnormal plot of leakage current versus voltage.
- F. Defective or Damage Cables
  - 1. The Owner shall make sole determination of the acceptability of the cables based on the submitted test reports. Do not energize cables until the test reports have been reviewed and approved.
  - 2. If, in the opinion of the Owner, the cables or terminations or splices are determined to be damaged or defective, provide the following remedial actions at no additional cost.
    - a. Remove splices and terminations and completely re-test the cables to determine whether the cables are damaged or defective.

- b. Remove and replace damaged or defective cables as directed by the Owner.
- c. Remake terminations and splices with new kits.
- d. Completely re-test cable, splices and terminations in accordance with Paragraph 3.03C above.

END OF SECTION

## SECTION 26 05 20

### ELECTRIC WIRES AND CABLES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide wires, cables, termination and identification materials for complete electrical systems, as indicated and specified.
- B. Perform tests on installed wire and cables in accordance with Section 26 08 13.
- C. Provide fire stops for all electrical penetrations routed through fire rated walls and floors.

##### 1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. B3: Soft or Annealed Copper Wire.
  - 2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - 3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. Delaware Electrical Code.
- C. National Fire Protection Association (NFPA):
  - 1. NFPA-70: National Electrical Code (NEC).
- D. Underwriters Laboratories, Inc. (UL):
  - 1. UL 44: Wires and Cables Rubber Insulated.
  - 2. UL 83: Wires Thermoplastic-Insulated.
  - 3. UL 854: Cables, Service Entrance.
  - 4. UL 1479: Fire Tests of through Penetration Firestops.
- E. National Electrical Manufacturers Association (NEMA):
  - 1. ICEA S-61-4021/WC 5: Thermoplastic Insulated Wire & Cable.
  - 2. ICEA S-66-524/NEMA WC7; Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable

3. ICEA S-68-516/WC 8: Ethylene-Propylene-Rubber-Insulated Wire & Cable.

#### 1.03 PRODUCT HANDLING

- A. Comply with the requirements specified in Section 011006.
- B. Products shall be shipped, stored and handled in a manner consistent with the written recommendations of the manufacturer and as to not to degrade quality, serviceability or appearance. All products delivered to the project site shall be accompanied by test reports certifying that the pipe conforms to the ASTM specifications listed herein. Any unit found to be defective either before or after installation shall be removed from the project site and replaced with a sound unit.
- C. If stored for more than two weeks, the materials shall receive all maintenance considerations required by the manufacturer for proper storage of the materials.

#### 1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.
  - 2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
    - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.
  - 3. Submit the following data for fire stop material:
    - a. Manufacturer's Listed Systems Designs.
    - b. Manufacturer's Product Data Sheets.
    - c. Manufacturer's Materials Safety Data Sheets.
    - d. Manufacturer's printed instructions for installation on each proposed product. Identify where each material will be used at the Project site.
    - e. Manufacturer's prefabricated devices providing descriptions for identification at the Project site.

1.05 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.
- B. Firestop Materials and Smoke Seal materials shall have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. 600 V Cable:
  - 1. Prysmian Cable Corporation.
  - 2. Okonite.
  - 3. The Rockbestos Company.
  - 4. Southwire.
  - 5. Or approved equal.
- B. Metering and Instrumentation Wire, 600 V:
  - 1. The Rockbestos Company.
  - 2. Okonite.
  - 3. Prysmian Cable Corporation.
  - 4. Or approved equal.
- C. Cable Fireproofing Tape:
  - 1. MAC Products, Inc.
  - 2. 3M Company.
  - 3. Thomas & Betts Company.
  - 4. Or approved equal.
- D. Fire Stop Material and Barriers:
  - 1. Nelson Fire Stop Products.
  - 2. Dow Corning Corporation.

3. 3 M Company.
4. Or approved equal.

## 2.02 MATERIALS AND COMPONENTS

- A. Material and stranding of conductors to conform to ASTM B3, ASTM B33, and to ASTM B8.
- B. Uncoated, soft or annealed copper wire conforming to ASTM B3.
- C. Wires and Cables for Maximum 600 volt power: Furnish copper conductors. For No. 8 AWG and smaller, provide THWN/THHN type cable. Provide No. 6 AWG and larger as XHHW/2. Provide No. 12 AWG and No. 10 AWG as solid conductor. Provide No. 8 AWG and larger as stranded conductor. Provide wires and cable conforming to UL 83.
- D. Wires and Cables for Maximum 600 volt control, indicating, metering, or alarm circuits: Furnish copper conductors, type THWN/THHN stranded, rated 75 C with thermoplastic insulation and nylon jacket. Provide wires and cable conforming to UL 83.
- E. Shielded Cable for Instrumentation Wiring: Provide 7-strand tinned copper conductors, size No. 16 AWG. Insulate conductors individually with color coded polyethylene or polyvinylchloride. Twist pairs twisted with varying lay (if more than one pair) and cover with cable tape and copper or aluminum coated Mylar shielding tape and tinned copper drain wire. Jacket shall be polyvinylchloride. Cables shall be rated 600 volts and 90 degrees C.
- F. Category 6 (CAT6) Cable: Category 6 cable shall consist of 4 twisted pairs of different lay and ground wires, enclosed by an overall conductive Mylar backed aluminum foil shield. This shall be enclosed by an overall thermoplastic jacket. The cable shall meet the applicable requirements of ANSI/TIA/IEA-568-B.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Provide all material, equipment, and labor to install the electric wire and cables as indicated and as specified.
- B. Perform work in accordance with the Delaware Electrical Code.
- C. Provide power cable identification as follows:



System

<u>Voltage</u>	<u>Neutral</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>
208/120V	White	Black	Red	Blue
240/120V	White- Gray Stripe	Black- Blue Stripe	Red- Blue Stripe	None
480/277V	Gray	Brown	Orange	Yellow

- D. Use green to identify insulated ground conductors.
- E. NOTE: Colored insulation, tapes or sleeves may be used to provide color coding but they must be installed on all conductors at all pull and junction boxes. Insulated ground conductors must have green insulation. Permanently identify each grounded and ungrounded conductor for each nominal voltage system at each panelboard.
- F. Provide control, indicating, metering or alarm cable identification as follows:
  - 1. AC Control Red
  - 2. DC Control Blue

3.02 INSTALLATION OF WIRING

- A. Unless otherwise indicated, use no conductor smaller than No. 12 AWG for power, No. 14 AWG for control, and No. 16 AWG for shielded applications.
- B. Install conductors continuous from outlet to outlet and make no splices except within outlet or junction boxes.
- C. Install cable in underground raceway system without splices. There shall be no splices between connection points unless otherwise indicated.
- D. Draw all conductors contained within a single conduit at the same time.
- E. Apply wire pulling compound to conductors being drawn through conduits.
- F. Use no cable bend with radius of less than eight times its diameter.
- G. Wire and cables installed without prior submittal review are subject to removal at no additional expense.
- H. Pull cables in underground conduit system without splices. Use lubricants recommended by the cable manufacturer. Do not exceed maximum pulling tension specified by the manufacturer. Use a gauge to measure pulling tension to ensure that the recommended limit is not exceeded.

- I. Wrap cables in manholes and handholes on an individual cable basis with fireproof tape 2 inches wide. Extend fireproofing 1 inch into any duct. Install tape in accordance with manufacturer's instructions.

### 3.03 CONDUCTOR IDENTIFICATION

- A. Label each wire at both termination points. Label each wire at each end using numbering system consisting of equipment tags, terminal numbers and circuit number where wire is coming from. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards. Random numbering labels similar to what is used for "Quick Pulls" type wiring shall not be acceptable.
- B. Identify each wire in junction boxes, cabinets, and terminal boxes where total number of control, indicating, and metering wires is three or more and no terminal board is provided, including all power wire. Where no termination is made use a plastic-coated, wire marker and where termination is made use a, plastic, pre-printed sleeve wire marker.
- C. In cases where terminal boards are provided for the control, indicating, and metering wires, identify all wires including motor leads and other power wires too large for connection to terminal boards, by sleeve wire markers as specified above.
- D. In manholes and handholes, identify each power wire by laminated plastic tag with "to" and "from" destinations identified. Tags shall be located to be visible. Control wires to be bundled and marked with "to" and "from" destinations identified.

### 3.04 CONNECTORS, TERMINAL LUGS AND BOARDS

- A. For wiring of circuits consisting of No. 10 or No. 12 AWG solid wires, such as for lighting branch circuits, utilize self-insulated pressure type connectors for all splices or joints.
- B. Terminate all wires connected to terminal boards, or to other similar terminals by means of ring and tongue, nylon self-insulated, tin-plated copper pressure terminals.
- C. Fabricated terminal boards shall be 600 volts and rated for 125% of the ampacity of the connected circuit. They shall have screw terminals, with white marking strips for wire identification, of the 4-, 6-, 8-, or 12-pole type.
- D. Mark terminal strips with ink or indelible pencil. Mark each wire consistently throughout entire system, using notation of wires given on manufacturer's wiring diagrams.
- E. Wire connections for which terminals are not supplied, for example, at solenoids or motor terminal junction boxes:

1. 10 AWG and smaller: Use self insulated pressure-type connectors.
2. 8 AWG and larger: Use insulated, mechanical type with set screw or follower bearing directly on the wire. Split bolt connectors are not acceptable.

3.05 FIELD CABLE TESTS

- A. Perform cable testing in accordance with Section 26 08 13.
- B. Submit results of all cable tests on forms indicating cable size, voltage, and date with name of tester and witness.

3.06 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 05 26

### GROUNDING

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Provide a single, integrated grounding system, including conductors, raceways, and connections, indicated and specified, and in accordance with the National Electrical Code (NEC) and Delaware Electrical Code and the National Electrical Safety Code.
- B. Include grounding of electric equipment enclosures, generators, transformers, ground grid systems with ground rod and water pipe connections; and structural steel.
- C. Include grounding conductors completely inter-connecting water supply pipe, ground grid, other distribution equipment, and other groundable equipment.

##### 1.02 REFERENCES

- A. American National Standards Institute (ANSI):
  - 1. ANSI C2: National Electrical Safety Code
- B. National Fire Protection Association (NFPA):
  - 1. NFPA 70: National Electrical Code
  - 2. NFPA 780: Lightning Protection Code
- C. Delaware Electrical Code
- D. American Society for Testing and Materials (ASTM):
  - 1. B3: Soft or Annealed Copper Wire.
  - 2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
  - 3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- E. Underwriters Laboratories, Inc. (UL):
  - 1. UL 44: Wires and Cables Rubber Insulated.
  - 2. UL 83: Wires Thermoplastic-Insulated.
- F. National Electrical Manufacturers Association (NEMA):

1. WC 3: Rubber Insulated Wire & Cable.
2. WC 5: Thermoplastic Insulated Wire & Cable.
3. WC 7: Cross-Linked-Thermosetting Polyethylene-Insulated Wire & Cable.
4. WC 8: Ethylene-Propylene-Rubber-Insulated Wire & Cable.

#### 1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00.

1. Submit shop drawing and manufacturers' product data in accordance with the requirements of Section 26 05 10.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.

#### 1.04 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01 43 00 and as specified.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

A. Ground Rods:

1. Erico Products Inc.
2. Galvan Electrical Products.
3. Nehring Electrical Works.
4. Or approved equal.

B. Exothermic Welding:

1. Erico Products, Inc.
2. American Brass Mfg. Co.
3. Orgo-Thermit, Inc.

4. Or approved equal.

C. Connecting Hardware:

1. American Brass Mfg. Co.

2. Thomas and Betts

3. Anderson Electric Corp.

4. Or approved equal.

2.02 MATERIALS AND COMPONENTS

A. Conductors:

1. Provide tinned copper grounding conductors, sized as indicated and as required by the NEC. Provide protection of conductors if physical damage would result from direct exposure.

2. Provide uninsulated conductors where conductors are buried in the earth or where they are embedded in the concrete.

3. In buildings, provide insulated grounding conductors with green insulation. Provide insulated grounding conductors with insulation rated at 600 volts.

B. Ground Bus:

1. Provide a 2-in. by 1/4-in. tinned copper bar with bolted type connectors as indicated.

C. Ground Rods:

1. Provide copper-clad steel or galvanized steel ground rods; type, diameter and length as indicated on drawings. Make cable to ground rod connection without passing over end of ground rod.

D. Connections:

1. Provide silicon bronze ground clamps for use on copper or brass pipes which are UL listed.

2. Provide ground clamps, for use on iron pipes, of galvanized or malleable iron, or of standard noncorrosive material.

3. Furnish ground clamps, for use on pipes, with rigid metal base providing solid contact by seating on the pipe. Do not use strap type clamps.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF GROUNDING CONDUCTORS

- A. Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.
- B. Run grounding conductors associated with direct burial cables in common trenches above or if indicated beside cables.
- C. Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.
- D. Where raceways are used to contain and protect grounding conductors, install in accordance with Sections 26 05 33 and 26 05 43.
- E. Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.
- F. Install loop type, low impedance, grounding system interconnecting all components so two grounding connections are provided for each item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.
- G. Buried and concealed ground connections are to use exothermic welding.
- H. Make accessible connections to structural members by exothermic welding process. Connections to equipment or ground bus shall be by bolted connectors.

### 3.02 INSTALLATION OF GROUND RODS

- A. Install ground rods in handholes in accordance with requirements specified under Section 26 05 43. Connect each grounding conductor entering a handhole to ground rod by exothermic weld.
- B. Install ground rods where indicated. Install the top of the rod 12 inches below the ground surface.
- C. Make connection to overall grounding system as indicated.
- D. Ensure that final resistance of interconnected ground system is 3 ohms, or less. Measure ground resistance in normally dry conditions, and not less than 48 hours after rainfall.

### 3.03 EQUIPMENT GROUNDING

- A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment with copper wire sized in accordance with Delaware Electrical Code. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600-volt insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system.
- B. Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.
- C. Connect two separate ground connections from ground grid to ground bus of switchboard assemblies. Confirm that each connection for item of equipment is from different section of ground grid.
- D. Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.
- E. Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on one end of conduit run.
- F. Connect grounding conductors from equipment in area where ground bus is required to ground bus. Connect ground bus to grounding system. Mount ground bus on pedestal insulators.
- G. Where lightning arresters are furnished with electrical equipment and grounding connections are not inherently provided, confirm that separate grounding conductor connects lightning arresters with system ground.
- H. Connect generator neutral to grounding system by a grounding conductor of size required by NEC, unless a larger size is indicated. Connect grounding conductor to generator disconnect enclosure and generator neutral on generator side of disconnect. Ground generator frame with two separate independent connections, so removal of one connection will not impair continuity of other.
- I. Ground transformers, lightning arresters, insulators and other appurtenances, installed on poles, poles and timber structures, or metal structure. Run grounding conductors between poles or structure and ground rods. Protect grounding conductor by molding applied for 8 ft. above ground, with both molding and conductor stapled. Install ground rod where indicated and driven until top of rod is 1 ft. below ground.
- J. Interconnect the water piping systems with the grounding system per the Delaware Electrical Code.



### 3.04 SIGNAL GROUNDING

- A. Ground signal surge protection and shields of twisted, shielded cable using a signal bonding conductor. The signal bonding conductor shall be a continuous path from the instrument surge protection or shield to the grounding electrode conductor. The signal bonding conductor shall be isolated from the equipment grounding conductor for its entire path.
- B. Where convenient several signal bonding conductors may be combined, providing that all the following conditions are met:
  - 1. The combined signal bonding conductor shall have the equivalent cross section of the conductors that it was combined from or three times the cross section of the largest conductor that it was combined from, whichever is less.
  - 2. The combined signal bonding conductor shall be isolated from the equipment grounding conductor.
  - 3. Where two signal bonding conductors are combined use a three port insulated splice.
  - 4. Where three or more signal bonding conductors are combined, use a copper bus mounted on 600 V insulators. Attach each conductor to the bus using an insulated ring tongue lug and screw terminal.

### 3.05 TESTS AND CHECKOUTS

- A. Provide checkout and testing of the entire grounding system in accordance with Section 26 05 10 and 26 08 13.

### 3.06 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 05 33

### ELECTRICAL RACEWAY SYSTEMS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide raceway systems, with matching accessories, fittings and boxes, as indicated and specified. When non-metallic raceway systems are specified, provide green insulated grounding conductor sized per National Electrical Code (NEC) and Delaware Electrical code requirements.
- B. All raceway runs are indicated diagrammatically to outline general routing of raceway. Unless specifically identified for installation in concrete walls or slabs, raceways shall be run exposed with raceway supporting systems. Avoid interfering with pipes, ducts, structural members, or other equipment. Any installation deviations from the contract requirements shall be corrected at no cost to Owner.
- C. Raceways and conductors between lighting, switches, power, receptacles and other miscellaneous low voltage and signal systems as specified and indicated are not shown on the Plan View Drawings. Raceways and conductors shall be provided for complete and operating systems. Conduit and wiring descriptions are indicated on the Riser Diagrams for the Instrumentation Systems. Raceways shall be installed exposed unless otherwise indicated on the Electrical Drawings. Avoid conflicts with HVAC ducts, cranes, hoists, monorails, equipment hatches, doors, windows, structural beams and process equipment.
- D. Provide raceway systems in accordance with the following:
  - 1. In NEMA 1, NEMA 4, or NEMA 12 areas, use galvanized rigid steel (GRS) raceway systems, fittings and accessories.
  - 2. In areas designated NEMA 4X, use PVC coated rigid steel raceway systems, fittings and accessories.
  - 3. In classified hazardous areas designated as Class I, Division I and Class 1, Division 2, use PVC coated rigid steel raceway systems, fittings and accessories with tapered threads and sealing fittings as required by the Delaware Electric Code for hazardous applications.
- E. All raceway systems shall be installed in accordance with the criteria described in this specification section. Any proposed deviations from these requirements shall be submitted to the Engineer in writing for review and disposition.
  - 1. Use 316 stainless steel support systems for exterior application, hazardous areas, NEMA 4 and in NEMA 4X areas.

- 2. NEMA 1 and NEMA 12 areas shall use hot dipped galvanized steel support systems.
- F. Aluminum conduit and boxes are not acceptable products.
- G. All raceways shall be supported to National Electric Code requirements and to meet all applicable seismic criteria. Raceways 2-in. outside diameter or greater shall be independently supported in a manner to meet the criteria to resist failure during earthquake events. All hardware supports shall be specifically designed for the magnitude of the earthquake event as defined in Section 26 05 10.
- H. Provide fire stops for all electrical penetrations through fire rated walls and floors.

## 1.02 REFERENCES

### A. National Fire Protection Association (NFPA):

- 1. National Electrical Code (NEC)

### B. Delaware Electrical Code

### C. Underwriters Laboratories, Inc. (UL):

- 1. UL-1: Electrical Flexible Metal Conduit
- 2. UL-6: Rigid Metal Electrical Conduit
- 3. UL-360: Electrical Liquid-Tight Flexible Steel
- 4. UL-651: Schedule 40 and 80 PVC Conduit
- 5. UL-886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C, and D and Class 11, Groups E, F, and G

### D. National Electrical Manufacturers Association (NEMA):

- 1. RN-1: Polyvinylchloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- 2. TC-2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

## 1.03 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.

## 1.04 SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 01 33 00.

1. Submit shop drawing and manufacturers' product data in accordance with the requirements of Section 26 05 10.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.
3. Submit certificate of Unit Responsibility in accordance with Section 01 43 00.

#### 1.05 SEISMIC REQUIREMENTS

- A. Conform to the requirements as indicated on the structural drawings and as defined in Section 01 41 20.
- B. It shall be the responsibility of the manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.
- C. Install supports for raceway systems greater than 2 inches in diameter to meet the seismic requirements indicated and specified.

#### PART 2 - PRODUCTS

##### 2.01 ACCEPTABLE MANUFACTURERS

- A. Rigid Metal Conduit and polyvinylchloride-coated rigid steel conduit:
  1. Triangle/PWC, Inc.
  2. Perma-Cote Industries.
  3. Republic Steel Corporation.
  4. Robroy Industries.
  5. Allied Tube and Conduit
  6. Or approved equal.
- B. Polyvinylchloride (PVC) Conduit
  1. Triangle/PWC, Inc.
  2. Robroy Industries.

3. Carlon Electrical Sciences, Inc
  4. Or approved equal.
- C. Flexible Conduit:
1. American Flexible Conduit Company.
  2. Anamet, Inc.
  3. Electri-Flex Company.
  4. International Metal Hose Company.
  5. Or approved equal.
- D. Boxes and Fittings:
1. O.Z./Gedney Company.
  2. Crouse-Hinds Electrical Construction Materials.
  3. Appleton Electric Company.
  4. Or approved equal.
- E. Fiberglass-Reinforced Polyester Boxes:
1. Crouse-Hinds Electrical Construction Materials.
  2. Fibox.
  3. Hoffman Engineering Company.
  4. Vynckier Enclosure Systems.
  5. Or approved equal.
- F. Support Systems:
1. Michigan Hanger Co., (O-Strut).
  2. Thomas & Betts (Superstrut).
  3. Unistrut Corp.
  4. Or approved equal.
- G. Fire Stop Material and Barriers:

1. Nelson Fire Stop Products.
2. Dow Corning Corporation.
3. 3 M Company.
4. Or approved equal.

## 2.02 MATERIALS AND COMPONENTS

### A. Rigid Metal Conduit:

1. Provide galvanized rigid metal conduit, each with a coupling on one end and thread protector on other end.
2. Hot-dip galvanize rigid steel conduit over entire length, along interior and exterior surfaces, including threads. Conduit shall conform to UL-6.

### B. Flexible-Metal Conduit:

1. Provide liquid tight flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit shall conform to UL-1.
2. Provide liquid-tight PVC coated flexible-metal conduit for use in damp areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. All fittings and accessories shall be PVC coated. On larger than 1-1/4-in., furnish separate external ground wire. Liquid-Tight flexible-metal conduit shall conform to UL-360.
3. Provide stainless steel braided flexible conduit in all hazardous areas.

### C. Polyvinylchloride (PVC) Conduit:

1. Provide PVC conduit, Schedule 40 conforming to NEMA Standard TC-2 and UL-651. PVC Schedule 40 conduit shall not to be used unless embedded in concrete and unless otherwise indicated on the drawings.

### D. Polyvinylchloride-Coated Rigid Steel Conduit:

1. Provide polyvinylchloride-coated (PVC-Coated), rigid steel conduit conforming to NEMA Standard RN-1 consisting of hot-dipped galvanized rigid steel conduit, with a polyvinylchloride jacket bonded to the outside of all conduit surfaces with a nominal thickness of 40 mils meeting the requirements of NEMA RN-1, 3.1. The adhesive strength of the bonding to equal or exceed tensile strength of the coating. Provide couplings and fittings for this conduit conforming to the requirements of NEMA RN-1, 3.5.

2. A two-part urethane coating shall be applied to the interior of all conduit and fittings at a two mil thickness. The interior coating shall be flexible to allow field bending without cracking or flaking.

E. Boxes:

1. In NEMA 1 and NEMA 12 areas, provide standard, sheet-metal, outlet and junction boxes constructed of code-gauge, galvanized sheet steel. Size each box by the Delaware Electrical Code.
2. Provide boxes containing fixture studs for hanging fixtures. Use concrete-tight boxes for installation in concrete. Do not use shallow boxes unless building construction is such that it is impossible to use standard-depth boxes.
3. Provide outlet boxes, junction boxes, pull boxes and fittings for hazardous locations conforming to UL-886 for class, group, and division indicated.
4. Provide boxes and covers for polyvinylchloride-coated steel conduit made of fiberglass reinforced resin or, in classified areas and outside, galvanized cast iron, with a polyvinylchloride factory-applied coating over the galvanizing. Provide coating thickness of 40- mil. Boxes shall have hubs with extruded sleeves extending beyond the hub in the same manner as specified for conduit couplings. Provide cover screws of Type 316 stainless steel.
5. Provide cast boxes with covers or device plates suitable for area classification. Use cover screws of stainless steel or high brass for iron boxes.
6. Provide polyvinylchloride boxes for use as junction boxes and provide high impact strength fiberglass-reinforced polyester boxes for use as device boxes, pull boxes, and terminal boxes. Size each box as required by the Delaware Electrical Code.
7. Boxes of dimensions 10 inches by 10 inches by 6 inches deep and larger shall be hung from ceilings constructed of angle or channel frames and shall be made of sheet metal with welded joints. All welds shall be ground. Provide neoprene gaskets for sealing. Sectionalize covers longer than 36-in. to facilitate handling and gasket sectionalized covers where covers meet, using angle iron or channel cross members at the joint. Sheet metal shall be No. 12-gauge galvanized sheet steel. Fabricate interior angles and supports of galvanized steel. Provide each box with a grounding lug for connection to the nearest ground bus. Current capacity of ground lug shall be that required by the National Electrical Code for the largest feeder entering the equipment.
8. Provide terminal blocks in all terminal boxes, panels, and instrumentation cabinets/panels requiring terminations as indicated or by wiring diagrams for equipment actually purchased. All terminals shall be rated 600V, 20 amp. All terminals shall be screw type with provisions for white markers.

9. In NEMA 4 and NEMA 4X areas, provide stainless steel outlet and junction boxes. Size each box as required by the Delaware Electrical Code.

F. Fittings:

1. Provide cast-iron fittings of malleable iron or a mixture of gray iron and cast steel.
2. Provide expansion fittings where conduits cross expansion joints. Furnish these fittings with grounding straps, clamps, and copper bonding jumpers.
3. For PVC conduit, provide PVC fittings that can be solvent welded to match conduit.
4. Provide PVC-coated coupling and fittings for PVC-coated conduit with an integral, bonded, overlapping pressure-sealing sleeve of the same thickness as conduit coating. Provide extended sleeves one pipe diameter or 2-in. (whichever is less) beyond the end of the coupling so sleeve of coupling makes a watertight fit with the plastic jacket on the conduit when coupled together. Sealing sleeves at threaded connections shall seal out vapors and liquids.
5. Provide PVC coated fittings and accessories with PVC-coated rigid galvanized steel conduit.

G. Supports:

1. Provide raceway component supports which are meant to function with the raceway and will support the raceway as indicated and meet the NEC and manufacturer's requirements.
2. Provide 316 stainless steel, channels, straps, clips, and clamps for raceways provided in hazardous areas, NEMA 4, NEMA-4X and exterior areas. Provide stainless steel bolts, nuts and washers.
3. Provide hot dipped galvanized steel support system for raceways installed exposed in NEMA 1 and NEMA 12 areas.
4. Provide support for flexible conduit with components which do not compress and do not deform conduit.

## 2.03 FIRESTOP PRODUCTS

- A. Only firestop systems listed and tested to the UL 1479 Standard complete with prototype test data showing their individual applications shall be used.
- B. Fire resistance ratings of installed firestop systems shall not be less than the fire resistance rating of the surrounding fire separation or firewall.
- C. All listed system designs selected for use shall have a smoke seal incorporated within the rated firestop systems.



- D. All firestop materials that will come directly in contact with plastic pipe or plastic coated wire shall have undergone Firestop Material compatibility testing by the Firestop Systems manufacturer and/or the pipe or wire manufacturer.
- E. All firestop materials and smoke seals shall have elastomeric characteristics to allow for building settling and seismic movement.
- F. All firestop materials and smoke seals shall be free of asbestos.
- G. Site firestop systems must be installed in accordance with the UL 1479 Standard listed system design limitations.
- H. All listed system designs used must provide a Flame (F), Temperature (T) and Hose (H) stream rating in accordance with those outlined in the most recent BOCA codes, including any additional requirements of the Work in this specification section.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Provide all material, equipment, and labor to install the electrical raceway systems as indicated and as specified herein.
- B. Perform all Work in accordance with the Delaware Electrical Code and National Electrical Code.
- C. Use no conduit less than 3/4-in. in diameter, unless otherwise indicated.
- D. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's printed instructions.

### 3.02 SEISMIC RESTRAINTS:

- A. For conduits and other raceways installed in open areas, not adjacent to and secured to structural elements, and 2-in [50 mm] outside diameter or greater, support such raceways using seismic restraints rated for the applicable project earthquake criteria.
- B. Methods of Restraining Raceways:
  - 1. Utilize threaded rod with rod stiffeners and transverse channel braces at 45 degrees angle, at 15-ft. on center, maximum, and on one side of rod support.
  - 2. Utilize longitudinal bracing with channel braces at 30 feet on center, maximum.
  - 3. Strap raceways directly to transverse channel braces, using pipe strap with both ends of strap bolted into the channel brace.

4. Do not rigidly brace raceways to different parts of a building that may respond differently during an earthquake. Seismic restraints shall not limit expansion and contraction of the raceway support system.
5. Provide flexible connections for conduits 2-in. outside diameter or greater when terminating to fixed equipment to prevent loss of raceway integrity in the event of an earthquake.

### 3.03 INSTALLATION OF FITTINGS

- A. Install expansion fittings and bonding jumpers wherever conduits cross structural expansion joints. Keep the fittings in line with conduit and install with regard to temperature so that full working range of expansion is available.
- B. Do not install fittings to replace elbows and pull boxes unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain bending radius.
- C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.
- D. Equip ends of all conduits with conduit fittings. Fit conduits terminating at power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 awg. Install ground wire larger than 12 gauge when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires No. 6 Awg. copper or larger.
- E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.
- F. Terminate conduits entering nongasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or equivalent.
- G. Join raceways with fittings listed for the purpose. Make joints tight. Use raceway fittings compatible with raceway use and location. Use threaded rigid steel conduit fittings, except as otherwise indicated.
  1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  2. Use insulating bushings to protect conductors.
  3. Tighten set screws of threadless fittings with suitable tool.

### 3.04 INSTALLATION OF RACEWAYS

- A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with bends, elbows, and pull boxes. Space parallel runs evenly throughout. Attach in place with hangers and fasteners. Ground raceways by connection to grounded enclosures, bonding, or other means, to obtain permanent low resistance path to ground throughout installation. Raceway sections in single run and in parallel runs shall be of same type and finish.
  - 1. Run parallel or banked raceways together, on common supports where practical.
  - 2. Install raceways level and square and at proper elevations. Provide minimum 7 ft. headroom.
- B. Support raceways concealed above suspended ceilings from slab above ceiling in same manner as exposed raceways. Do not support raceways from ceiling supports.
- C. Provide cast-in-place inserts in concrete to support all runs, unless otherwise permitted. Use stainless steel sleeve type concrete anchors for installing boxes, and conduit supports. Provide Type 316 stainless steel nuts, bolts, and washers, for use with concrete anchors. Wedge inserts shall not be used.
- D. Support conduits by hangers or pipe straps spaced according to Delaware Electrical Code, but in no case more than 10 feet on center.
- E. Provide hot-dipped galvanized supports for galvanized conduit.
- F. Provide sleeves passing through exterior walls and slabs which are wall entrance seals of watertight construction. Furnish watertight seal between slab and sleeve, and between sleeve and conduit or cable. Use wall-entrance seals of malleable iron with watertight sealing gland which may be tightened any time after installation.
- G. Do not use dissimilar metals in conjunction with each other. Use insulation between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers as insulation.
- H. Install fittings to match raceway being used.
- I. Install expansion fittings wherever conduits cross structural expansion joints. Keep fittings in line with conduit and install with regard to temperature so that full working range of expansion is available.
- J. Where conduits pass through firewalls, grout hole around the conduit to the full depth of the material penetrated using UL listed fire stop material.

- K. Provide separate metallic raceways for all low voltage raceways 50 volts and below, shielded wiring, instrumentation, communication, and I/O data highway wiring and install 12-inches from control and power raceways.
- L. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box; use two locknuts, one inside and one outside the box.
- M. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- N. Install pull wires in all empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having 200-lb. tensile strength. Leave 12 inches of slack at each end of the pull wire.
- O. Keep raceways 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- P. Complete raceway installation before beginning conductor installation.
- Q. Use temporary closures to prevent foreign matter from entering raceway.
- R. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- S. Conduit in transition (through walls and through concrete) shall be PVC coated rigid galvanized steel (PVC-RGS). PVC-RGS conduit shall extend one foot above transition finished floor.

### 3.05 BENDS

- A. Make all bends to prevent distortion of circular cross section. Field bent conduit shall have an inside radius of nine diameters.
- B. The maximum number of bends in any single conduit run shall be in accordance with the Delaware Electrical Code requirements.

### 3.06 CUTTING, THREADING AND CONNECTING

- A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with Delaware Electrical Code. No running thread shall be permitted. Make all connections mechanically strong and tight, with connectors. Where conduit surface coating is damaged or removed in the cutting, threading or reaming process, restore the surface to its original condition.

### 3.07 CONDUIT CLEANING

- A. Clean conduits before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections.
- B. After installation of each new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.
- C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.
- D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

### 3.08 CONDUIT DRAINAGE

- A. Pitch conduit to drain to outlet boxes or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting to match conduit system with drain hole at low point.

### 3.09 INSTALLATION OF BOXES

- A. Unless otherwise indicated, install NEMA 1 or NEMA 12 sheet metal boxes only in dry, accessible locations. Install NEMA 4 and 4X rated boxes in exterior concrete or masonry walls, in floor slabs, in basements, all other below grade locations and elsewhere as indicated. Unless otherwise indicated, cast metal boxes shall be used where vapor-tight fixtures are required, for all surface mounting of wall switches and receptacles and for all outdoor use.
- B. Install boxes in conformance with all the requirements of Delaware Electrical Code. Install boxes designed for type of construction involved. Support boxes in same manner as conduit. Size boxes to provide bending radius for wire or cable of eight times diameter or in accordance with Delaware Electrical Code, whichever is larger.
- C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.
- D. Place all outlet boxes, junction boxes and pull boxes, in accessible locations when they are installed above or behind plastered ceilings, furred spaces, or suspended ceilings. Install access panels. Mark all access panels for all boxes so panels can be readily located in future. Mark, using metal tabs or plastic buttons which cannot mark ceilings or walls that can be used for type of construction being used.
- E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.

- F. Provide cast boxes with covers and device plates that can be used for the area classification. Install screws of Type 316 stainless steel or high brass for iron boxes.

### 3.10 FLEXIBLE CONNECTIONS TO MOTORS AND EQUIPMENT

- A. At all motors and electrically operated equipment to which conduit connections are made, install with a connection between end of conduit and terminal box of motor or other equipment.
- B. Install the conduits in locations permitting direct connection to motors.
- C. Make connections between rigid raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with one quarter bend so that no vibration can be transmitted beyond flexible connection.
- D. Use maximum of 6 feet of liquid tight flexible conduit for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Locate conduit to reduce the possibility of damage to the exterior flexible conduit jacket. Use fittings that screw into flexible conduit and provide gaskets. Install separate ground conductor across flexible connections.

### 3.11 HAZARDOUS AREAS

- A. Install all conduits, fittings, equipment and devices within areas to comply with requirements of Delaware Electrical Code including Hazardous Locations, Class, Division, and Group as indicated on the contract drawings.
- B. In such hazardous locations, seal conduits terminating at boxes enclosing circuit-opening equipment at entrance to enclosure with compound-filled, commercial, sealing fittings to prevent passage of explosive or combustible gases through conduits.
- C. Seal all conduits leading from or entering such hazardous locations at points of exit or entrance with two-part epoxy sealant.
- D. Install conduit connections with five threads tightly engaged, and made up with thread compound.
- E. Where drain/seal fittings are required, they shall be of malleable iron construction with an internal drainage path which provides a visual means to see that the compound chamber is filled. The installation shall enable the drain/breather fitting and filler plug to be installed right after the compound is poured.
- F. Provide liquid tight stainless steel braided flexible conduit rated for hazardous area locations when making connection between rigid raceway and motor or equipment subject to vibration and adjustment.

### 3.12 FIRESTOP INSTALLATION

- A. Firestop and smoke seal gaps and holes in all fire separation and firewall construction through which conduit, wire, cable, pass as a result of Electrical Work using a Listed System Design.
- B. In combustible construction, firestop and smoke seal all through electrical penetrations of the faces as above and firestop and smoke seal all penetrations that enter or exit (transverse) the edges of one fire separation into another fire separation. (i.e. where the header or sill plate is penetrated in the interior of a wall separation into the hollow ceiling or floor cavity of the adjacent separation.)
- C. Apply firestop systems at unpenetrated electrical openings and sleeves installed for future use through fire separations and firewalls.
- D. All Electrical items that pass through, transverse or terminate within fire separations or firewalls must be fire stopped. Fire stopping forms part of the Work of this specification section.
- E. All recessed electrical boxes or panels in fire separations shall be noncombustible (steel) and must be separated by one stud or joist cavity. Back to back installations and/or combustible (plastic) boxes and panels are not allowed unless the gypsum board trade has constructed a fire rated enclosure equal to that of the fire separation rating around each box or panel.
- F. All holes or voids created in fire separations or firewalls for single penetrating wires, cables and conduit the annular space shall not exceed 1" for penetrating items up to 2" in outside diameter. For penetrating items over 2" in outside diameter the annular space must not exceed 1½".
- G. All holes or voids created in fire separations or firewalls for multiple penetrating electrical items must have a fill ratio 50% of the overall void or hole size.
- H. In all firestop systems that require mineral wool or ceramic fiber backer or filler materials, these materials must be dry and free of other contaminants before, during and after installation of sealant firestop materials. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.
- I. Apply firestop systems and smoke seals in strict accordance with manufacturer's instructions and Listed Systems Designs to provide temperature and flame rated seals, to prevent the passage of fire and smoke.

### 3.13 PROTECTION

- A. Provide protection and install in accordance with manufacturer printed instructions such that coatings, finishes, and enclosures are without damage or deterioration at completion of Project.
- B. Repair damage to PVC with matching touch-up coating recommended by the manufacturer.

### 3.14 CHECKOUT AND TESTING

- A. Provide in accordance with Sections 26 05 10 and 26 08 13 and as specified herein.
- B. Check overhead conduit system installation by using the following checklist:
  - 1. Conduits are supported on independent supports (i.e., not on process piping, pipe ways, or piping hangers).
  - 2. Exposed conduits are run, parallel or perpendicular to structural members.
  - 3. Conduits are routed far away from fire hazards and heat sources.
  - 4. Conduits are supported at the specified intervals.
  - 5. Pull boxes and fittings are installed so that covers are removable. Verify that covers are installed and tightly bolted with gaskets provided where needed.
  - 6. Circular cross sectional area is same at conduit bends. Single bends do not exceed 90 degrees.
  - 7. Conduits are terminated in threaded hubs or bushings to prevent damage to wire.
  - 8. Conduit joints are tight.
  - 9. Seal fittings and/or sealing compound is installed at moisture barriers to prevent entry of moisture and gases into equipment and/or where indicated.
  - 10. Drains and conduit seals are installed on vertical conduit runs entering devices, equipment, and enclosures to prevent entrance of moisture and gases.
  - 11. Flexible conduit is installed at motors and other equipment as specified. Verify that cabling and conduit runs are identified at each end.

### 3.15 CONDUIT SEALS

- A. Furnish and install sealant to maintain fire ratings of walls and floors in annular space between conduit and building finish.
- B. Apply sealant after cable installation and all testing.



- C. Furnish and install moisture/fire proof sealant in conduit interior and cable interstitial space where conduits enter/leave electric rooms, in all control panels, terminal boxes, and switchboard.

### 3.16 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 05 43

### UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Provide complete underground distribution system as indicated and specified.
- B. Conform to lines, grades, elevations, and dimensions. Resolve interferences with other underground conduits and piping or equipment. Match components suitable for proper installation.
- C. Provide concrete encasement of duct system. Include forms and reinforcing in installation. Perform work in accordance with Section 26 05 10.
- D. Provide cast-in-place or pre-cast handholes complete with ground rods, windows, ladders, frames, covers, cable racks, supports, pulling irons, and other inserts. Use reinforced concrete. Perform work in accordance with Section 26 05 10.
- E. Provide Schedule 40 polyvinyl chloride (PVC) conduits for power and control circuits within concrete encased duct bank system. Provide rigid galvanized steel conduits for instrumentation, I/O, and communication networks within a concrete encased ductbank system.

##### 1.02 REFERENCES:

- A. Delaware Electrical Code.
- B. National Electrical Code.

##### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
  - 1. Submit shop drawing and manufacturers' product data for all components and materials used in the construction of underground distribution systems in accordance with the requirements of Section 26 05 10.
  - 2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.

- a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.

3. Provide "As-Built" drawings of underground ductbank system.

#### 1.04 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. Polyvinyl chloride (PVC) Conduit:
  1. Specified in Section 26 05 33.
- B. Rigid Steel Conduit, Galvanized:
  1. Specified in Section 26 05 33.

#### 2.02 MATERIALS AND COMPONENTS

- A. Conduit Spacers: Furnish conduit spacers made of plastic to maintain spacing between conduits.
- B. Concrete: Minimum compressive strength, 4,000 psi.
- C. Handhole Frames and Covers as indicated and specified:
  1. Heavy duty cast iron covers shall be capable of withstanding a 20-ton wheel load transferred through dual rubber tires.
  2. Provide machine-finished seat.
  3. Mark "ELECTRICAL" on cover of handholes used for electrical duct lines.
  4. The handhole covers shall be a minimum of 24 inches in diameter.
  5. Conform to details indicated on the drawings and as specified.
- D. Cable Supports in Handholes:
  1. Cable racks, 316 stainless steel.
  2. Cable supports, 316 stainless steel.
  3. Insulators, high grade dry-process porcelain with smooth-glazed surfaces.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Perform work in accordance with the Delaware Electrical Code and project drawings.

### 3.02 INSTALLATION OF CONDUITS

- A. Provide minimum separation of power and control conduits of 3 inches both vertically and horizontally. Build ductbank layer by layer, backfill and compact each layer to provide support for next layer.
- B. Separate power and control ducts from signal ducts by a minimum of 12 inches
- C. Backfill ductbank in layers and tamp or puddle as indicated in Section 31 23 33. Provide yellow ductbank marker tapes, reading "Caution - Electrical Lines Below", over entire length of ductline. Locate tapes 12 inches below grade. Provide a tape for every 12 inches of width of ductline.
- D. Install conduit, encased in concrete with spacers and reinforcing, as specified.
- E. Install conduit runs following routing on drawing and running in straight lines. Where deviation from a straight line becomes necessary, install bends of radius which allow for rodding and installation of cable.
- F. Accomplish changes in direction of runs exceeding total of 10 degrees, either vertical or horizontal, by long sweep bends having minimum radius of curvature of 25 ft. Manufactured bends can be used at ends of short runs of 100-ft. or less, and then only at or close to the end of run. Provide long sweep bends made up of one or more curved or straight sections and/or combinations thereof. Install manufactured bends with minimum radius of 36-in. where larger radius cannot be used.
- G. Install spacers at intervals of approximately 4 ft. and stagger between tiers of ducts to provide not less than 12-in. of longitudinal separation. Install base spacers to provide at least 3-in. between bottom of trench and underside of bottom conduits. Completely fill space with concrete. Firmly wire conduits and spacers together before concrete is placed.
- H. Prior to placing of concrete, remove all dirt, sand, and any other debris from between conduits and from trench bottoms. Hold conduits in place to prevent floating or accidental movement.
- I. Stagger joints in conduits at least 6-in. Do not allow couplings to rest on bottom of trench. Install couplings for plastic conduit in accordance with manufacturer's recommendations.
- J. Install concrete encasements so minimum clearance of 12 inches from concrete to parallel pipes, lines, structures, etc., is maintained. Where ducts cross, minimum clearance of 6 inches is required.

- K. Roll and grade backfill and restore surface to condition equal to the site finish grade, or as otherwise indicated.
- L. Keep conduits clean of concrete, dirt, and other substances during the course of construction. After the ductlines have been completed, pull a standard flexible mandrel not less than 12-in. long, having a diameter approximately 1/4-in. less than the inside diameter of the conduit, through each conduit, after which pull a brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line. Replace conduit runs that do not allow the passage of the mandrel. Pneumatic rodding may be used to draw in the lead wire. Install in spare conduits a pull wire or rope, and plug and seal spare conduits after cleaning.
- M. Conduit in transition (from below to above grade, through walls and through concrete) shall be PVC coated rigid galvanized steel (PVC-RGS). The transition shall be made below grade at the final sweep before the transition for exposed conduit. PVC-RGS conduit shall extend one (1) foot minimum above transition finished floor.

### 3.03 HANDHOLES

#### A. Contractor shall:

1. Provide handholes of 4,000 psi concrete cast in place or pre-cast.
2. Place a minimum 8-inch compacted sand base under each handhole.
3. At convenient point close to wall, drive a ground rod into earth. Extend ground rod approximately 6-in. above finished manhole and handhole floor. After completion of manhole or handhole, connect 6 foot length of No. 4 bare copper ground wire to ground rod. Connect grounding bushings, cable racks, covers, other metallic parts, splices, and ground wire installed with each feeder to ground loop.
4. Size space, and place reinforcing bars as indicated and as specified.
5. Set handhole frames to the required grade, in full bed of concrete mortar to make watertight connection.
6. Install galvanized corrosion-resistant channel support, with continuous slot and required fittings designed for concrete encasement.

### 3.04 HANDHOLE WATERPROOFING

- #### A. Contractor shall apply two coats of bituminous waterproofing material to exterior surfaces of handholes. Apply by brush or spray, in accordance with manufacturer's printed instructions. Allow time between coats to permit sufficient drying.
1. Two coats applied with a minimum dry film thickness of 12 to 14 mils per coat.

3.05 RECORD DRAWINGS OF UNDERGROUND WORK

- A. Furnish two sets of marked copies of contract electrical drawings, showing exact routing and depths of all underground conduits, ducts, and handholes. Furnish scaled plot plans, showing principal outline of buildings and structures. Reference conduits, ducts, and all bends deviating from straight line, dimensionally from fixed objects or structures.

3.06 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 05 70

### ELECTRICAL SYSTEM STUDIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide electrical system studies as indicated and in compliance with Contract Documents.
  - 1. Provide a short circuit, protective device coordination and arc-flash study for the electrical distribution system constructed under this contract as shown on the electrical single line drawings. The study shall consider the electrical utility system upstream protective devices down to the 208Y/120V transformer secondary. The study shall include data to verify the short circuit ratings of the electrical distribution equipment to be provided under this contract and to identify the required settings of associated protective devices.
    - a. Provide a report summarizing the study including: one-line of system, relay and breaker setting tabulation, relay, circuit breaker, and fuse protective device coordination and short circuit analysis, all prepared by an independent specialty firm. Device calibration and settings are to be based on the results of this coordination study.
- B. The firm performing the Work of this specification section shall not be part of or affiliated with the electrical equipment supplier organization(s) or manufacturer(s) or the Contractor.
- C. Contact the electrical utility to obtaining the available fault current and utility protection equipment data.
- D. Changes and additions of equipment characteristics based on the actual equipment supplied shall be suggested by the results of the short circuit and protective device coordination studies. Submit suggested changes and additions as part of the study. Field settings of devices, adjustments, and minor modifications to equipment that are required to accomplish conformance with the accepted short circuit and protective device coordination studies shall be provided at no additional cost.
- E. The studies shall be performed for two operating conditions:
  - 1. The system is powered by the electrical utility.
  - 2. The system is powered by the on-site generator.

## 1.02 REFERENCES

- A. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. C37.010: Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
  - 2. 242: IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
  - 3. 519: IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power System
  - 4. 1584: IEEE Guide for Performing Arc-Flash Hazard Calculations
- B. National Fire Protection Association (NFPA):
  - 1. 70E: Standard for Electrical Safety Requirements for Employee Workplaces.
- C. Delaware Electrical Code.

## 1.03 SUBMITTALS

- A. Shop Drawings:
  - 1. Submit the following shop drawings in accordance with Section 01 33 00.
  - 2. Submit shop drawing and manufacturers product data in accordance with the requirements of Section 26 05 10.
- B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - 1. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.
  - 2. Short circuit and protective device coordination study concurrent with the preliminary shop drawing submission for the main electrical distribution system equipment and overcurrent protective devices. Submit an initial study and a final study, with all electronic files, at the completion of the project.
    - a. The study shall be performed using the latest edition of one of the following commercial software programs.
      - (1) ETAP
      - (2) EasyPower



(3) SKM System Analysis

- b. The study shall consider the effects of non-VFD motor driven contribution during fault conditions, at various buses in the system.
  - c. The study shall include cable sizes, cable lengths and raceway types for considering the effects of cable impedance in the system based on information to be provided by the Contractor.
  - d. The maximum fault contribution at the incoming source(s) shall be documented via correspondence from the authority responsible for this source(s).
  - e. Transformer inrush points and damage curves shall be plotted on coordination curves.
  - f. Obtain from the engine generator supplier, reactance values, protective device type and data and generator decrement curves.
  - g. Plot on common drawings, single-line diagrams and the curves for each protective device to verify proper selectivity and protection for all components of the system for both the normal utility and standby generator source. Label each device uniquely.
  - h. Identify recommended settings for all devices.
  - i. Devices which do not provide full selectivity and coordination shall not be used as a recommended device in the study.
  - j. Submittals of electrical distribution equipment affected by the study shall not be submitted until successful completion of the specified electrical study.
- 3. After completion of the coordination study, the Contractor shall set all devices based on the study.
  - 4. Submit qualifications of specialty testing and/or study firm, as specified.
  - 5. Provide electronic files of the performed studies' electrical model including all input data base information.

1.04 QUALIFICATIONS OF SPECIALTY FIRM

A. Submit evidence of the following:

- 1. Firm's experience:
  - a. Specialty firm shall have been in the business of the type of work specified, for at least the past five years.

- b. The firm shall have a minimum of five projects of equal or greater size, service, and the type of equipment specified.
- c. At least the following information must be submitted:
  - (1) The number of years the firm has been in the business of performing coordination studies.
  - (2) Summary of five previously performed studies including:
    - (a) A brief description of each study.
    - (b) Name of owner of installation on which study was performed with address, telephone number, and contact person.
    - (c) Date of study.
  - (3) List of projects and contact persons for which protective device settings were performed.
  - (4) Any other information indicating the firm's experience, ability to perform the work, and business status.
- B. Firm shall have a licensed Professional Electrical Engineer, licensed in Delaware, supervise all work and seal all reports.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.01 SHORT CIRCUIT STUDY

- A. Perform a short circuit study in accordance with ANSI Standard C37.010 to verify the adequacy and correct application of circuit protective devices and other electrical system components.
- B. The study shall address the case when the system is being powered from the utility source as well as from the on-site generating facilities. Minimum and maximum possible fault conditions shall be covered in the study.
- C. Include the fault contribution of non-VFD driven motors. Horsepower shown in the Contract Documents may be used to calculate fault contribution of motors.
- D. Calculate short-circuit momentary duties and interrupting duties on the basis of an assumed bolted 3-phase short circuit at each bus. The short circuit tabulations shall include X/R ratios, asymmetry factors, kVA and symmetrical fault-current. Where ground fault protection is specified, provide a ground fault current study for the same system areas, including the associated zero sequence impedance diagram. Include in

tabulation form, fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.

- E. The studies shall include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.

### 3.02 PROTECTIVE DEVICE COORDINATION STUDY

- A. Provide a protective device time current coordination study with coordination plots of current limiting devices, plus tabulated data, including ratings and settings selected. In the study, balance shall be achieved between the competing objectives of protection and continuity of service (with emphasis on continuity of service) for the system specified, taking into account the basic factors of sensitivity, selectivity and speed.
- B. Provide separate plots for utility and generator operation as applicable. Show maximum and minimum fault values in each case. Multiple power sources shown in one plot is not acceptable.
- C. Each primary protective device required for a delta-to-wye-connected transformer shall be selected so the characteristic or operating band is within the transformer parameters, which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults. Separate low voltage circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults. Separate protective relays by a 0.4 second time margin when the maximum 3-phase fault flows to assure proper selectivity. The protective device characteristics or operating bands shall be terminated to reflect the actual symmetrical and asymmetrical fault-currents sensed by the device. Provide the coordination plots for 3-phase and phase-to-ground faults on a system basis. Include all devices down to largest branch circuit feeder circuit breaker. Include all adjustable setting ground fault protective devices.
- D. Identify discrepancies in the conclusions and recommendations of the report. Upon resolution of discrepancies and recommendation, update all associated analyses and revise the affected studies.
- E. The coordination plots shall graphically indicate the coordination proposed for the several systems centered on full scale log forms. The coordination plots shall include complete titles, representative one-line diagrams and legends, associated upstream power system relays, fuse or system characteristics, significant motor starting characteristics, significant generator characteristics, complete parameters for power, complete operating bands for low voltage circuit breaker trip devices, fuses, and the associated system load protective devices. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required. The short-time region shall indicate the relay instantaneous elements, the magnetizing inrush, and ANSI transformer damage curves,

the low voltage circuit breaker and instantaneous trip devices, fuse manufacturing tolerance bands, and significant symmetrical and asymmetrical fault-currents.

- F. The thermal limit of all feeder cables to each bus and large motors, where applicable in the study, shall be shown.
- G. No more than six devices shall be shown on one coordination plot. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots in order to provide cross reference. Give each unique protective device curve in the study a study-unique number or letter identifier to permit cross reference between plots. Do not use identifier letters or numbers more than once.
- H. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings. Include C.T. ratio, burden and all other calculations required for the determination of settings.

### 3.03 ARC FLASH HAZARD ANALYSIS

- A. Perform arc flash hazard analysis for the following items:
  - 1. Distribution Panels
  - 2. Panelboards
  - 3. Control panels with voltage over 50 volts
  - 4. Transformers that have auxiliary electrical devices operating at over 50 volts
  - 5. Automatic Transfer Switches
  - 6. Main circuit breaker (MCB-1)
  - 7. Disconnect Switches
  - 8. Motor Starters
- B. Methods of performing analysis:
  - 1. Use IEEE 1584 calculations.
    - a. If the conditions fall within the IEEE 1584 parameters use the IEEE 1584 calculations based on actual OCPD curves and settings.
    - b. If the conditions do not fall within the 1584 parameters, use the Lee method.

C. Provide color coded arc flash labels for each equipment item for which the calculations were performed with the following information:

1. Limited approach boundary
2. Information required by NFPA 70E.
3. Restricted approach boundary
4. Personal protective equipment required within restricted approach boundary
5. Flash protection boundary
6. Personal protective equipment required within flash protection boundary
7. Prohibited approach boundary

#### 3.04 FIELD TESTING

A. Integrate results of this study with functional testing of the contract electrical equipment in accordance with Section 26 05 10 and Section 26 08 13.

#### 3.05 CONTRACT CLOSEOUT

A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 05 90

### ELECTRICAL CONTROLS AND MISCELLANEOUS ELECTRICAL EQUIPMENT

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Provide and connect the electrical control equipment and miscellaneous electrical equipment, including such instruments and devices indicated and specified. Device enclosures for electrical equipment shall comply with the requirements of Delaware Electrical Code including Hazardous Locations, Class, Division, and Group as indicated.

##### 1.02 REFERENCES

- A. Underwriters Laboratories, Inc. (UL):
  - 1. UL-467: UL Standard for Safety, Grounding and Bonding Equipment.
  - 2. UL-489: UL Standard for Safety, Molded-Case Circuit Breakers and Circuit Breaker Enclosures.
  - 3. UL-823: Electrical Heaters for Use in Hazardous (Classified) Locations.
- B. National Electrical Manufacturers Association (NEMA):
  - 1. 250: Enclosures for Electrical Equipment (1000 volts maximum).
  - 2. ICS 1: General Standards for Industrial Control and Systems.
  - 3. ICS 2: Industrial Control Devices, Controllers and Assemblies.
  - 4. ICS 4: Terminal Blocks for Industrial Use.
- C. American Society for Testing and Materials (ASTM) Publications:
  - 1. D 178: Specification for Rubber Insulating Matting.
- D. National Fire Protection Association (NFPA):
  - 1. NFPA-70 National Electrical Code (NEC).
- E. Delaware Electrical Code.

##### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:

1. Submit shop drawings and manufacturer's product data, brochures including wiring diagrams in accordance with Section 26 05 10.
2. Wiring diagrams to show control interface points provided with other equipment.
3. Shop drawings to include:
  - a. Outline drawings with elevations.
  - b. Equipment arrangement drawings.
  - c. Anchor bolt location drawings.
  - d. Electrical schematics and wiring diagrams.
  - e. Electrical fuse/circuit breaker characteristics.
  - f. Equipment performance curves and technical data.
  - g. Bill of installation/assembly materials.
  - h. Equipment weights.
  - i. Completed manufacturer's data sheets.
  - j. Assembly sizes and weights.
4. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.

#### 1.04 SEISMIC REQUIREMENTS

- A. Conform to the requirements as indicated on the structural drawings and as specified in Section 01 41 20.

#### 1.05 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE ELECTRICAL MANUFACTURERS

- A. Allen-Bradley.

- B. General Electric Company.
- C. Cutler-Hammer.
- D. Square D Company.
- E. Appleton Electric Company.
- F. Crouse-Hinds Company.
- G. O-Z/Gedney.
- H. Or approved equal.

2.02 ACCEPTABLE STAINLESS STEEL/GALVANIZED STEEL CHANNEL MANUFACTURERS

- A. Unistrut Corp.
- B. Power-Strut.
- C. B-Line Systems, Inc.
- D. Or approved equal.

2.03 ACCEPTABLE FIBERGLASS CHANNEL MANUFACTURERS

- A. Omnistrut, Champion Fiberglass.
- B. Durostrut, Enduro Composite Systems.
- C. Struttech, Entrum Industries.
- D. Or approved equal.

2.04 SAFETY DISCONNECT SWITCHES

- A. Provide heavy duty type, safety switches, with external operating handles, 3 PST, rated 600 volt, 60 Hertz with ampere rating as indicated, and having provisions for padlocking.
- B. Provide rejection type fuses, 600 volts, 200,000 A.I.C., dual element, time delay, Class RK-5.
- C. Heavy duty safety switches to be UL listed, and meet or exceed NEMA Standard KS1.



## 2.05 PUSHBUTTON AND SELECTOR SWITCH STATIONS

- A. Provide HAND-OFF-AUTO switches, start-stop, push buttons, tumbler switches and other accessory devices as necessary for the control of motors and other electrical equipment or devices as indicated where shown on the wiring schematics and/or plan drawings.
- B. Provide pushbutton and selector switch stations made for heavy-duty service and with momentary or maintaining contacts as indicated or as necessary for starting and stopping of equipment with 10 amp contact ratings.
- C. Provide push buttons with momentary or maintained contacts as required; one set of NO contacts, one set of NC contacts. Minimum contact rating shall be 10 A at 120 VAC.
- D. Provide emergency stop push buttons with one set of NC contacts, 2 position push-pull operator and non-illuminated pull release red cap.
- E. Provide selector switches with quantity of N.O. or N.C. contacts and quantity of operator positions as required by control functions; contacts shall be maintained in all positions.
- F. All pilot lights shall be 120 VAC rated, push to test, heavy-duty, oil tight, LED type with following colors:
  - a. Open valve                      Red
  - b. Close valve                      Green
  - c. Equipment Running              Red
  - d. Equipment Off                    Green
  - e. Equipment Failure              Amber
- G. Acceptable manufacturers of heavy-duty switches and pushbuttons are Square D, Cutler-Hammer, Allen Bradley or equal. Indicating lights to be LED cluster type.
- H. At stations provide nameplates with white letters on black background.
- I. Provide explosion proof stations approved for use in Delaware Code, Class I, Division 1, Group C & D areas. Stations shall also meet NEMA 4X area requirements.
- J. Provide galvanized cast-iron enclosures for NEMA Type 4 watertight stations.
- K. Provide fiberglass reinforced polyester NEMA Type 4X enclosures for stations located in highly corrosive areas. Provide gaskets and Type 316 stainless steel screws, to prevent entry of chemicals.

## 2.06 MANUAL MOTOR STARTERS

- A. Provide manual motor starters where indicated and for 120 volt, 60 Hertz fractional horsepower motors.
- B. Provide each manual motor starter with overload heater or heaters of suitable capacity for motor-running over-current protection for motor controls. Provide manual starters as single or 2 pole, as necessary, and with toggle mechanisms indicating OFF and ON positions. Provide manual starters with built-in HAND-OFF-AUTO switches. Provide enclosures as indicated and have provisions for padlocking.
- C. Manual starters to be located within sight of motors, as defined by Delaware Electrical Code.
- D. Manual motor shall be provided per the area classification schedule.
- E. All enclosures located outdoors and below grade level shall be rated in accordance with the Area Classification Schedule on the Electrical Drawings.

## 2.07 WALL-MOUNTED COMBINATION STARTERS

- A. Provide each combination starter with motor circuit protector and full-voltage magnetic starter. Provide starters in an enclosure that meets the requirements of the enclosure schedule.
- B. Provide control transformer for the control circuit of each motor controller, rated 480-120/240 volts, single-phase, 3-wire, 60 Hertz, of adequate VA capacity for operation of supplied equipment in addition to extra capacity of 50 VA.
- C. Indicating lights shall be LED cluster type, heavy-duty, oil-tight units rated at 120 volts. Lights shall be Red for "OFF" position, Green for "ON" position and Amber for "Alarms".
- D. Provide heavy duty, oil-tight type pushbuttons to provide momentary contacts or maintained contacts for starting and stopping the motor.
- E. Use minimum size 1 combination starter, consisting of a circuit breaker fusible switch, or motor circuit protector and magnetic starter, as indicated. Momentary and interrupting ratings of circuit breakers, motor circuit protectors, and fused disconnect switches shall be a minimum of 65kAIC. Type of starters are as indicated. Furnish magnetic starters with thermal overload protection on each phase with external manual reset.
- F. Solid-State Overload Relay:
  - 1. Provide a solid-state overload relay for protection of the motors. The relay shall be Cutler-Hammer type CEP7 or approved equal.

2. The overload relay shall provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.
  3. The overload relay shall be modular in design, be an integral part of a family of relays to provide a choice of levels of protection, be designed to directly replace existing electromechanical overload relays, and be listed under UL Standard 508.
- G. Furnish starter operating coils suitable for operation on 120-volt, single-phase, 60-Hertz.
1. Furnish each starter with at least one normally open and one normally closed auxiliary contact. Furnish additional normally open and/or normally closed auxiliary contacts for indicating lights, interlocking and other requirements as indicated.
- H. Furnish within each starter compartment a control transformer with primary fuses and secondary fuse. Secondary voltage 120VAC, unless otherwise indicated. Determine load of each motor control circuit including equipment and devices provided under the other specification sections and furnish control circuit transformer 2-winding, dry-type of suitable volt-ampere rating, but not less than 75 volt-amperes. Control circuit loads may consist of but not be limited to solenoid operators, motorized valves, motorized dampers, relays, motor heaters, etc.
- I. Provide each motor starter with pushbuttons, lights, interlocks, and other control devices as indicated within wiring diagrams shown on the Contract Drawings.

## 2.08 SOLID STATE REDUCED VOLTAGE STARTER

A. Manufacturers:

1. Siemens
2. Square D Altistart
3. Cutler Hammer
4. Or equal

B. Features:

1. Provide current limited starting.
2. Capable of starting when powered from a generator rated for non-linear loads. Start successfully with simultaneous voltage drop of 30% and frequency drop of 10%.

3. Full wave, 6-SCR power bridge type.
4. Stepless acceleration.
5. Isolation contactor opens when motor stops, on motor overload, and on drive fault.
6. Bypass contactor energized at full speed or for across-the-line starting.
7. SCRs fire only during starting and stopping.
8. Door-interlocked circuit breaker.
9. Solid state motor overload relay with selectable Class 10, 20 or 30 curve and adjustable current setting.
10. Thermal protection to prevent overheating of drive.
11. Phase reversal, phase loss, and stall protection.
12. Torque boost.
13. Transient voltage surge suppression.
14. Constant voltage control power transformer.
15. Enclosure as required by area classification table.

C. Rating:

1. Continuous current rating 115% of motor full load amps.
2. Overload: 450% for 1 minute, 500% for 30 seconds, 600% for 5 seconds.
3. Operate successfully at 460 VAC, +/-10% (except for starting transients), 3 phase.
4. 60 HZ, +/-5% (except for starting transients).
5. PRV of SCR 2.5 times nominal line voltage.
6. Ambient temperature of 0 to 40 degrees C.

D. Adjustments:

1. Voltage ramp or current limit select.

2. Current limit: 200-500% of motor full load amps.
3. Voltage start ramp: 1-60 seconds.
4. Voltage stop ramp: 1-45 seconds.

E. Front of Panel Controls and Indicators:

1. Heavy duty, 30 mm selector switches and pushbuttons.
2. Heavy duty, 30 mm, LED cluster indicating lights.
3. LOCAL/REMOTE selector switch.
4. RUN/OFF selector switch.
5. RESET pushbutton.
6. Reduced voltage or across-the-line start selector switch.
7. Power ON indicating light.
8. Motor RUN indicating light.
9. Drive FAULT indicating light.
10. Motor OVERLOAD indicating light.
11. Mechanical RUN TIME meter.
12. LCD display to show motor current and drive output voltage. This screen shall also show and set drive adjustments.

F. Outputs:

1. NO, 2 amp, 120 V isolated contacts.
2. Power ON.
3. Motor RUN.
4. FAULT/OVERLOAD.

G. Inputs:

1. NO, unpowered remote contacts.
2. Motor RUN in remote.
3. Run INHIBIT (overrides local RUN).
4. RESET.

2.09 WALL MOUNTED CIRCUIT BREAKERS

- A. Provide manually operated circuit breakers, ambient-compensated, providing thermal magnetic inverse time-limit overload and instantaneous short circuit protection. Provide overload protection on all poles; trip settings as indicated.
- B. Provide breakers that are rated 480 voltage alternating current; 3 PST, have 100-amp or larger frames, and have an interrupting capacity of not less than 65kAIC rms symmetrical amperes at 480 volts.
- C. Provide time-current characteristic curves for each size of circuit breaker furnished.
- D. Provide circuit breakers housed in NEMA type enclosure indicated, having external operating handles with provisions for padlocking.

2.10 AUTOMATIC TRANSFER SWITCH

- A. Furnish open transition automatic transfer switch of the current, voltage and short circuit current ratings indicated on the drawings, capable of switching all classes of load, and fully rated. Provide in conformance with Underwriters Laboratories, Inc., Standard 1008. The automatic transfer switch shall provide a minimum of 65kAIC.
- B. Acceptable manufacturers of transfer switches are Russelectric, Inc., Type RMT or Zenith or Automatic Switch Company, Type ASCO 7000, or equal.
- C. Provide double throw transfer switch; interlocked molded case circuit breakers or contactors shall not be used unless otherwise indicated.
- D. Provide load contacts with silver surfaces, arcing tips and arc extinguishing devices. Furnish switch capable of closing on in-rush current values to 20 times its full load rating without contact damage and capable of withstanding the system fault clearing time of the overcurrent device. Operate transfer switch from the source to which the load is to be transferred, with time of transfer in either direction not exceeding one-half second. Positively interlock the normal and alternate contacts, both mechanically and electrically, to prevent them from being closed together at any time. Furnish main contacts mechanically held in position.

- E. Provide the transfer switch with an internal manual operator that is safely operated from outside the enclosure with door closed. Provide the same contact-to-contact transfer speed as the electrical operator when manual operating handle is a permanently attached device to the operating mechanism.
- F. Construct switch that will not allow switch to remain in a neutral position with both main and alternate contacts open if a coil fails or there is a disarrangement of any part.
- G. On failure of a standby source, retransfer back to normal source without time delay if normal source available.
- H. Provide transfer switch with solid state, microprocessor based controller with LCD front panel screen to provide the following:
  - 1. Full-phase relay protection with three voltage sensing relays.
  - 2. Starting and load transfer to alternate source on a drop to 80 percent on any phase of normal voltage or frequency. Retransfer of load to normal source when voltage of all phases is restored to 90-95 percent.
  - 3. Nonadjustable time delay, 6 seconds, with suitable contact for engine starting.
  - 4. Transfer to standby generator when generator voltage and frequency are 90 percent of rated values.
  - 5. Adjustable time delay, 0 to 30 minutes, on transfer from alternate to normal.
  - 6. Auxiliary and control contacts as follows:
    - a. One closed contact when switch is connected to the normal source for remote alarm.
    - b. Two sets of contacts. Each set will include one contact to close when switch is connected to the normal source and one contact to close when switch is on alternate source.
    - c. Two normally closed contacts to open on detection of loss of utility power for remote alarms.
    - d. One normally closed contact to open to indicate transfer switch trouble or fail condition for remote alarm.
- I. After transfer to the normal source, engine generator to run for adjustable time period to 0 to 30 minutes before shutdown.

- J. Test switch to test operation of standby generator and transfer switch.
- K. Pilot lights to indicate presence of all three phases of normal source.
- L. Pilot light to indicate switch position.
- M. Terminal blocks for all external control and indication connections.
- N. Furnish on the external side of the front door the following sign of laminated plastic material, 3/32-in. thick, with 1/2-in. high white letters on a red background:
- O. Programmable exerciser to automatically exercise generator with or without load.
- P. Provide transfer switch within enclosure that meets the Area Classification Schedule NEMA ratings.

## 2.11 CONTROL PANELS AND ELECTRICAL ENCLOSURES

- A. Provide enclosures with back panels constructed of at least 14 gage steel and provided with terminal blocks for connection of external wiring. Provide door and body stiffeners in panels over 36 inches in length. NEMA 4 and NEMA 4X panels shall be provided with hand operated quick disconnects of 316 stainless steel material.
- B. Provide UL listed and NEMA rated pushbuttons, LED cluster type indicator lights and switches of heavy duty, oil tight types. Provide relays of industrial types, with 120-volt, 60-Hertz operating coils, and contacts rated for intended service. Power from fused control power transformers.
- C. Provide nameplates for each panel and each device on panel. Nameplates of laminated plastic material, at least 3/32 in. thick, and with white letters on a black background.
- D. Secure nameplates with self-tapping, Type 316 stainless steel metal screws.
- E. Terminal Blocks:
  - 1. Provide terminal blocks rated for 600 volts with screw type terminals.
  - 2. Terminal blocks to be one piece with full barriers.
  - 3. Acceptable manufacturers of terminal blocks are General Electric, Marathon, Weidmuller or equal.
- F. Provide print pocket on inside of enclosure and include as-built drawings.
- G. Where 480V AC and 120 VAC are required within the same enclosure, install components to insure separation of wiring for the panel voltage circuits.



- H. Free standing enclosures shall be provided with light fixtures, light switch and 20 amp GFI protected receptacle. Light fixtures shall be UL listed for wet locations and provided with glass globe, metal guard and LED light fixture.
- I. Where visual strobe or warning lamps are required, provide heavy duty beacon. Acceptable manufacturers are Edwards Signal Catalogue No. 93, Hubbell, Gamewell or equal.
- J. Where audible horn alarms are required, provide from the following acceptable manufacturers: Edwards Signal 870P, Simplex, Faraday, or equal.
- K. Where intrinsically safe wiring is required within the panels, the following requirements shall be met:
  - 1. Within enclosures, conductors or intrinsically safe (IS) circuits shall be separated two inches from conductors of any non-intrinsically safe circuit. Within the enclosure the conductors shall be secured.
  - 2. Intrinsically safe wiring shall not be routed in the same conduit as non-IS wiring.
  - 3. Terminals in panels with IS wiring shall be identified in a manner that will prevent unintentional interference with the control circuits during testing and servicing.
- L. All indicating lamps to be LED cluster type. Provide “Red” lights to indicate equipment on status. Provide “Green” lights to indicate equipment off status. Provide “Amber” to indicate alarm conditions.
- M. Provide enclosure types to meet the requirement of the area classification schedule indicated on the Contract Drawings.

#### 2.12 RUBBER MATS

- A. Provide insulating rubber mats conforming to ASTM D-178 Type I, Class I: Mats shall be 3 ft. wide and have a length equal to the equipment before which they are to be placed. Provide two spare mats, each 4 feet long as spares.
- B. Provide mats for transformers, panelboards, and control panels.

#### 2.13 CONTACTORS AND RELAYS

- A. Provide mechanically held, heavy duty industrial type contactors (relays) for lighting control, rated 30 amps, 600 volts, with number of poles as indicated.
- B. Provide contactor in the required NEMA enclosure suitable for wall mounting. Provide circuit breaker or fuse protection on each ungrounded pole. Provide mechanically held

contactor from the following acceptable manufacturers: Automatic Switch Company 917 series, Cutler-Hammer, Square D or approved equal.

- C. Provide control power transformer with primary and secondary fuse protection. Control power to be 120 volts, single-phase.
- D. Provide solid-state, industrial grade timing relays from the following acceptable manufacturers: Allen Bradley Series 700, Cutler-Hammer, Siemens or approved equal.
- E. Provide industrial grade relays, NEMA rated, from the following acceptable manufacturers: Square D Class 8501, Cutler-Hammer, Allen Bradley or approved equal.

#### 2.14 NAMEPLATES

- A. Provide nameplates for equipment (including pushbutton and selector switch stations) listed in this specification section to designate the equipment controlled and their function.
- B. Nameplates shall be laminated black bakelite with one-quarter inch (1/4-in.) high, white, recessed letters. Securely attach to the equipment with Type 316 stainless steel screws, or rivets. Adhesives, glue or cements will not be permitted.
- C. Provide all junction boxes, pull boxes, disconnect switches and control panels with a nameplate to designate the system wiring contained within.
- D. Install nameplates in a location near or on the equipment or devices.

#### 2.15 TERMINAL BLOCKS:

- A. Provide terminal blocks in all terminal boxes panels, control and instrumentation cabinets/panels requiring terminations as indicated on contract electrical drawings or by wiring diagrams for equipment actually purchased. All terminals shall be rated 600 V, 20 A. All terminals shall be screw type with provisions for white wire markers.

#### 2.16 WALL MOUNT CIRCUIT BREAKERS:

- A. Unless otherwise indicated, furnish manually operable circuit breakers and provide thermal-magnetic, inverse-time-limit overload, and instantaneous, short-circuit protection. U.L. listed circuit breakers conforming to NEMA Std. ABI.
- B. Provide molded case type breakers, rated 480 volts, 3 pole and having 100-ampere or larger frames. Interrupting rating equal to bus bracing shall be required. The molded case type breakers shall provide a minimum of 65kAIC.
- C. Furnish overload protection on all poles with trip settings as indicated. Breakers of 225-ampere frames and larger shall be provided with interchangeable trip units and adjustable magnetic trip elements.

- D. Provide circuit breaker within an enclosure in accordance with the Area Classification Schedule.

## PART 3 - EXECUTION

### 3.01 WIRING OF MISCELLANEOUS DEVICES

- A. Make electrical connections required for recording and indicating instruments, and miscellaneous devices. Provide electrical supplies to metering, instrumentation, and control systems.
- B. Connect HAND-OFF-AUTO switches, safety switches, tumbler switches, and other accessory devices as indicated or necessary for control of motors and other electrical equipment or devices.
- C. Install conduit and wiring and make electrical connections between all instrument panels, consoles, cabinets, and external equipment and devices. Panels, cabinets, etc., are indicated.

### 3.02 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS

- A. As specified in Section 26 05 10, install conduit, wiring, and connections for equipment and devices furnished under other Sections of specifications, and as indicated.
- B. Unless otherwise indicated, control equipment, relays, control wiring, conduit and connections for control of heating, ventilating, and air-conditioning systems are provided as specified in Section 23 00 00. Refer to mechanical specifications and drawings for locations of pressure-operated control switches, float switches, metering instruments, control panels, alarm actuating contacts, indicating lamps, limit switches, and other devices requiring wiring or interconnections with equipment supplied under Electrical Sections of these specifications.

### 3.03 CHANNELS

- A. Install Type 316 stainless steel for mounting of electrical equipment in outdoor areas, NEMA 4 or 4X areas, and on below grade, outside building and structure walls.
- B. Provide hot-dipped galvanized after fabrication for steel channel and accessories.
- C. Provide channel of the proper material to match equipment classifications, per Section 26 05 33.

### 3.04 PHYSICAL CHECKOUT AND TESTING

- A. Provide field and functional testing in accordance with Sections 26 05 10 and 26 08 13.

3.05 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 08 13

### FIELD INSPECTION AND ACCEPTANCE TESTS

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Provide field inspections and acceptance testing as specified herein.
- B. After electrical installation is complete, (a) adjust and set all protective devices (in accordance) with results of electrical studies, (b) perform tests to demonstrate that the entire system is in working order and in accordance with applicable codes, manufacturer's instructions, Drawings and Specifications. Test shall be performed per International Electrical Testing Association (NETA): Acceptance Testing Specification for Electrical Power Distribution System and Equipment (STD). Tests are in addition to, and not a substitution for, tests of individual items at the manufacturer's facilities. Perform insulation and ground resistance tests before operating tests. Determine proper rotation of motors before permanent connections are made.
- C. Tests are also intended to accomplish the following:
  - 1. Provide initial acceptance tests and recorded data.
  - 2. Ensure a successful start-up with a minimum of last minute interruptions and problems.
  - 3. Determine the suitability of the equipment and systems for energizing and placing into operating service.
  - 4. Ensure that each system component is installed satisfactorily, will perform and will continue to reliably perform its function.
- D. Provide all necessary supervision, labor, materials, tools, test instruments or other equipment or services and expenses required to test, adjust, set, calibrate, functionally and operationally check all work and components of the various electrical systems and circuitry throughout the installation.
- E. Engage the services of a nationally recognized Independent Electrical Tester to perform the required field inspections, test, and adjustments specified. The Independent Electrical Tester shall meet the following qualifications:
  - 1. The testing firm is not to be a subsidiary, division, or department of the Contractor.
  - 2. The testing firm is not to be subsidiary, division, or department of the manufacturer of the equipment, materials or systems being inspected or tested.

3. The testing firm shall be NETA certified and shall perform all testing in accordance with International Electrical Testing Association, Inc. (NETA), standards and procedures. All testing results shall be submitted on NETA forms and the testing data shall be certified by a Registered Professional Electrical Engineer in Delaware. Test results shall indicate recommended action for sub-par test results. Results shall list recommended test values that should be obtained for a new installation.
  4. Testing and checkout work shall be performed with personnel skilled and trained in the particular tests being conducted.
  5. Evidence of the proposed testing firm's qualifications, accreditation, and experience shall be submitted for evaluation. Testing shall be performed by a member of NETA or a testing agency having a minimum of five years of testing industrial electrical systems to NETA requirements and procedures.
- F. The Independent Electrical Testing Contractor shall provide supervision, labor, materials, tools, test instruments, or other equipment, and services, required to adjust, set, calibrate, and test operate the components of the various electrical systems and circuits throughout the installation, the construction package, and as specified herein.
  - G. Perform these tests after the electrical installation is complete. These tests shall demonstrate that the entire electrical system is in proper working order and in accordance with applicable codes, the supplier's instructions, drawings, and specifications.
  - H. Testing by the Independent Electrical Tester in no way changes the requirements to perform the specified tests, checkouts, and inspections required under the equipment specification sections.
  - I. The listings and descriptions of the tests, and checks described herein are not to be considered as complete and all inclusive.
  - J. Retests required by defects and failures of equipment to meet specifications shall be conducted at no additional cost.
    1. Replace wiring and equipment found to be defective, or failing to meet specified requirements, at no additional cost.
    2. Supply electric current necessary for tests.
  - K. Where specified in other Division 26 sections, perform work under the supervision of factory trained technicians, representing the equipment being tested or inspected.

## 1.02 SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 01 33 00:

1. Submit inspection and testing forms for all electrical distribution equipment to be inspected and tested under this specification section.
2. Submit data sheets for the insulation resistance testing of conductors and motors prior to performing operating testing. List all cables and motors to be tested.
3. Provide space on data sheet forms to enter the results of testing, instruments used with serial numbers, and name of personnel performing testing. This data to be filled out during testing.
4. After completion of the testing, submit all test results with observed notes and recommendations.

### 1.03 REFERENCES

A. All inspections and tests shall be in accordance with the latest revisions of the following applicable codes and standards except as provided otherwise herein.

1. National Electrical Manufacturers Association – NEMA
2. American Society for Testing and Materials – ASTM
3. Institute of Electrical and Electronics Engineers – IEEE
4. International Electrical Testing Association – NETA – Acceptance Testing Specification for Electric Power Distribution Equipment and Systems (STD).
5. American National Standards Institute – ANSI:
  - a. ANSI C2: National Electrical Safety Code
  - b. ANSI Z244-1: American National Standard for Personnel Protection
6. State and Local Codes and Ordinances
7. Insulated Cable Engineers Association – ICEA
8. Association of Edison Illuminating Companies – AEIC
9. Occupational Safety and Health Administration:
  - a. OSHA Part 1910; Subpart S, 1910.308
  - b. OSHA Part 1926; Subpart V, 1926.950 through 1926.960
10. National Fire Protection Association – NFPA:
  - a. ANSI/NFPA 70B: Electrical Equipment Maintenance

- b. NFPA 70E: Electrical Safety Requirements for Employer Workplaces
- c. ANSI/NFPA 70: National Electrical Code
- d. ANSI/NFPA 780: Lightning Protection Code
- e. ANSI/NFPA 101: Life Safety Code

B. All inspections and tests shall utilize the following references:

- 1. Project Design Specifications
- 2. Project Design Drawings
- 3. Manufacturer's instruction manuals applicable to each particular apparatus

#### 1.04 SCHEDULING

- A. The Contractor is responsible for the preparation of proposed procedures, testing and inspection forms, and schedules for all inspections, tests, settings and calibrations specified or otherwise required prior to or during the check out for start-up and acceptance of all the electrical components, equipment and systems. This work shall be coordinated and shall be compatible with the work of other crafts and the project schedule. The above must be organized and submitted with all proposed testing and NETA approved check out forms for the review. The procedures must provide specific instructions for the checking and testing of each component in addition to the system functional checks.
- B. Prior to check out and testing for start-up, verify that all equipment and wiring is permanently identified with nameplates and tags. Check and tighten all terminals and connection points, remove all shipping blocks and hardware, thoroughly clean all equipment, repair all damaged or scratched finishes, inspect for broken and missing parts and review and collect manufacturer's drawings and instructions. Make routine checks and tests as the job progresses to verify that all wiring and equipment are properly installed.
- C. Safety practices shall include, but are not limited to, the following requirements:
  - 1. Occupational Safety and Health Act
  - 2. Accident Prevention Manual for Industrial Operations, National Safety Council
  - 3. Applicable state and local safety operating procedures
  - 4. Owner's safety practices
  - 5. National Fire Protection Association



6. American National Standards for Personnel Protection
- D. All tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
- E. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.
- F. Ensure that all testing and checkout work is conducted in a safe manner. Special safety precautions such as the following to be utilized where appropriate:
  1. Locking and tagging procedures
  2. Barricades
  3. De-energization and/or isolation of equipment prior to testing
  4. Review of procedures with site personnel
  5. Erection of warning signs
  6. Stationing of guards and watchmen
  7. Maintenance of voice communications
  8. Personnel orientation
- G. Report all inspections, tests, and calibration in writing on NETA approved report forms. The recorded data form shall have the signatures of the persons conducting the tests and authorized witnesses. The forms shall serve as the test and inspection checklist for inspection requirements. Submit all test and check out data in accordance with Section 01 33 00 prior to adjustments, repairs, drying out, or similar work prior to final testing and acceptance. "As-found" and "as-left" test data to be recorded and reported in writing.
- H. Sequence tests and checks such that the equipment can be energized immediately after the completion of the applicable tests.

## PART 2 - PRODUCTS

### 2.01 TESTING EQUIPMENT

- A. Calibration:
  1. All calibration and setting checks by the Independent Electrical Test shall be performed with the laboratory's calibrated test instruments. This test equipment to have calibrations traceable to the National Bureau of Standards. The Independent Electrical Tester dated calibration labels shall be visible on all test

equipment. Calibrations over 6 months old will not be acceptable on field test instruments. All testing instruments shall be checked to verify satisfactory operation prior to proceeding with the tests. Serial and model numbers of the instruments used shall be recorded on the test forms.

2. Make necessary openings in circuits for testing instruments and place and connect all instruments, equipment, and devices, necessary for the tests. Upon completion of tests, remove instruments and instrument connections and restore all circuits to permanent condition.

## 2.02 TESTING

### A. Coordination:

1. Coordinate activities, and cooperate with others on project, to ensure that systems are energized when required, loads applied, and other requirements are carried out on timely, coordinated basis.
2. Conduct tests in presence of the Owner. Provide ten calendar days or more advance notification of when any test is to be performed.
3. Conduct testing such that warranties or guarantees are not voided. Coordinate all testing with manufacturer's factory trained technicians, where applicable. Where specified tests are not compatible with the manufacturer's recommendations, obtain the manufacturer's review prior to testing. Permit witnessing by the manufacturer's representative if so requested.

### B. Preparation:

1. Make up no low voltage connections at service entrance, transformers, and motors, permanently until correct phase rotation of all equipment is determined. Install and insulate these connections temporarily, if necessary, while determining proper rotation. Make permanent connections after proper rotation has been established and subsequent to completion of insulation resistance and dielectric tests.

## PART 3 – EXECUTION

### 3.01 INSULATION TESTS OF EQUIPMENT, CABLE, AND CIRCUITS

#### A. Independent Electrical Testing:

1. The Independent Electrical Tester shall perform all inspections and testing as specified herein.

#### B. List each circuit and measured resistance as test data.

- C. Maintain records of all insulation resistance values. Identify conductor, or equipment, date that value was taken, and resistance value. Submit the information in neat tabular form in accordance with General Conditions Article 4.7.

### 3.02 SPECIFIC TESTS AND INSPECTIONS

#### A. General:

1. The following specific items or work shall be performed by the Independent Electrical Tester. The equipment and cable shall be de-energized and isolated as necessary to perform the tests.
2. Perform tests and inspections as specified throughout Division 26. Tests and inspections required by these sections are not necessarily repeated under this section.
3. Provide assistance as requested by the Independent Electrical Tester in performing its work.

#### B. Equipment Test and Inspection During Construction and Prior to Acceptance Testing:

##### 1. Motors:

- a. Before energizing any machine, visually inspect for serviceability. Verify that proper alignment has been performed. Check nameplate for electrical power requirements.
- b. Test run all motors before placing into regular service. A check on the motor for rotation, speed, current and temperature rise shall be made and results recorded. Maintain the proper color codes for phase identifications. A motor phase rotation meter should be used prior to connection at motor to prevent later swaps of phase wires.

##### 2. Grounding Systems:

- a. All building loops and major equipment grounds to be tested to remote earth or directly referenced to a low resistance (3 ohm) reference ground benchmark. Visual inspection of all systems, raceway and equipment grounds to be made to determine the adequacy and integrity of the grounding. All ground testing results to be properly recorded, witnessed, and submitted.
- b. Ground tests shall be performed in accordance with NETA using a J. G. Biddle Company low resistance, Null balance type, ground testing ohmmeter, and test lead resistance compensated for. The test instrument to be the type which compensates for potential and current rod resistances.

- c. Test entire grounding system for continuity of connections and for resistance. Ensure that ground resistance of conduits, equipment cases, and supporting frames does not vary appreciably from that of system as whole and does not exceed 3 Ohms.
- 3. Circuit Breakers – Low Voltage:
  - a. At the time of equipment receipt, visually check the exterior for any damage or defects.
  - b. Perform complete inspection and electrical test in accordance with NETA.
- 4. Dry-Type Transformers:
  - a. All 480 volt primary, air-cooled, transformers shall be given an insulation test, by means of a megger, after connections with the primary cables are complete. The supply cable shall be meggered with the primary winding and to the open air circuit breaker. Secondary leads may be meggered with the secondary windings to the open load breakers.
  - b. Check continuity and correctness of connections of all windings and ratings.
  - c. Perform inspection checks, and electrical tests in accordance with NETA.
- 5. 600 V AC Wire and Cable:
  - a. Before energizing, the continuity and insulation resistance of all wiring shall be measured with a megger from each wire to all others and to ground.
  - b. All cables and wires to be checked for proper identification numbering and/or color coding.
  - c. Perform inspection checks and electrical tests in accordance with NETA.
- 6. Panelboard electrical checks shall be as included in the Wire and Cable section of this specification. Panelboards to be checked for proper circuit identification on the door schedule.
- 7. Sealing of Openings: Inspect the entire job to ensure that all openings and holes provided or utilized are properly sealed as specified.
- 8. Where referenced NETA Standards indicate optional testing, perform these tests as described.

3.03 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 26 20 00

ELECTRIC MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Low voltage electric motors and accessories furnished under other Sections, and which are a part of equipment assemblies shall be in conformance with the requirements specified in this Section, unless otherwise noted.
- B. Unless otherwise specified, all electric motors shall conform to the requirements specified herein.
  - 1. Motors shall be NEMA Premium Efficient as per NEMA-MG-1.

1.02 REFERENCES:

- A. National Electrical Code (NEC)
- B. Delaware Electrical Code (NJEC)
- C. Underwriters Laboratories, Inc. (UL)
- D. National Electrical Manufacturers Assoc. (NEMA)
  - 1. NEMA Standard MG-1 – Motors and Generators
  - 2. NEMA WP-1 – Enclosed Electric Motor
- E. American Bearing Manufacturers Association (ABMA)
- F. American National Standard Institute (ANSI)
- G. Institute of Electrical and Electronics Engineers (IEEE)
  - 1. IEEE Standard 112 – Test Procedures for Polyphase Induction Motor and Generators
  - 2. IEEE Standard 85 – Airborne Sound Measurements on Rotating Electric Machinery, Test Procedure for

3. IEEE Standard 429 – Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form – Wound Stator Coils
4. IEEE Standard 841 – Service Duty Totally Enclosed Fan Cooled (TEFC) Squirrel Cage Induction Motors

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Descriptive literature and motor characteristics, including thermal limit curves and speed vs. torque curves. Provide thermal limit curves for motors 75 Hp and greater and all motor data.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in return of the entire submittal without further review and consideration until the marked-up specification are re-submitted with the entire package.
3. Submit motor data with the associated driven equipment submittals.
4. Shop drawings and descriptive data to include:
  - a. Complete list of all motors to be furnished.
  - b. Outlines, dimensions, weights, and wiring diagrams.
  - c. Location of main and accessories boxes with size of conduit entrance.
  - d. Efficiency and power factor at 1/2, 3/4 and full load.
  - e. Bearing life data and grease requirements.
  - f. Nameplate data.
  - g. Prototype test data.
  - h. Ground pad locations.
  - i. Strip heaters KW and voltage ratings.

- j. Full load current
  - k. Locked rotor current
  - l. Full load torque in lb.-ft.
  - m. Starting and breakdown torque in percent of full-load torque
  - n. Number and frequency of permissible starts under specified conditions
  - o. Horsepower versus current curves
  - p. Moment of inertia of rotor
  - q. The zero load, rated speed (with no load connected) kW and kvar input
  - r. The locked rotor KVA and power factor at rated voltage
  - s. Service factor
  - t. Descriptive bulletins or catalog cuts with full description of the insulation system
  - u. Manufacturer, type, size and rating of bearings
  - v. Motor thermal limit or damage curves
5. Submit certified copies of all factory shop test results.
  6. Submit list of recommended spare parts and maintenance tools for each type of motor.
  7. Provide manufacturer's printed installation instructions including anchoring details to meet earthquake requirements as specified and indicated on the structural drawings.
  8. Performance Test Reports: Upon completion of installed system, submit in booklet form all field tests performed.

#### 1.04 QUALITY ASSURANCE:

- A. Motors shall comply with the latest reference standards specified.
- B. Routine tests shall be performed on representative motors less than 100 Hp in size and shall include the information described on NEMA MG1-12.54 Report of Test Form for Routine Tests on Induction Motors. Efficiency shall be determined in accordance with



IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

## PART 2 - PRODUCTS

### 2.01 ACCEPTABLE MOTOR MANUFACTURERS:

- A. ABB
- B. Reliance Electric
- C. Toshiba
- D. U.S. Electric Motors
- E. Or approved equal.

### 2.02 ELECTRIC MOTOR RATINGS:

- A. Voltage Ratings:
  - 1. Unless otherwise specified, motors with ratings of 1/2 to 500 Hp shall be rated 460-volt (nameplate rating), three-phase, 60-Hertz; motors of 1/3 Hp or less to be rated 115-volt, single-phase, 60 Hertz.
- B. The following specific motor requirements shall be identified in each equipment specification:
  - 1. RPM.
  - 2. Motor enclosure type.

### 2.03 MOTOR REQUIREMENTS:

- A. Every motor shall be of capacity to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or its specified temperature limit at rated voltage. Each motor shall develop the necessary torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where indicated on the electrical drawings to be operated on a reduced voltage starter, the motor shall develop the necessary torque under the conditions imposed by the reduced voltage starting method.
- B. The motor shall have capacity to operate the driven equipment as given in the equipment detail specifications. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.

C. Type of Motors:

1. All motors shall be NEMA Design B or of a type having starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be for full-voltage starting.

D. Insulation:

1. All motors shall have Class B (fractional horse power only) and Class F insulation for all other size motors.
2. Insulation systems shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies and mechanical or thermal shock for 480 Volt motors. Provide a Class F insulation system for an ambient temperature motor operation of 0 to 40 degrees C at no more than 3300 feet above sea level for inverter duty motors.
3. Motors shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.
4. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H insulation shall be used.

E. Enclosures:

1. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box, as specified below. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-in. diameter, shall be provided inside the conduit box for motor frame grounding.
  - a. Totally enclosed fan cooled: TEFC motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 40 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance.
  - b. Totally enclosed non-ventilated: TENV motors shall include the same rating and accessories as specified for TEFC motors.

- c. Explosion proof motors shall comply with all requirements of Class I, Division 1, Group D, hazardous locations as defined by the National Electrical Code and with all other safety codes pertaining thereto.
- d. Motors in NEMA 4, NEMA 4X and classified areas shall be provided with severe duty rating. Motors shall be of the corrosion resistant type conforming to motors designated by the manufacturer as “Corro-Duty”, “Mill and Chemical”, “Custom Severe Duty”, or similar quality designation. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box and 1.15 service factor at 40 degrees C and tapped drain holes (corrosion resistant plug for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger).

F. Special Purpose Motors:

1. Hermetically sealed air conditioning units, hoists, cranes and other devices complying with special safety codes shall be furnished with motors, control equipment, accessories and safety devices, in accordance with the manufacturer's standards and to be rated for the duty cycle as specified for the driven equipment. Service factor 1.15 above 3 hp.

G. Auxiliary Devices:

1. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and to be provided with a single conduit box.

H. General Design of Motors:

1. Motors shall comply with the latest NEMA Standards Publication No. MG1 for Motors and Generators, unless otherwise specified.
2. All polyphase non-explosion proof motors shall be provided with energy efficient operation and meet the requirements of MG1-12.53 a and b.
3. Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with an insulating compound that protects against moisture and slightly acid or alkaline conditions.
4. Bearings shall be of the self-lubricating type, provided so that there is proper alignment of rotor and shaft and to prevent leakage of lubricant.

- a. Bearings for open motors shall be of the sleeve or ball type, as specified under the respective items of mechanical equipment.
  - b. Bearings for totally enclosed and explosion proof motors shall be of the ball type.
  - c. Bearing L-10 fatigue life in hours at 100 percent load shall be 50,000.
  - d. Bearing grease shall be of the 120 deg. C thermal capability type.
  - e. Bearings for 50 HP and larger VFD driven motors shall be isolated type bearings.
5. Vertical motors shall be provided with thrust bearings for all thrusts to which they can be subjected in operation.
  6. All three phase two speed motors shall be of the two-winding design.
  7. All three phase motors shall be provided with a 1.15 service factor.
  8. Three phase motors shall be of cast iron construction including frame and end brackets.
  9. Motor nameplates shall be Type 316 stainless steel.
  10. Motor Terminal Boxes and Leads:
    - a. Motors shall be furnished with oversize conduit terminal boxes to provide for making and housing the connections, and with flexible leads of sufficient length to extend for a distance of not less than 4 in. beyond the face of the box. Solderless lugs shall be furnished. Totally enclosed and explosion proof motors to have cast-iron terminal boxes.
    - b. A grounding terminal shall be provided in the main terminal box and a bronze grounding bolt to be furnished at the conduit side of the motor frame.
    - c. For inverter rated motors, provide oversized terminal boxes with oversize conduit opening and oversized cable lugs for cables as indicated.

I. Motor Efficiencies:

1. Three phase motors rated 1 Hp and larger shall be of the premium efficiency, "Design E", type per Table 12.1 of NEMA MG1 Part 12. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112,

Method B. Motors with horsepower or rpms not listed shall conform to comparable standards of construction and materials as those for listed motors.

J. Shop Painting:

1. Unless otherwise specified, motors shall be given a shop application of paint filler or enamel sealer, a flat coat of undercoater for enamel, and two coats of enamel or, in lieu of this treatment, other corrosion-resistant treatment customary with the manufacturer.

K. Motor Data:

1. Provide five certified copies of characteristic curves of each motor furnished, except 115-volt motors. Curves shall be supplied as a part of the driven equipment submittal.

L. Motor Shop Tests:

1. Motor shop tests shall be made in accordance with the IEEE Test Codes as specified in the NEMA MG1 Standards for Motors and Generators. NEMA report-of-test forms to be used in submitting test data.
2. Motor efficiency shall be determined by use of IEEE Standard 112 Test Method B, and by use of MGI-12.53 a and b.
3. For induction motors 5 hp, up to 100 hp, copies of routine test reports of electrically duplicate motors shall be furnished.
4. For motors 3 hp or less, no test data need be furnished.
5. Where required by the load equipment specifications, provide testing support for shop testing at the equipment manufacturer's facility.

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Verify heaters are energized when supplied on motors.
- B. After motor installation, but before connection to power wiring, test motor winding insulation.
- C. After connection to power wiring, check for operating temperature, correct rotation, vibration, alignment and operating current drawn under load.

D. Submit all motor test results for review and record.

3.02 TESTING:

A. Inspect physical and mechanical condition.

B. Inspect for correct anchorage, mounting, grounding, connection, and lubrication.

C. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturers published data.

D. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

E. Megger test motor winding insulation.

F. Provide testing in accordance with Section 26 08 13.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 22 14

### DRY-TYPE TRANSFORMERS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide copper-wound, dry-type transformers as indicated and specified.
- B. Provide transformer windings and enclosures rated for the installation location and in accordance with the requirements herein.

##### 1.02 REFERENCES

- A. Underwriters Laboratories, Inc. (UL):
  - 1. UL 506 - Transformers, Specialty.
- B. National Electrical Manufacturers Association (NEMA):
- C. ST 20 - Dry-Type Transformers for General Applications (ANSI C89.2).
- D. TP-1 – Guide for Determining Energy Efficiency for Distribution Transformers.
- E. American Society for Testing and Materials (ASTM):
  - 1. D 635 - Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
- F. Delaware Electrical Code.

##### 1.03 SEISMIC DESIGN REQUIREMENTS

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

##### 1.04 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.

##### 1.05 SUBMITTALS

- A. Shop Drawings: Submit the following shop drawings in accordance with Section 01 33 00.
  - 1. Submit shop drawing and manufacturer's product data in accordance with the requirements of Section 26 05 10 – Electrical Work – General.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.
3. Submit shop drawings and manufacturer's product data of the transformer, enclosure, core and coil, insulation system and all specified accessories.
4. Provide manufacturer's printed installation instructions including anchoring details to meet seismic requirements as specified and indicated.

#### 1.06 REQUIREMENTS OF REGULATORY AGENCIES

- A. Furnish transformers in accordance with NEMA ST 20 and UL 506.
- B. Furnish transformers with UL listing mark.

#### 1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with requirements specified in Section 011006.
- B. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- C. Accept transformers on site. Inspect for damage.
- D. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle and stored in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Siemens
- C. Schneider Electric
- D. Or approved equal.



## 2.02 TRANSFORMERS

- A. Provide copper-wound, dry type transformers.
- B. In NEMA 1 and NEMA 12 designated areas, furnish general purpose, ventilated, dry-type transformers in indoor-style enclosure. On single-phase transformers and three-phase transformers above 9 KVA, provide two windings per phase.
- C. Auto transformers shall not be used in place of general purpose dry-type transformers.
- D. Furnish two 2-1/2 percent full capacity taps above and below nominal in high voltage winding for transformers rated above 15 kVA. Provide two five percent taps below rated voltage for transformers rated 15 kVA and below.
- E. Furnish transformers, single-phase or three-phase, as indicated. Furnish transformers with kVA ratings as indicated.
- F. Furnish three-phase transformers, Delta-Wye, Delta-Delta or Wye-Wye connected as indicated and conforming to latest NEMA standards. Scott-T connected transformers above 9 kVA shall not be used.
- G. Furnish transformers with primary and secondary voltages and frequency, wye connected, as indicated for secondary windings, with neutral brought out for cable termination.
- H. Furnish transformers that have continuous operation at rated kVA with normal life expectancy as defined in NEMA ST 20.
- I. For transformers rated 30 kVA or less, furnish 180 deg. C insulation. Performance shall be obtained without exceeding 115 deg. C average temperature rise by resistance or 145 deg. C hot spot temperature rise in 40 deg. C maximum ambient and 30 deg. C average ambient. Maximum coil hot spot temperature shall not exceed 185 deg. C.
- J. Transformers rated greater than 30 kVA shall be provided with 220 deg. C insulation materials with proven reliability and low-loss 80 deg. C full load operating temperature rise rating.
- K. Furnish transformers made of flame retardant materials that will not support combustion as defined in ASTM D 635.
- L. Furnish core mounting frames and enclosures of welded and bolted construction with mechanical rigidity and strength to withstand shipping, erection and short circuit stresses.
- M. Furnish transformers that meet UL thermal overload test of 200 percent of rated current for one half hour.
- N. Furnish transformers not to exceed the 65 deg. C rise established by UL as safe limit for maximum surface enclosure temperature.

O. Furnish transformers with sound level not exceeding:

Trans. kVA	Average Sound Level in dB NEMA ST 20
0-09	40
10-50	45
51-150	50
151-300	55
301-500	60

P. Install transformers with sound levels greater than 50 dB on resilient vibration isolating mounts to prevent amplification of sound. Transformers rated 15 kVA and larger to be provided with rubber washer anti-vibration pads and molded neoprene assemblies to isolate noise from the transformer to the mounting surface.

Q. Provide a grounded copper electrostatic shield between the primary and secondary windings. The design of the shield shall be to shunt noise and transients to the ground path.

R. Furnish transformers sized and configured for 100 percent neutrals for the secondary full load current.

S. Furnish transformers with copper windings.

T. Furnish transformers that meet efficiency guidelines of NEMA Standard TP-1 and DOE 2016 Efficiency levels.

### 2.03 SHOP TESTING

A. Furnish results of audible-sound-levels tests in accordance with NEMA ST 20 of similar size transformer.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install and guard transformers as specified by latest Delaware and ANSI standards, and in accordance with manufacturer's printed instructions.

B. Install transformers so that there is space around transformer to dispose of transformer full load losses by ventilation without ambient temperature reaching 40 deg. C. maximum as specified in Paragraph 2.2.

- C. Unless otherwise indicated, wall mount with supports, transformers rated 15 kVA and below. Floor mount transformers rated above 15 kVA.
- D. Provide lifting lugs and jacking plates on transformer enclosure.
- E. Provide concrete pad for all floor mounted transformers.

### 3.02 CHECKOUT AND TESTING

- A. Provide in accordance with Sections 26 05 10 and 26 08 13.

### 3.03 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 24 16

### PANELBOARDS

#### PART 1 – GENERAL

##### 1.01 DESCRIPTION

- A. Provide panelboards including circuit breakers, surge protection devices (SPD) and cabinets, as indicated and specified.
- B. Surge Protection Devices (SPD) shall be integral to the panelboard cabinet. SPD shall be as specified in Section 26 43 00.

##### 1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA):
  - 1. PB1- Panelboards
  - 2. AB1- Molded Case Circuit Breakers
- B. Federal Specifications (FS):
  - 1. W-P-115A - Panel, Power Distribution.
  - 2. W-C-375B - Automatic Circuit Breakers.
  - 3. QQ-S-365B - Silver Plating, Electro deposited, General Requirements for
- C. Delaware Electrical Code
- D. Underwriters Laboratories, Inc. (UL):
  - 1. UL 67 – Panelboards
  - 2. UL 489 – Molded Case Circuit Breakers

##### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
  - 1. Submit shop drawing and manufacturer's product data in accordance with the requirements of Section 26 05 10.
  - 2. Submit time current characteristic curves, short circuit rating, and data for each circuit breaker type and rating.

3. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.

#### 1.04 SEISMIC DESIGN REQUIREMENTS

- A. Conform to the requirements indicated on the structural drawings and as defined in Section 01 41 20.

#### 1.05 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.
- B. Review the manufacturer's recommended installation with the manufacturer prior to installation.

### PART 2 - PRODUCTS

#### 2.01 ACCEPTABLE PANELBOARD MANUFACTURERS

- A. Eaton Cutler-Hammer
- B. General Electric (GE)
- C. Siemens, Inc.
- D. Or approved equal.

#### 2.02 PANELBOARDS

- A. Provide factory assembled dead front type panelboards.
- B. Provide panelboards with branch circuit breakers and a main circuit breaker or main lugs only as indicated.
- C. Furnish panelboards with full capacity separate ground bus, separate neutral bus and furnish panelboards connected to a 3-phase, 4-wire service or single phase, 3-wire service as indicated. All buses shall be tinned copper.
- D. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB1, Federal Specification W-P-115A. UL 67, and the N.E.C.

- E. Furnish the panelboard main and 100% neutral buses, with 98 percent conductivity rectangular copper bars provided with bolted type lugs.
- F. Drill buses to fit either "A", "B" or "C" Phase connectors, and make sure that connectors are inter-changeable and installed in a distributed phase sequence.
- G. Silver plate copper buses connections and terminals, to a thickness of 0.005-in., conforming to the requirements of Federal Spec. QQ-S-365B.
- H. Prevent terminal lugs from turning per NEMA standard PBI and verify they can be used for the conductor material and size.
- I. Provide main bus-bracing for each panelboard for 10,000 amperes symmetrical short circuit at 240 volts or less and 65,000 amperes symmetrical short circuit at 480 volts unless otherwise indicated. Panelboards shall be fully rated, series rating is not acceptable
- J. Provide typed panelboard directory cards with the following information:
  - 1. Panelboard name designation.
  - 2. Panelboard voltage rating.
  - 3. Panelboard ampere rating.
  - 4. Panelboard short circuit rating.
  - 5. Panelboard pole/circuit numbers and branch circuit description as wired in the field.
  - 6. Indicate 2 pole and 3 pole branch circuit breakers.
  - 7. Label spare circuit breakers "spare".

### 2.03 CIRCUIT BREAKERS

- A. Furnish bolt-on type branch and main circuit breakers. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating. Furnish breakers meeting the requirements of F.S. W-C-375B and NEMA AB1. Provide circuit breakers marked with ampere trip rating that can be read at a distance of two feet from the panel. Provide breakers meeting the requirements of Fed. Spec. W-C-375B and NEMA AB1.
- B. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Automatic tripping indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip-free on overloads.

- C. Do not use single pole breakers with handle ties or bails in lieu of multipole breakers.
- D. Furnish handle locking device on all circuit breakers to prevent the manual opening of the selected breakers.
- E. Voltage and interrupting rating of all breakers in a panelboard shall not be less than voltage and short circuit rating of the panelboard main buses, as indicated. Series rated circuit breakers shall not be used. Furnish breakers to operate satisfactorily at the frequency indicated.
- F. Furnish ground fault interrupter circuit breakers for circuits as indicated. The circuit breaker shall be UL listed, Class A, Group I device (5 milliamp sensitivity, 25 millisecond trip time).
- G. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.
- H. Furnish time-current characteristic curves and catalog information and data for each size of breaker furnished.
- I. Provide transient surge protective devices in accordance with Section 26 43 00 as specified herein and as indicated.

#### 2.04 CABINETS

- A. Provide cabinets without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts. NEMA rating of panels to match areas as denoted on the drawings.
- B. Finish cabinet fronts, trims and surface-mounted boxes in ANSI No. 61 or 49, light-gray enamel over a rust-inhibitive primer. Front covers shall be hinged to cabinets and shall be double door (door in door) construction. Provide cabinets for surface or flush mounting as indicated.
- C. Unless otherwise specified, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters for the risers and outgoing circuits.
- D. Provide all panelboard locks keyed alike.
- E. Provide cabinets drilled only for the exact conduit entrances and mounting bolts.

#### 2.05 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Mount panelboards such that the height of the top operating handle does not exceed 6 ft. 6-in. from the floor.
- B. Hang each door of the cabinet on semi- or fully-concealed hinges with a combination catch and lock.
- C. On cabinets 48 in. high and over, install a 3 point catch assembly latching at top, bottom and middle.

### 3.02 CHECKOUT AND TESTING

- A. Provide checkout, field, and functional testing in accordance with Section 26 05 10 and 26 08 13.

### 3.03 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION



SECTION 26 32 13

DIESEL ENGINE-GENERATOR SET  
AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Furnish, place in operation, and field test standby diesel engine driven generator set, EPA Compliant, complete with instrumentation and controls, air cooled radiator and required supporting systems as specified herein.
- B. The unit shall be provided indoor.
- C. The generator system shall be provided with a sub base fuel storage tank
- D. The unit shall have a minimum standby power rating as specified in the contract Electrical Drawings at 80 percent lagging power factor with three-phase, 60-Hertz, 480 volt, four-wire, alternating current generator.
- E. The unit shall be arranged for automatic starting and stopping, and load transfer upon failure of the normal source of power.
- F. The engine generator set shall exhibit less than 20% voltage dip and less than 5% frequency dip during starting of the loads identified in Attachment A to this Section.
- G. The engine-generator package shall be complete in all respects and shall include all equipment and controls necessary for a fully operational standby power supply system.
- H. The generator unit shall comply with the State of Delaware, local and federal codes and regulations for standby diesel generators.

1.02 REFERENCES

- A. American Gear Manufacturers Association (AGMA)
- B. American Institute of Steel Construction (AISC)
- C. American Iron and Steel Institute (AISI)
- D. American Society of Mechanical Engineers (ASME)
- E. American National Standards Institute (ANSI)

- F. American Society for Testing Materials (ASTM)
- G. American Welding Society (AWS)
- H. American Bearing Manufacturers Association (ABMA)
- I. Institute of Electrical and Electronic Engineers (IEEE)
- J. National Electrical Code (NEC)
- K. National Electrical Manufacturers Association (NEMA)
- L. Occupational Safety and Health Administration (OSHA)
- M. Steel Structures Painting Council (SSPC)
- N. Underwriters Laboratories, Inc. (UL)
- O. National Fire Protection Association (NFPA)

1.03 DESIGN REQUIREMENTS:

- A. Provide an EPA emission standby certified generator and in compliance with Delaware emissions regulation and standards.

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
    - a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.
  - 2. Outline equipment drawings, equipment catalog cuts, internal wiring and ladder diagram schematics and other documents required to completely describe the systems and equipment being furnished. Elevation drawings with shipping splits and estimated weights identified.
  - 3. Identification, description and dimensions.
  - 4. Engine-generator skid base drawings.

5. Performance specifications of all items of equipment.
6. Engine generator loading calculation, per the requirements of Attachment A to this section.
7. Provide certificate of conformance to UL Standard 2200, Stationary Engine Generator Assemblies.
8. Attenuation curve for the silencing equipment as offered to accomplish the required silencing for this installation.
9. EPA Tier compliance certificate.
10. Data to be provided by engine generator system supplier:
  - a. Submit generator loading calculations and data for engine, generator, and accessories: (for rated kW capacity).
    - (1) Engine Data
      - (a) Manufacturer
      - (b) Model
      - (c) Number and arrangement of cylinders
      - (d) RPM
      - (e) Bore X stroke
      - (f) Maximum power at rated RPM
      - (g) BMEP at rated kW (including any parasitic loads and generator efficiency)
      - (h) Piston speed, feet per minute
      - (i) Make and model of governor
      - (j) Make and model of overspeed shutdown device
    - (2) Generator Data
      - (a) Manufacturer

- (b) Model
  - (c) Rated kVA
  - (d) Rated kW
  - (e) Voltage
  - (f) Temperature rise above 40 degrees C ambient. Stator by thermometer and field by resistance in degrees C.
  - (g) Class of insulation
  - (h) Generator efficiency including excitation losses at 80 percent PF
    - 1) Full load
    - 2) Three quarters load
    - 3) Half load
  - (i) Generator subtransient reactance in ohms
- (3) Guaranteed maximum fuel consumption rate at generator terminals @ 138,000 BTU/gallon of ultra-low sulfur diesel fuel:
- (a) Full load, gal/hr
  - (b) Three-quarters load, gal/hr
  - (c) Half load, gal/hr
- (4) Generator unit and accessories
- (a) Weight of unit
- (5) Exhaust gas emissions data, maximum values at full load, 3/4 load, 1/2 load, and 1/4 load:
- (a) Temperature in degrees F
  - (b) Flow in ACFM (mass and volume)
  - (c) Combustion air volume in CFM

(d) Cold cranking amperes rating of engine starting batteries (CCA).

11. Provide manufacturer's printed installation instructions including anchoring details to meet earthquake requirements as specified and indicated.
12. Performance Test Reports: Upon completion of installed system, submit in booklet form all field tests performed to prove compliance with specified performance criteria including final settings of devices.
13. Information on the proposed jacket water treatment and procedures for flushing of the cooling systems.
14. Engine-generator base drawings, indicating size and location of anchor bolts, and conduit locations.
15. Operations and Maintenance Manuals, covering all equipment furnished, annotated to reference only the specific model numbers supplied. Include parts lists and parts prices current to the date of submittal; include information relevant to part supply and ordering. Submit prior to the startup and testing of the engine/generator units.
16. Manufacturer's certified shop test record of complete engine driven generator unit.
17. As-built drawings and material summary shall be shipped with the equipment.
18. Control panel layout drawings, dimensions, and component bill of materials. Outline drawings showing conduit entry areas and anchoring information. Description of control including operation of interface equipment.
19. Complete electrical, instrumentation, control and wiring diagrams in sufficient detail to allow installation of instrumentation and controls and electrical components.
20. Time versus current characteristic curves for generator main circuit breaker.

#### 1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. The engine-generator set shall be factory designed, certified prototype tested, and as specified. The manufacturer shall be regularly engaged in the production of this type of equipment and shall maintain a permanent service organization and supply of spare parts, of the types utilized for the equipment specified herein.

- C. The manufacturer shall have testing facilities for performing the shop tests and inspections specified herein.
- D. Provide services of Service Technician, specifically trained on type of equipment specified. Person-day requirements are listed exclusive of travel time:
  - 1. Assist in location of devices, methods of mounting, field erection, inspection prior to energizing the equipment, etc.
    - a. 1 person-day
  - 2. Start-up and testing.
    - a. 2 person-days
  - 3. Operations and maintenance training.
    - a. 1 person-day per generator
  - 4. Person-day is defined as one 8-hour day, excluding travel time.
  - 5. The manufacturer shall certify that equipment has been inspected and is ready to be placed into service.

#### 1.06 UNIT PERFORMANCE:

- A. The units shall be utilized to provide standby power service in the event the normal source is not available.
- B. The voltage regulation shall be within plus or minus one percent from zero load to full-rated load. Upon application or removal of full-rated load in one step, the transient voltage dip and recovery to steady state operation shall be within five seconds.
- C. Stable or steady state operation is defined as operation with the frequency variation not exceeding plus or minus 0.25 percent (0.15 Hertz) and voltage variation plus or minus one percent of their mean value for constant load from zero load to full rated load. A rheostat shall provide plus or minus five percent voltage adjustment from rated voltage.

#### 1.07 ACCEPTABLE MANUFACTURERS:

- A. Cummins
- B. Kohler
- C. Caterpillar

- D. Or approved equal

## PART 2 - PRODUCTS

### 2.01 GENERAL:

- A. Engine-generator set shall be a factory-assembled unit that is a standard production unit with existing torsional analysis data.
- B. The engine and generator shall be directly connected with a flexible coupling, shall be free from injurious torsional or other vibration and shall be mounted on a heavy steel sub-base.
- C. The engine and generator shall be directly connected and shall operate at the same rotative speed. The use of gearing or other speed adjustment between the engine and the generator, such that the engine and generator operate at different rotative speeds will not be allowed.
- D. The engine-generator set shall allow easy access to the various parts for maintenance purposes.
- E. The engine-generator set shall be pre-piped and pre-wired.
- F. The complete engine-generator unit shall be free from harmful torsional or other vibration throughout the entire operating range of speed and load. The engine manufacturer shall provide, an analysis of the complete engine-generator unit, which shall show where any critical speed will be encountered, together with the order, the frequency and magnitude of any critical speed.
- G. The generator set and sub base fuel tank shall not exceed length and width as shown on the Contract Drawings.
- H. The sub base diesel fuel tank shall provide 24 hours at full load.

### 2.02 ENGINE:

- A. The diesel engine shall be of V-type construction, sixteen cylinders, four-stroke cycle, turbo-charged, full compression ignition, diesel, with electronic fuel injection. The unit shall operate at a speed of 1800 rpm.
- B. The rating of the engine shall not exceed the manufacturer's published standby rating. The gross engine horsepower required to produce the standby rating shall not exceed the manufacturer's published continuous duty rating by more than 150 percent. Continuous duty rating shall be as defined in BS649 or DIN6270 but in no case shall it exceed the manufacturer's published continuous duty rating. The gross engine horsepower required

for the generator set standby rating described above shall include all parasitic demands such as generator inefficiencies, fuel pumps, water pumps, and all accessories necessary to the unit's proper operation while operating at rated loads.

- C. The engine shall be capable of satisfactory operation on ultra-low sulfur diesel fuel.

## 2.03 EQUIPMENT:

### A. Governor:

1. Provide isochronous solid state governor, capable of maintaining isochronous regulation from no load to full rated load within 0.25 percent of rated frequency.
2. The governor controller shall be mounted within the generator control panel. The governor shall have the capability for manual adjustment of speed setting and speed droop. Speed droop shall be adjustable from 0 to 5 percent from no load to full load. The controller shall eliminate all electromagnetic interference.
3. Provide a separate overspeed shutdown device which shall, in case of predetermined overspeed of the operation of various protective devices as later specified, instantly stop the engine without the fuel injection system losing its prime.

## 2.04 GENERATOR AND EXCITATION SYSTEM:

- A. The generator shall be drip-proof, guarded, and be able to connect to the specified engine output and shall be 3-phase, 60-Hertz, 4-wire, 480 volt operation, "WYE" connected. The generator shall be mechanically and torsionally matched to the engine driver and shall be provided to withstand inherent pulsating torques of the engine. Full load efficiency of the combined generator, exciter and regulator shall be not less than 95 percent.
- B. The generator shall conform to the applicable parts of the following standards, unless otherwise specified:
  1. NEMA MG1, Motors and Generators
  2. IEEE 43, Recommended Practice for Insulation Testing of Large AC Rotating Machinery
  3. CSA C22.2-100 Designation ABL3
  4. Testing shall be in accordance with IEEE-115 and NEMA MG-1 standards
- C. The generator windings, insulation and excitation system shall be braced to withstand any possible short-circuit stresses.



- D. The temperature rise of the generator windings, when operated at rated prime power load and under continuous duty conditions with cooling air inlet temperature of 40 degrees C, shall not exceed 130 degrees C when measured by the resistance method.
- E. The stator frame shall be fabricated bar and plate steel construction.
  - 1. All insulation materials used in the stator shall have a temperature rating of Class H per IEEE Standard 1. The coils shall be of a formed coil construction using a magnet wire meeting NEMA MW36-C specifications.
  - 2. The complete stator shall be wound with a 2/3 stator winding pitch and processed in a vacuum pressure impregnation chamber. Encapsulation of the stator shall be accomplished with a two-part epoxy system.
- F. The rotor shall be of the fully laminated, salient pole type. Cooling fans shall be an integral part of the rotor assembly. The rotor shall be dynamically balanced for all speeds up to 125 percent of rated speed per NEMA specification.
  - 1. Insulation materials used on the rotor shall have a temperature rating of Class H. The poles shall be of a layer wound construction using a magnet wire meeting NEMA MW35-C or MW36-C specifications.
  - 2. The complete winding and rotor pole assembly shall be in a vacuum pressure impregnation chamber. Encapsulation of the assembly shall be accomplished with a thixotropic, single component epoxy resin.
- G. The exciter shall be a high frequency, direct connected, rotating brushless type, three phase, full wave rectified, and shall be matched with the generator rotor and control system. Both the armature and field windings shall be a vacuum pressure impregnated with epoxy resin.
- H. The pilot exciter shall be permanent magnet generator type. The stator winding shall be vacuum pressure impregnated with epoxy resin. The permanent magnet generator shall have the ability to provide a nominal 300 percent of the 130 degrees C rise rated three-phase short circuit for ten seconds at the alternator terminals.
- I. The digital voltage regulator shall be hermetically sealed, silicon controlled rectifier type and shall employ a zener reference and three phase sensing. The voltage regulator shall provide automatic protection of the entire unit on 3 phase short-circuits. The voltage regulator shall include automatic over-excitation and under-frequency protection. Input isolation transformers and filters shall be provided. Exciter shall be fast response type with a rotating rectifier and surge suppresser, 3-phase, full-wave bridge.

- J. The voltage regulator and associated equipment shall be mounted in the generator terminal box. Manual voltage adjustment potentiometer shall be mounted in the Generator Control Panel.
- K. Generator stator leads shall be connected to tinned copper bus bars in an oversize terminal box. The box shall allow bottom entry of cables and conduits shown on the contract drawings.

## 2.05 SYSTEMS:

### A. Engine Fuel System:

1. Diesel fuel system shall consist of an engine-driven fuel supply pump, fuel filters and lift pump set.
2. Fuel filters shall have elements be easily replaced without breaking any fuel line connection or disturbing fuel pumps or any other part of engine.
3. The engine generator shall be provided with external above ground diesel fuel storage tank specified under Section 23 10 00.

### B. Electric (Battery) Starting System:

1. Starting shall be accomplished by a 24-volt, engine mounted, solenoid shift electric starter, capable of withstanding four consecutive continuous cranking periods of 10 seconds duration each separated by 10 seconds rest periods before shutting down completely and sounding the overcrank alarm.
2. The starting batteries shall be low maintenance, premium industrial grade, high-output, long-life, lead acid type especially designed for diesel engine cranking service, and of a capacity as recommended by the battery manufacturer for cranking the engine being furnished. The engine starting batteries shall be sized to also supply power to the generator control panel.
3. Furnish an engine starting battery charger for charging the starting batteries for the engine. The battery charger shall be U.L. listed, fully automatic, filtered, equalize and float-type, appropriate for wall or rack mounting. Supply voltage shall be 120 volts, AC, single phase, 60 Hz. The DC output shall be not less than 20 amperes, regulated to within one percent with plus or minus ten percent fluctuations of the input voltage, and shall be current limited at 120 percent of rated output. Accessories shall include DC ammeter and voltmeter (panel type; 2 percent accuracy), adjustable float and equalize controls toggle switch, AC and DC circuit breakers, AC power failure alarm relay, low DC voltage alarm relay and DC ground fault relay. Fault relays shall operate individual alarm indicators on the face of the charger panel and shall also operate a common alarm relay for remote transmission of alarm. Charger shall have a continuous power rating

sufficient to power all generator control devices in both the standby mode and the running mode.

C. Lubrication System:

1. The engine shall be provided with a full pressure lubricating oil system arranged to lubricate and cool the pistons and distribute oil to all moving parts of the engine including the turbocharger bearings. The system shall include a full flow oil filter of the replaceable element type, an appropriately sized shell and tube type oil cooler, and an automatic temperature regulator.
2. Furnish a low oil level float switch to alarm to the generator control panel.

D. Engine Cooling System Radiator:

1. General: Provide a unit mounted radiator complete with integral jacket water circulating pump, thermostatic central of cooling system, fan and drive motor sized to maintain full load operation continuously as specified herein for engine-generator set.
2. Provide radiator to operate engine at full rated generator load at 104 F ambient temperature.
3. Provide jacket water treatment for the prevention of both scale formation and corrosion in the engine water jackets and cooling system components which are in contact with the engine jacket water. This treatment shall be added to the cooling system prior to running the field acceptance test.

E. Miscellaneous Equipment and Requirements:

1. Heaters:
  - a. Automatic thermostatically controlled heater(s), shall be provided to maintain not less than 90° F temperature for the engine jacket water system.
  - b. Engine Jacket Water Heater shall be rated 208V, single phase, and generator heater shall be rated 120V, single phase.
  - c. Automatic thermostatically controlled heater(s), shall be provided to prevent condensation in the generator stator.
  - d. Generator stator heater shall be rated 120V, single phase.
  - e. Heater shall be automatically deactivated when the engine-generator unit is in operation.

2. Emergency Stop Pushbuttons:
  - a. Furnish emergency stop pushbuttons as follows:
    - (1) One on the engine control panel.
  - b. The emergency stop buttons shall be maintained type, red colored, push to stop, mushroom type with a hinged plastic Lexan cover, labeled as "Emergency Stop," "Push."
  - c. Each pushbutton shall be wired to the engine-generator instrument/control panel and shall immediately stop the engine.
3. Silencer:
  - a. Provide hospital grade rated generator silencer to withstand exhaust flow pressure and temperature without creating excessive engine backpressure.
4. Control Power Fuses:
  - a. Fuses shall be mounted in locations where they are accessible. Pullout type fuses shall be provided.
5. Main Circuit Breaker
  - a. Provide generator with a molded case circuit breaker to protect generator against overload and short circuit conditions. Circuit breaker shall be rated for 65 kA short circuit symmetrical and shall conform to the provisions of NEMA Standard AB1 and UL Standard 489.
  - b. Provide circuit breaker with microprocessor-based rms sensing adjustable trip unit, rating plug, long-time, short-time and instantaneous protective relaying and ground fault protection.
6. Terminal Blocks:
  - a. Terminal blocks shall be one-piece, 20 AMP rated, with barriers appropriate for ring tongue terminals and provided with binding head screws. The terminal block rating shall be 600 V.

7. Solid State Circuitry:

- a. Heavy-duty solid state controls, relays, timers or monitors shall meet the following specifications:

Accuracy:	+ 2% of set point
Temp Range:	- 40 C to +65 C (-40 F to 150 F)
Protection:	Transient overvoltage withstand of 1500 volts peak, 1 m sec. time constant
Ratings:	Current ratings to exceed application of devices. Devices shall be UL listed.

2.06 SYSTEM OPERATING SEQUENCE:

- A. The engine generator unit shall be operated in the following manner:

1. The engine generator unit shall be arranged for automatic or manual starting and stopping.
2. The engine generator shall be brought up to rated voltage and frequency and closed onto the open transition automatic transfer switch (ATS-1).

- B. Normal – system utility powered:

1. During normal system operation, the normal utility shall power the electrical distribution system with loads as indicated.

- C. Loss of utility power - standby operation:

1. Upon loss of utility power, automatic throw-over system shall sense loss of power and after an adjustable time delay the automatic transfer switch shall initiate generator start.
2. When the generator is up to speed and capable of accepting load, DP-1 loads will transfer to generator power.
3. Upon return of utility power, automatic throw-over system shall initiate transfer back to the utility after an adjustable time delay.
4. After an adjustable cool-down period, the engine-generator shall shutdown.

## 2.07 ENGINE CONTROL PANEL:

- A. The engine starting control logic shall be microprocessor based and shall automatically start, protect and monitor the engine-generator set. Electro-Mechanical controls are unacceptable.
- B. The following gauges shall be mounted within an engine mounted control panel. Gauges shall be digital:
  - 1. Jacket water temperature cooler temperature into heat exchanger
  - 2. Lube oil temperature
  - 3. Lube oil pressure
  - 4. Lube oil filter differential pressure.
- C. An engine coolant level switch shall be furnished. Level switch shall shut down generator on low level.
- D. The engine starting control logic shall be capable of controlling the following engine devices.
  - 1. Starting motor magnetic switch.
  - 2. Electrically operated fuel control.
  - 3. Normally open protective switches that close for abnormal conditions of pressure, temperature, speed and liquid level.
- E. The panel shall have the following controls:
  - 1. Emergency stop
  - 2. Lamp test
  - 3. Cycle crank
  - 4. Voltage control
  - 5. Cool-down timer
  - 6. Phase selector switch
  - 7. Programmable relays 4 (std)

8. Stop/Auto/Test.
- F. The panel shall be provided with the following indicating lights:
1. Low oil pressure
  2. High coolant temperature
  3. Over speed
  4. Over crank
  5. Emergency stop
  6. Fault shutdown
  7. 3 spare lights, programmable input.
  8. Not in Auto
- G. Protection shall include:
1. Over and under voltage
  2. Over and under frequency
  3. Low coolant level
  4. Oil temperature.
- H. Provide contacts to alarm the following functions:
1. Low oil pressure
  2. Low battery voltage
  3. Common fault alarm
  4. Not in automatic
  5. E-stop activated
  6. Generator run status
- I. Provide analog (4-20mA) output from fuel tank control panel for fuel level.

- J. Engine Start/Stop Operation: The automatic engine control logic shall initiate operation of the engine upon receipt of a signal from a contact at automatic throw-over system. The contact(s) shall close for engine run and open for engine stop.
- K. If the engine fails to start after 4 adjustable cranking attempts (factory set at 10 seconds on, 10 seconds off, adjustable from 5 to 30 seconds) or if any protective device should operate while the engine is running, the engine shall be disconnected from service and immediately stopped. The engine control logic shall lock the failed set out of service and requires a manual reset. The engine control logic shall include a provision for conversion to single cycle cranking, adjustable from 35 to 210 seconds.
- L. Three-position engine control switch:
  - 1. **Stop/Reset:** In this position, the engine shall not be capable of starting and/or running. If the engine was shutdown due to the operation of a protective device, the shutdown malfunction shall be reset when the switch is moved to this position. If the engine is running when the switch is moved to this position, it shall be immediately shutdown.
  - 2. **Automatic:** In this position, the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.
  - 3. **Test:** When placed in this position, the engine shall start and run as if a start signal were received except it shall not be connected to the bus unless a start signal is received. When returned to the automatic position, the engine will shut down.

#### 2.08 SHOP PAINTING:

- A. The engine-generator set shall be shop primed and finished coated in accordance with the manufacturer's standard practice prior to shipment. A supply of touch-up paint shall be supplied by the manufacturer.

#### 2.09 SHOP TESTING

- A. The complete engine-generator set shall be shop tested to simulate a complete and integrated system prior to shipment.
- B. Provide all details of the proposed testing, including arrangements, test instruments and calibration, and procedures to be used to verify controls and alarms. Four copies of the complete certified test record shall be submitted within 30 days after the completed test.
- C. Tests shall assure that unit will operate successfully and meet all specified operational requirements.
- D. The shop test shall include four continuous hours of operation at full load and at varying



power factor. Voltage and frequency regulation and transient response shall be tested and recorded to show full compliance with this specification. During the shop test, readings shall be taken and recorded every thirty minutes for each of the following:

1. Time
2. Ambient temperature
3. Volts for each phase
4. Load:
  - a. Amps for each phase
  - b. KW
  - c. Power factor
  - d. Frequency
5. Engine jacket water temperature
6. Lubricating oil pressure
7. Exhaust gas temperature
8. Fuel consumption.

E. The procedure for the shop test of the diesel engine shall cover the engine manufacturer's standard practice.

#### 2.10 SPARE PARTS:

- A. Provide a recommended list of spare parts.
- B. Provide one year supply of all filter types installed.

### PART 3 – EXECUTION

#### 3.01 INSTALLATION

- A. The generator unit shall be installed as indicated and in accordance with the manufacturer's instructions.
- B. Provide services of a qualified factory representative to inspect in detail the installation of the engine-generator units, and related auxiliary systems, prior to energizing any equipment to confirm manufacturer's recommended installation.

- C. The generator unit shall be mounted on a concrete pad provided by the Contractor under this contract.

### 3.02 EQUIPMENT START-UP

- A. Provide fuel for startup and testing of the generator unit as specified.
- B. Operate the unit to demonstrate ability to operate continuously without vibration, jamming, leaking or overheating and to perform specified functions, after installation and after manufacturer's representative check of installed equipment.
- C. Comply with manufacturer's operating and maintenance instructions during start-up and operation.
- D. Make all final adjustments necessary to place the equipment in working order. Prior to any testing or operation of the units, the manufacturer's service representative shall inspect the installation, and shall certify, in writing, that the assemblies are, in all ways, ready for operation. Start-up shall not commence without the presence of the manufacturer's representative.

### 3.03 FIELD TEST

- A. Upon completion of the installation and as soon as conditions permit, the diesel engine driven generator, including the engine, generator, electrical circuit controls, transfer controls other devices shall be tested in the presence of the Owner by the Contractor and the service representative for the manufacturer of the engine driven generator unit to assure that the system functions as specified.
  - 1. Perform load bank tests with portable load banks for a four-hour duration to verify loading and ratings. Take system data readings each 30 minutes.
  - 2. Perform actual load test with the facility operating loads connected to the engine. Run the test for a duration of four hours.
  - 3. During the test, system parameter readings, shall be taken and recorded at 30-minute intervals.
- B. As part of the field test, each of the automatic shutdown devices shall be tested and the respective values recorded at which the devices will stop engine. Any adjustments required shall be made in the devices to make the operating values correspond to those recommended by the engine manufacturer and as recorded during the stop test.
- C. Take and record octave band sound pressure level readings while the engine driven generator is operating using the station load. These readings shall be within the limits identified in the engine generator data submittals for acceptable sound level.
- D. At the conclusion of the specified testing, the Contractor shall fully fill the diesel fuel tank for Owner's use.

3.04 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

ATTACHMENT A  
TO SECTION 26 32 13

Loads to be powered up by the engine-generator for engine generator load calculation. The Generator shall be capable of picking up the loads in order shown.			
<b>Distribution Panels DP-1/DP-2</b>			
<b>Equipment</b>	<b>Total Quantity</b>	<b>Quantity Operating</b>	<b>HP/AMPS/kVA/kW</b>
<b>STEP 1</b>			
Pump Room Supply Fan 10-SF-1**	1	1	(Operating) 0.75 HP
Pump Room Exhaust Fan 10-EF-1**	1	1	0.75 HP
Lighting Panel LP-1	1	1	35.77 kVA
Heating load EDH-1	1	1	21.9 kW
Electric Unit Heater EUH-1,-2,-3	3	3	15 kW
<b>STEP 2</b>			
Monorail RWW.HST-1	1	1	(Operating) 5 HP
Grinder CH.GR-1	1	1	5 HP
Overhead Door OHD-1	1	1	0.5 HP
<b>STEP 3</b>			
RWW.PMP-1/2*	2	1	60 HP
* Motor is powered by reduced voltage soft starter.			
** Full Voltage Non-Reversing Starters (FVNR)			

SECTION 26 41 13

LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide lightning protection system for the pump station building as indicated on the contract drawings. The system shall consist of air terminals, conductors, ground terminals, interconnection conductors, arresters, and other connectors or fittings for a complete system.
- B. All systems are to be provided and installed by a trained Service Technicians having five (5) years active experience. Provide proof of previous MASTER LABEL installations receiving the U.L. "C" plate of acceptance.

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Section 26 05 10: Electrical Work – General
- C. Section 26 05 26: Grounding
- D. Section 26 08 13: Field Inspection and Acceptance Tests

1.03 REFERENCES:

- A. Underwriters' Laboratories, Inc. (UL):
  - 1. UL-96: Lightning Protection Components.
  - 2. UL-96A: Installation Requirements for Lightning Protection Systems.
- B. National Fire Protection Association (NFPA):
  - 1. NFPA-70: National Electrical Code.
  - 2. NFPA-780: Lightning Protection Code.
- C. New Jersey Electrical Code.

#### 1.04 SUBMITTALS:

##### A. Submit the following in accordance with Section 01 33 00:

1. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.
  - a. Failure to include a copy of the marked-up specification sections will result in rejection of the entire submittal with no further review and construction.
2. List of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, installation instructions.
3. Detailed shop drawings, drawn to scale, indicating type, placement, and location of protection devices, including cable attachments, grounding, mounting and any other details integral with the system for each structure.
4. Submit a Certificate of Delegated Design Services signed and sealed by a registered professional Delaware engineer stating the system meets the specified requirements and the applicable codes and standards.
5. Spare Parts Data: Provide a list of recommended spare parts for the material and equipment to be provided, including current unit prices and source of supply.
6. Inspection and Maintenance: Provide a written recommended inspection and maintenance procedure, including periodicity of inspections.
7. As-Built Drawings: Provide a complete set of "as-built" drawings showing the location of all grounds as well as a detailed layout of type, size, location and method of installation of all downleads, roof cables, bonding leads and connections, air terminals, and in the case where structural steel is used for downleads, the method and location of all roof and ground connections to the steel must be clearly detailed.
8. Submit U.L. MASTER LABEL Certificate of Compliance for the work performed.

#### 1.05 QUALITY ASSURANCE:

- A. Conduit size and wire quantity, size, and type shall be useable for the equipment supplied.
- B. Provide systems furnished and installed by trained Service Technicians.

C. Provide UL listed components.

1.06 REQUIREMENTS OF REGULATORY AGENCIES:

A. Conform to UL 96 and 96A and NFPA-780.

1.07 SEISMIC REQUIREMENTS:

A. Conform to the requirements as indicated on the structural drawings and as specified in Section 01 41 20.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. National Lightning Protection.

B. Lightning Master Corp.

C. Alltec Corp.

D. Or Approved Equal.

2.02 MATERIALS:

A. Class I Materials: Provide conductors, fittings, and fixtures to protect ordinary buildings and structures not exceeding 75 feet (23 m) in height.

B. Materials, Class I. Table I gives sizes and weights for air terminals, and main and secondary conductors. Secondary conductors which are used for bonding and interconnecting metallic bodies to the main conductor, and which will not be required to carry the main lightning current, may be reduced in size to No. 6 AWG copper. Provide main conductor size for interconnection to metal water systems, steam or hot water heating systems, or other metallic masses having a low resistance to ground.

C. Table I: Class I Material Requirements:

Type of Conductor		Tinned Copper	
		Standard	Metric
Air Terminal, Solid	Diameter	1/2 inch	9.5 mm
Air Terminal, Tubular	Diameter		15.9 mm
	Wall Thickness	.032 inch	0.8 mm
Main Conductor, Cable	Size ea.	17 AWG	
	Strand Wgt. Per Length	187 lbs/1000 ft. 57,400 cm	478 g/m 29 square mm
	Cross Sect. Area		
	Thickness	16 AWG	
Main Conductor, Solid Strip	Width	1 inch	25.4 mm
	Wire Size	17 AWG	
Secondary Conductor, Cable	Number of Wires	14	14
	Thickness	16 AWG	
Secondary Conductor, Solid Strip	Width	1/2 inch	12.7 mm

D. Class II Materials: Provide conductors, fittings and fixtures necessary to protect ordinary buildings and structures exceeding 75 feet (23 m) in height; or one of any height which has a structural steel frame that may be substituted for lightning down conductors. Table II gives sizes and weights for air terminals and secondary conductors for Class II structures.

E. Table II: Class II Material Requirements:

Type of Conductor		Tinned Copper	
		Standard	Metric
Air Terminal, Solid	Diameter	1/2 inch	12.7 mm
Main Conductor, Cable	Size ea.	16 AWG	
	Strand Wgt. Per Length	375 lbs/1000 ft. 115,000 cm	558 g/m 58 square mm
	Cross Sect. Area		
	Wire Size	17 AWG	
Secondary Conductor, Cable	Number of Wires	14	14
	Thickness	16 AWG	
Secondary Conductor, Solid Strip	Width	1/2 inch	12.7 mm

F. Where any part of a protection system is exposed to mechanical injury, provide protection using molding or tubing with non-metallic clamps. If ferrous metal pipe or tubing is used around the conductor, connect the conductor electrically to the pipe or tubing at both ends.



- G. Furnish all conductors of stranded tinned copper, annealed to 98 percent conductivity, unless specifically otherwise stated by the Contract Documents. Provide all fittings, connectors, clamps and fasteners of high corrosion resistant materials that can be used for the intended environment and compatible with copper conductors.
- H. Provide all fastening devices compatible with surface materials they are to be attached. Direct copper to aluminum contact is not allowed.
- I. Copper-clad steel shall have a copper covering permanently welded to the steel core, in such proportions that conductance is 30 percent of the conductance of an equivalent cross section of solid copper.
- J. Where the installation requires aluminum materials, aluminum is acceptable as a substitute for copper in lightning protection, with the stipulations that: (a) aluminum shall not be used underground, in contact with ground or where air may be laden with corrosive elements, such as ocean air; (b) when an aluminum system is joined with copper or copper-clad grounds, the union shall be made with bimetal connectors; (c) precautions be taken at connections with dissimilar metals; and (d) cable conductors be of electrical conductor grade aluminum.
- K. Material such as galvanized steel is not acceptable.

#### 2.03 AIR TERMINALS:

- A. Air terminals shall be provided and located to intercept a direct lightning strike.
- B. Air terminals shall be 1/2 inch as indicated. Air terminals shall extend above the protected object between 10 inches and 36 inches. If over 24 inches high, air terminals shall be braced.
- C. Air terminals up to 24 inches high shall be spaced at intervals of 20 feet or less; those 24 inches or higher shall be spaced 25 feet or less. Terminals shall be placed on the ridges of gable, gambrel, and hip roofs of ordinary or high slope, and at the perimeters of flat or low-slope roofs. A shed roof with a high or normal slope shall be considered as half of a gable roof. There shall be an air terminal within two feet of the end of each ridge or each corner of a flat or low-slope roof.
- D. Air terminals shall be placed within two feet of the edge along the perimeter of a flat or low-slope roof. A low-slope roof is one which is 40 feet wide or less and has a pitch of 1/8 or less; or is over 40 feet wide and has a pitch of 1/4 or less. The center of such a roof shall have intermediate air terminals at intervals not exceeding 50 feet.

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Provide all material, equipment, and labor to install the lightning protection system as indicated and as specified. Equipment shall be installed by Service Technician specifically trained on installing lightning protection.
- B. Main conductors shall: (a) interconnect air terminals in a direct or closed-loop roof system; (b) serve as downloads from the roof system to the ground system; (c) connect metal bodies of inductance or conductance to the main conducting system; and (d) serve as ground electrodes in some cases, or to connect ground rods in certain other cases.
- C. Bend of conductor shall form an included angle of 90 degrees and have a radius of bend of 8 inches (203 mm).
- D. Interconnect all conductors, air terminals to form a two-way path from each air terminal horizontally or downward to connections with ground terminals.
- E. Conductors may be coursed through air without support for a distance of 3 feet (900 mm) or less. With a 5/8 inch (15.9 mm) rod or its equivalent as a support, fastened at each end, a conductor may be coursed through air for a distance not to exceed 6 feet (1800 mm).
- F. Install roof conductors to interconnect all air terminals and provide a two-way path to ground horizontally or downward from the base of each terminal.
- G. Install two down conductors on any kind of structure. Location depends on placement of air terminals, size of structure, most direct coursing, security against displacement and location of metallic bodies, water pipes, and ground conditions. Separate down conductors. For structures over 200 feet (71 m) in perimeter, install one additional down conductor for each additional 100 feet of perimeter or fraction thereof.
- H. Terminate each down conductor at a ground rod.
- I. Use connector fittings on all lightning conductors at "end-to-end" "tee" or "Y" splices. Attach them so as to withstand a pull test of 200 pounds (890 N). Make fittings for connection to metal tracts, gutters, downspouts, ventilators, chimney extensions, or other metal parts about the structure tight to the object by compression under bolt heads. Both crimp type and exothermic weld splicers of stamped or cast metal are acceptable under Class I requirements. Do not use crimp type clamps and splicers in Class II installations. Use exothermic welds for all below grade system connections.
- J. Attach conductors to the building or other object upon which they are placed. Use fasteners not subject to breakage. Furnish nails, screws and bolts, with which fasteners are attached, of the same material as the conductor or of such nature that there will be no

electrolytic corrosion in the presence of moisture because of contact between the different parts. Space conductor fasteners not more than 3 feet apart on all conductors.

- K. All requirements covering exposed systems apply to concealed installations. Conductors are coursed the same except that they may be coursed behind the exterior wall facing, in concealed or embedded conduit, or embedded directly in concrete.
- L. Materials, installation methods and procedures are to be in accordance with UL-96 and 96A, NFPA 780, NEC and local electrical codes. Provide for and obtain a "U.L. Certificate of Compliance" for the Work performed.

### 3.02 SYSTEM TESTING:

- A. Perform system testing as part of the grounding system tests identified in Sections 26 05 26 and 26 08 13.

### 3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 26 43 00

### SURGE PROTECTION DEVICES (SPDs)

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide Surge Protection Devices (SPD) integral to the electrical distribution system equipment as indicated. The distribution system includes 480V distribution panels and 120/208V panelboards.
- B. The components shall provide protection for electrical and electronic devices against the damaging effects of surges, transients and electrical line noise.

##### 1.02 REFERENCES

- A. Underwriters Laboratories, Inc. (UL):
- B. Delaware Electrical Code.
- C. American National Standard Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
  - 1. ANSI/IEEE C62.41 - IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits
  - 2. ANSI/IEEE C62.45 - IEEE Guide for Surge Suppressor Testing
  - 3. National Electrical Manufacturers Association (NEMA):
  - 4. NEMA 250 - Enclosures for Electrical Equipment (1000 volts maximum)
  - 5. NEMA LS 1 - Low Voltage Surge Protection Devices
- D. Military Standard: 220A - Radio Frequency Interference and Electromagnetic Interference.

##### 1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
  - 1. Shop drawings, manufacturer's product data, and component ratings in accordance with this section and the requirements of Section 26 05 10.
  - 2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance.

- a. Failure to include a copy of the marked-up specification sections will result in submittal return without review until marked up specifications are submitted in a complete package.
3. Provide verification that the SPD complies with the required ANSI/UL 1449 listing by UL.
4. Submit SPD type, model number, system voltage, phases, modes of protection, voltage protection rating (VPR) and nominal discharge current (In).
5. Provide outline drawings and internal wiring diagrams.
6. Submit factory test data.
7. Operating and Maintenance Instruction Manuals:
  - a. Furnish:
    - (1) Operating instruction manuals outlining step-by-step procedures for system startup and operation and in accordance with Section 017823.
    - (2) Manufacturer's name, model number, service manual parts list.
    - (3) Brief description of equipment and basic operating features.
    - (4) Maintenance instruction manuals outlining maintenance procedures.
    - (5) Troubleshooting guide listing possible breakdown and repairs.
    - (6) Simplified connection wiring diagrams for each circuit.

#### 1.04 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00 – Quality Requirements.
- B. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL Standard (ANSI/UL 1449 3<sup>rd</sup> Edition).
- C. SPD units shall be UL approved for use with Lightning Protection Systems.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Transient voltage surge suppression components.
  - 1. Eaton-Cutler Hammer
  - 2. General Electric.
  - 3. Siemens
  - 4. Schneider Electric
  - 5. Or approved equal.

2.02 GENERAL

- A. Electrical Requirements:
  - 1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
  - 2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 125% of the nominal system operating voltage.
  - 3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
  - 4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current ( $I_n$ ) – All SPDs applied to the distribution system shall have a 20kA  $I_n$  rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an  $I_n$  less than 20 kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

MODES	208Y/120	480Y/277
L-N; L-G; N-G	400V	800V
L-L	800V	1800V

7. ANSI/IEEE C High Let-Through Voltage – The let through voltage based on an ANSI/IEEE C62.41 Category C High waveform (10kV, 10kA) shall not exceed the following:

Mode	208Y/120	480Y/277
L-N	560V	960V

8. ANSI/IEEE Cat. B Ringwave Let Through Voltage – The let-through voltage based on an ANSI/IEEE C62.41 Category B Ringwave (6 kV, 500 amps) shall not exceed the following:

Mode	208Y/120	480Y/277
L-N	160V	165V

**B. SPD Design:**

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
  - a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
    - (1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
    - (2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
    - (3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
  - b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
  - c. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of  $50 \pm 20A$  occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental



resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

- (1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection

- a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements

- a. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.03 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations	250 kA	125 kA
B	480 VAC Distribution Panelboards	160 kA	80 kA
A	208/120 VAC Panelboards	120 kA	60 kA

- C. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

#### 2.04 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
  2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
  3. The panelboard shall be capable of re-energizing upon removal of the SPD.
  4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
  5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
  6. The SPD shall be of the same manufacturer as the panelboard.
  7. The complete panelboard including the SPD shall be UL67 listed.

#### 2.05 SHOP TESTING

- A. Provide a factory performance test for each unit. The tests shall be in accordance with the latest version of NEMA and UL Standards.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Visually inspect delivered unit(s) and accessories for conformance with the contract electrical drawings and specifications.

3.02 INSTALLATION

- A. Install unit in compliance with the manufacturer's printed instructions. All electrical installation Work shall be in accordance with UL Listing Requirements and applicable Delaware Electrical Codes.

3.03 CHECKOUT AND TESTING

- A. Provide checkout, field, and functional testing in accordance with Sections 26 05 10 and 26 08 13.

3.04 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 017400.

END OF SECTION

## **DIVISION 31 – EARTHWORK**

## SECTION 31 05 19.13

### GEOTEXTILES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide geotextile indicated or in compliance with Contract Documents.

##### 1.02 REFERENCES:

- A. American Association of State Highway and Transportation Officials (AASHTO):

- 1. M288: Standard Specification for Geotextile Specification for Highway Applications.

- B. ASTM International (ASTM):

- 1. D1683: Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics.
- 2. D4355: Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
- 3. D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- 4. D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- 5. D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- 6. D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- 7. D4833: Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

##### 1.03 DEFINITIONS:

- A. Minimum Average Roll Value (MARV): All property values, with the exception of apparent opening size (AOS), represent minimum average roll values in the weakest principal direction. MARV listings for AOS represent the maximum average roll value.

1.04 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 013400.
  - 1. Sustainable Design Submittals.
  - 2. Manufacturer Certificates.
  - 3. Manufacturer Installation Instructions and Details.
  - 4. Manufacturer Catalog Data.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.
- B. Sustainability Standards Certifications.
- C. Manufacturer Testing Certificates: Provide mill certificate or affidavit signed by a legally authorized official from the company manufacturing the fabric. The mill certificate or affidavit shall attest that the fabric meets the chemical, physical, and manufacturing requirements stated in this specification. Submit to Engineer for acceptance at least two weeks prior to shipment.
- D. Manufacturer Installation Instructions and Details: Submit to Engineer for review.

1.06 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. Label each roll of geotextile fabric with number or symbol to identify production run.
- C. Wrap fabric in a heavy-duty protective covering until it is ready for installation. Recover previously opened rolls with a waterproof cover.
- D. Protect the fabric from direct sunlight, ultraviolet rays, temperatures greater than 140 degrees F, mud, dirt, dust, and debris at all times during shipment and storage.
- E. Store fabric on clean, dry surfaces, free of foreign substances such as grease, oil, paint, epoxy, cement, or any other substances which would have a deleterious effect on the fabric.
- F. Elevate fabric a minimum of 12 inches above ground level when stored outside.
- G. Do not use hooks, tongs, or other sharp tools and instruments when handling fabric.
- H. Unload or handle fabric in one of the following ways:

1. By placing slings under the rolls.
2. By using a pole inserted through a hollow core, provided the pole extends 1-foot (0.30 m) minimum beyond each end of the core and lifting and handling devices are attached to only that portion of the pole located outside the ends of the core.
3. By hand.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS:

- A. Provide the following nonwoven geotextile fabric:
  1. FX-60HS as manufactured by Carthage Mills.
  2. Geotex 601 as manufactured by Propex.
  3. Mirafi 160N as manufactured by TenCate Geosynthetics.
  4. 150EX as manufactured by Thrace - LINQ.
- B. Provide the following woven geotextile fabric except for silt fence:
  1. FX-55 as manufactured by Carthage Mills.
  2. 200ST as manufactured by Propex.
  3. Mirafi 500X as manufactured by TenCate Geosynthetics.
  4. GTF200 as manufactured by Thrace-LINQ.
- C. Provide the following woven geotextile fabric for silt fence:
  1. FX-11 as manufactured by Carthage Mills.
  2. Geotex 2130 as manufactured by Propex.
  3. W100 as manufactured by SKAPS Industries.
  4. Beltech 940 by Belton Industries Inc.

### 2.02 PERFORMANCE/DESIGN CRITERIA:

- A. The average test results of any roll in a lot sampled for conformance or quality assurance testing shall meet or exceed the MARV.

2.03 MATERIALS:

- A. Filter Fabric: Permeable sheet of woven or nonwoven plastic yarn.
  - 1. Physical Requirements: AASHTO M288.
  - 2. Strength Property Requirements: AASHTO M288, Class [1] [2] [3].
  - 4. Service Requirements: Table 31 05 19.13-1.

Table 31 05 19.13-1	
Service	Requirement
Subsurface Drainage	AASHTO M288 Table 2
Stabilization	AASHTO M288 Table 4
Permanent Erosion Control	AASHTO M288 Table 5
Temporary Silt Fence	AASHTO M288 Table 6
Paving Fabric	AASHTO M288 Table 7

- B. Fabric – Foundation Preparation: Nonwoven, Table 31 05 19.13-2. Woven, Table 31 05 19.13-3 (excluding silt fence).

Table 31 05 19.13-2			
Nonwoven Property	Test Method	Units	Value (MARV)
Grab Strength	ASTM D4632	lbs (N)	150 (670)
Grab Elongation	ASTM D4632	Percent	50
Trapezoidal Tear Strength	ASTM D4533	lbs (N)	60 (270)
Puncture Strength	ASTM D4833	lbs (N)	75 (330)
Permittivity	ASTM D4491	sec -1	1.3
Apparent Opening Size (AOS or O95)	ASTM D4751	U.S. Sieve No. (mm)	70-100 (0.212-0.150 mm)
Ultraviolet Stability	ASTM D4355	Percent	70



Table 31 05 19.13-3			
Woven Property	Test Method	Units	Value (MARV)
Grab Strength	ASTM D4632	lbs (N)	200 (900)
Grab Elongation	ASTM D4632	Percent	15
Trapezoidal Tear Strength	ASTM D4533	lbs (N)	75 (300)
Puncture Strength	ASTM D4833	lbs (N)	80 (350)
Permittivity	ASTM D4491	sec -1	0.02
Apparent Opening Size (AOS or O95)	ASTM D4751	U.S. Sieve No. (mm)	30-70 (0.60-0.212 mm)
Ultraviolet Stability	ASTM D4355	Percent	70

C. Erosion Control Silt Fence: Woven, Table 31 05 19.13-4.

Table 31 05 19.13-4			
Woven Property	Test Method	Units	Value (MARV)
Grab Strength	ASTM D4632	lbs (N)	100 (450)
Permittivity	ASTM D4491	sec -1	0.10
Apparent Opening Size (AOS or O95)	ASTM D4751	U.S. Sieve No. (mm)	20-30 (0.85-0.60 mm)
Ultraviolet Stability	ASTM D4355	Percent	70

D. Metal Geotextile Pins:

1. Diameter: 3/16 inch (5 mm), minimum.
2. Length: [18 inches (45 cm)], minimum.
3. Shape: Pointed at one end with head on other end for retaining washer.
4. Washer: Steel, with minimum outside diameter of [1-1/2 inches (38 mm)].

E. Wire Staples: 8 gage (4.3 mm) minimum.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Prepare the surface to receive fabric to a smooth condition free of sharp objects, obstructions, depressions, debris, and soft or low-density pockets of material.

### 3.02 INSTALLATION:

- A. Install geotextile fabric in accordance with manufacturer's printed instructions.
- B. Place geotextile fabric on the foundation subgrade prior to placing granular material screened gravel or crushed stone.
- C. Joints:
  - 1. Unsewn: Overlap fabric 18 inches (45 cm), minimum.
  - 2. Sewn: Overlap fabric 6 inches (15 cm), minimum.
- D. Place geotextile fabric to prevent tearing or puncturing.
- E. Lay geotextile fabric loosely but without wrinkles or creases so that placement of the backfill materials will not stretch or tear geotextile fabric. Leave sufficient slack in geotextile fabric around irregularities to allow for readjustments.
- F. Along Foundation Perimeter: Extend geotextile fabric and wrap around granular fill screened gravel or crushed stone.

### 3.03 INSTALLATION – CHANNELS, SHORELINES, AND TRENCHES:

- A. Install in accordance with AASHTO M288, Appendices A1 and A3 except as modified below.
- B. Do not use fabric with defects, rips, holes, flaws, deterioration, or damage of any nature.
- C. Handle and place filter fabric in accordance with the manufacturer's recommendations. Stretch, align, and place the fabric in a wrinkle-free manner.
- D. Place fabric with the long dimension parallel to the trench and lay smooth and free of tension, stress, folds, wrinkles, or creases. Place the strips to provide a minimum width of 18 inches (45 cm) of overlap for each joint.
- E. Insert securing pins with washers through both strips of overlapped fabric at intervals not greater than 2 feet (60 cm), along a line through the midpoint of the overlap.
- F. Install additional pins regardless of location to prevent any slippage of the filter fabric. Place the fabric so that the upper strip of fabric will overlap the next lower strip. Push each securing pin through the fabric until the washer bears against the fabric and secures it firmly to the foundation.
- G. Seams: Stitch fabric seams with thread meeting the chemical requirements for plastic yarn or bond by cementing or heat. Stitch fabric with yarn of a contrasting color. The size and composition of the yarn shall be as recommended by the fabric manufacturer. The stitches shall number 5 to 7 per inch (2 to 3 per cm) of seam. Attach the sheets of

filter fabric at the factory or another location to form sections not less than 3 feet (1 meter) wide. Test seams in accordance with method ASTM D1683, using 1-inch (25-mm) square jaws and 12 inches per minute (3 cm per minute) constant rate of traverse. The strengths shall be not less than 90 percent of the required tensile strength of the unaged fabric in any principal direction.

3.04 INSTALLATION – PERMANENT EROSION CONTROL:

- A. Install in accordance with AASHTO M288, Appendices A1 and A4.

3.05 INSTALLATION – TEMPORARY SILT FENCE:

- A. Install in accordance with AASHTO M288, Appendices A1 and A5.

3.06 INSTALLATION – PAVING:

- A. Install in accordance with AASHTO M288, Appendices A1 and A6.

3.07 REPAIR/RESTORATION:

- A. Protect the fabric at all times during construction from contamination by surface runoff. Remove and replace fabric so contaminated with uncontaminated fabric. Repair any damage to the fabric during its installation or during placement of bedding materials.
- B. Patch tears in geotextile fabric by placing additional section of geotextile fabric over tear with a minimum of 3 feet (90 cm) overlay.
- C. Repair fabric damaged during placing, in other than underdrain piping service, by placing a piece of fabric large enough to cover the torn or punctured area, meet the overlap requirement, and extend a minimum of 12 inches (30 cm) beyond the edge of the damaged area. Repair damaged sections of fabric used in underdrain piping by cutting out the damaged section over the full width of the spiral section and stitching a new fabric section in place for a minimum length of 18 inches (45 cm).
- D. Replace fabric that has become damaged from vehicular traffic, equipment, or repetitive operations.

3.08 PROTECTION:

- A. Prohibit construction equipment and traffic from traveling directly on geotextile fabric.
- B. Protect the geotextile during installation from clogging, tears, and other damage. Provide ballast (e.g., sand bags) to prevent uplift by wind.
- C. Do not leave the geotextile uncovered for more than 14 days after installation (excluding silt fence).

- D. Place cover soil or sand in a manner that prevents soil or sand from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, place soil or sand backfill from the bottom of the slope upward.
  - E. Do not drop cover soil or sand onto the geotextile from a height greater than 3 feet (1 m).
  - F. Do not operate equipment directly on top of the geotextile. Use equipment with ground pressures less than 7 psi (48 kPa) to place the first lift over the geotextile. Maintain a minimum of 12 inches (30 cm) of soil between full-scale construction equipment and the geotextile.
  - G. Maintain a minimum of 6 inches (15 cm) of material between the fabric and Contractor's equipment, during spreading and compaction of the bedding material. Where embankment material is to be placed on the filter fabric, maintain a minimum of 18 inches (45 cm) of embankment material between the fabric and the Contractor's equipment. Do not operate or drive equipment or vehicles directly on the filter fabric.
  - H. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph (8 km/h).
- 3.09 CLOSEOUT ACTIVITIES:
- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 31 10 00

### SITE CLEARING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide site clearing as indicated and in compliance with Contract Documents.
- B. Section Includes:
  - 1. Clearing and grubbing.
  - 2. Tree and shrub protection and removal.
  - 3. Removal of debris related to clearing and grubbing operations.

##### 1.02 DEFINITIONS:

- A. Caliper: Instrument used to measure tree diameter.
- B. Clearing: Removal and disposal of above-ground items defined herein.
- C. Grubbing: Removal and disposal of below-ground items defined herein.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 013400.
  - 1. Certificates
    - a. Copy of herbicide label bearing EPA registration number.
    - b. Copy of Arborist Certification

##### 1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.
- B. Permits:
  - 1. Perform Work in accordance with the approved Erosion and Sediment Control Plan. See General Conditions for additional requirements.
- C. Certifications:

1. Certified Arborist: All tree pruning, tree repair, and tree removal shall be performed by competent workers, under the supervision of an arborist holding certification from the International Society of Arboriculture (ISA).

1.05 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 101006.
- B. Herbicide: Comply with Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) – Title 7 U.S.C. Section 136. Submit copy of herbicide label, bearing EPA registration number.

1.06 SITE CONDITIONS:

- A. Existing facilities, structures, and utilities are shown in accordance with available surveys and records. The indicated locations of underground utilities and structures are approximate. Other utilities may exist which are not indicated.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. WOOD CHIPS

1. Material Source: Chipped wood from clearing work.
2. Do not use diseased wood and bark, nor trees infected with pest vectors.

2.02 ACCESSORIES:

- A. Herbicide: Registered EPA Pesticide.
- B. Tree Wound Paint: Bituminous based paint formulated for tree wounds.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify survey benchmarks and intended elevations for the Work are as indicated.
- B. Verify temporary erosion and sediment control measures are installed before commencing with any other work at the site.
- C. Verify location and existence of all underground utilities and structures by contacting utility owners, as required by law. Go to “Call Before You Dig” to receive state-specific

information. Access this information by dialing 811 or going to <http://call811.com/state-specific.aspx>.

- D. Provide 72-hour notice to existing utility owners, prior to beginning construction.
- E. Contact utility companies and authorities to make arrangements for handling and disposal of utilities encountered during construction.

### 3.02 PREPARATION:

- A. Protect bench marks, survey control points, and existing structures to remain from damage or displacement.
- B. Protect trees and vegetation to remain. Do not cut or injure trees and vegetation outside easement lines and outside designated clearing areas.
- C. Protect all underground utilities and structures that are to remain. If damage occurs, immediately notify the utility owner within the hour.
- D. Protect site features to remain from damage by construction equipment and vehicular traffic.
- E. Identify waste area(s) for stockpiling of removed materials.

### 3.03 RESTORATION:

- A. Existing surfaces, features, utilities, or structures that are to remain but are damaged during construction shall be restored to at least the condition in which they were found immediately before work began, unless noted otherwise.
- B. Restore damaged utilities to the satisfaction of the utility owner.
- C. Restore damaged private property to the satisfaction of the property owner.

### 3.04 CLEARING:

- A. Remove and dispose of off site:
  - 1. Trees, snags, brush, shrubs, downed timber, decayed wood, and other vegetative growth.
  - 2. Rocks, tiles, lumps of concrete, trash piles, debris, refuse, rubbish, and fencing. Remove all evidence of their presence from the surface.
- B. Clear ground within limits of work and width of permanent easement, unless otherwise noted.

- C. Manual cutting of trees, stumps, and stubs during clearing shall be as close to ground surface as practicable but no higher than 6 inches (150 mm) above ground for small trees (8 inches (200 mm) or less), and not higher than 12 inches (300 mm) above ground for larger trees (greater than 8 inches (200 mm)).
- D. Obey all federal, state and local regulations and guidance regarding the cutting, burning, and disposal of diseased trees and vegetation.
- E. Bury elm bark, at least 12 inches (300 mm) deep[, or burn in off-site incinerators equipped with anti-pollution and fire prevention controls,] to prevent spread of Dutch Elm disease.

3.05 CLEARING IN WOODED AREAS:

- A. Chip and stockpile cleared wood at location directed by Owner.
- B. Chip and spread cleared wood within clearing limits and cover as indicated.

3.06 GRUBBING:

- A. Remove and dispose of all stumps, buried logs, matted roots, roots larger than 2 inches (50 mm), and organic materials off site.
- B. Roots larger than 2 inches (50 mm) in diameter shall be removed to a depth of 12 inches (300 mm), and roots larger than 1/2-inches (12 mm) in diameter to a depth of 6 inches (150 mm).
- C. Areas designated to receive pavement or structures shall be grubbed a depth of 18 inches (450 mm). Measure depths of cut from existing ground surface or proposed finished grade, whichever is lower.
- D. Apply herbicide to remaining roots and vegetation to inhibit growth.
- E. Depressions made by grubbing shall be filled with suitable material and compacted to conform to original adjacent grade.
- F. Do not grub areas within drip line of trees to remain to avoid damage to roots.

3.07 TREE AND SHRUB REMOVAL:

- A. Remove trees and shrubs within permanent and temporary easement by felling or cutting individual vegetation and grubbing.

3.08 TREE AND SHRUB PROTECTION:

- A. Protect and prune indicated trees and shrubs within the clearing limits.



3.09 PRUNING:

- A. Trim dead branches 1-1/2-inches (38 mm) or more in diameter and branches to heights and in a manner as indicated. Neatly cut limbs and branches close to the bole of the tree or main branches. Paint cuts more than 1-1/4-inches (32 mm) in diameter tree wound paint.

3.10 BURNING:

- A. Burning is not permitted on site.

3.11 CLEANING:

- A. Promptly dispose of excess and unsuitable material off site.
- B. Remove debris, junk, and trash from site.
- C. Leave site in clean condition, ready for subsequent work.
- D. Clean up spillage and wind-blown debris before entering public or private property, adjacent to site.

3.12 CLOSEOUT ACTIVITIES:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 311001

### EROSION AND SEDIMENT CONTROL

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor shall furnish all labor, materials, equipment, transportation, disposal, inspection and incidentals as depicted, specified or required on the Contract Drawings to provide reasonable protection of resource areas, private property and roadways, both on and off of the construction site, that may suffer loss or damage from sediment erosion as a result of construction related activities.
- B. Measures for stabilization and pollution control shall be coordinated with the construction of the project. Temporary measures shall be constructed prior to or as soon as practicable after the grading operation is begun to assure economical, effective and continuous erosion and sediment control.
- C. All erosion and sediment control measures shall be in accordance with the Delaware Erosion and Sediment Control Handbook. The Contractor shall procure the services of a Certified Construction Reviewer (CCR) for the purposes of ensuring compliance with erosion and sediment control regulations.

#### PART 2 - PRODUCTS

##### 2.1 MATERIALS

- A. Materials for erosion and sediment control shall be in accordance with the Delaware Erosion and Sediment Control Handbook, and as depicted on the Contract Drawings.

#### PART 3 - EXECUTION

##### 3.1 GENERAL

- A. No work shall be started until the erosion and sediment control measures have been inspected by the Contractor's CCR and accepted by the Engineer.
- B. Erosion and sediment control measures shall be installed and maintained in a functioning state at the location and in accordance with the Contract Drawings, or as directed by the CCR or Engineer.

### 3.2 EROSION CONTROL

- A. The Contractor shall shape the graded area in such a manner as to permit the runoff of rainwater and shall construct earth berms along the top edges of embankments to intercept runoff water. Temporary slope drains shall be provided to carry runoff from cuts and embankments. The slope drains shall be capable of being readily shortened or extended as the cut or fill advances. Portable flumes shall be provided at the entrance to the temporary slope drains, and where necessary, energy dissipaters shall be provided at the outlet.
- B. The Contractor shall dress, prepare and seed cut slopes as the Work progresses and in accordance with the following sequence unless otherwise directed by the Engineer or CCR.
  - 1. Slopes whose vertical height is twenty (20) feet or greater shall be seeded in three (3) equal increments of height.
  - 2. Slopes whose vertical height is less than twenty (20) feet but more than five (5) feet shall be seeded in two (2) equal increments of height.
  - 3. Slopes whose vertical height is five (5) feet or less may be seeded in one operation.
- C. The dressing, preparing and seeding of slopes shall be performed immediately following the suspension of grading operations. Fill slopes shall be dressed, prepared and seeded as the embankment proceeds to the extent considered desirable and practicable. The Engineer or CCR will limit the area of excavation and embankment operations in progress commensurate with the Contractor's capability and progress in assuring that the finish grading, mulching seeding and other such permanent pollution control measures are current in accordance with the accepted erosion and sediment control plan. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken as required. All construction shall be confined to the minimum area necessary to accommodate the Contractor, equipment and work force engaged in this project.
- D. Each grading unit will be limited to the amount of surface area of erodible earth material exposed at one time. This area shall not exceed seven hundred and fifty thousand (750,000) square feet of grubbing operations and seven hundred and fifty thousand (750,000) square feet of grading operations (erodible slopes), unless the Contractor obtains the Engineer's approval for a greater area based on project conditions. A "grading unit" is defined as a complete grading spread consisting of earthmovers, hauling units, graders, compactors, etc. The Contractor shall be prepared to dress and seed behind each grading unit as noted above.
- E. There are individual project conditions where the following areas would be eliminated from the seven hundred and fifty thousand (750,000) square feet limits for clearing and grubbing. These areas are indicated on the Drawings:
  - 1. Forest or mountainous areas where the timber is removed but the forest floor or earth is generally left undisturbed.
  - 2. Low-lying bog or swamp areas where it is necessary to clear the entire project to facilitate drying before the soil can be worked.
- F. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted plan. Temporary pollution

control measures shall be used to correct conditions that develop during construction and that were not foreseen during the design stage. Pollution control measures are also needed to temporarily control erosion that develops during normal construction practices, but these measures are not associate with permanent control features on the project.

- G. Where erosion is likely to be a problem, clearing and grubbing operations shall be so schedule and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages.
- H. Wherever rock excavation is available in the immediate vicinity of the project, an eight (8) to fifteen (15) inch layer of such material shall be spread over the lower region of embankments in the immediate vicinity of stream crossings and shall be used to riprap ditches, channels and other drainage ways leading away from cuts and fills; however, all drainage ways shall be prepared for riprapping to the extent necessary to avoid reducing their cross-section. In the event rock excavation is not available on the project, soil stabilization matting shall be used as the covering material and shall be installed in accordance with the applicable specifications for such materials. The limits of the area to be covered will be as directed by the Engineer or CCR.

### 3.3 SEDIMENT CONTROL

- A. Sediment control practice and installation shall be in accordance with the Delaware Erosion and Sediment Control Handbook.
- B. Any erosion and sediment control measures damaged during the Work shall be repaired before the end of each working day or as soon as possible thereafter. The spoil material shall be graded in accordance with the grading plan and protective vegetation shall be established as soon as possible. Before, during and after construction, the Contractor shall utilize procedures as specified herein and also other procedures that will minimize the deposition of sediment in all waterways and bodies of water.
- C. Certain items must be considered when sediment control is exercised in the following areas:
  - 1. Streams
    - a. Comply with all conditions stated in environmental permits established for this project, notations and details depicted on the Drawings regarding stream flow by-pass, land disturbing activity and restoration associated with the creek crossing for sanitary sewer installation.
    - b. No spoil shall be wasted in a stream or adjacent bank area. Buffer strips shall be sued, wherever possible, to protect streams.
    - c. Crossings, whether of access ways or utility lines, shall be of a “permeable” nature such as gabion fords and ungrouted riprap placed over filter cloth or similar material. Obstructions shall not be left in the stream beyond the period of project construction. Stream channels shall be protected from storm drain discharges by using energy dissipaters, riprap, etc., when erodible velocities exist. Storm drains shall also have outlets in a location and direction so as not to disrupt a natural channel.

- d. Any necessary channel improvement work shall be done in accordance with the requirements of the Department of Natural Resources and Environmental Control (DNREC) so as to preserve as much of the natural ecological value of the stream as possible. Consideration shall be given to using materials and techniques best suited for stream channel stabilization and protection. Any channel improvement work shall be done so as to minimize the disturbance to the natural stream channel alignment, and to prevent excessive increases in velocity of water flow.
2. Floodplains
- a. The Limit of Disturbance through the floodplain shall be as small as possible, and clearing shall be kept to a minimum. No debris or obstructions shall be left unstabilized in the floodplain beyond the period of project construction. The method of construction shall provide for daily protection of all disturbed areas. Any cross-drainage through the floodplain shall be safely channeled through disturbed areas to protected outlets. Where the season permits, permanent vegetative stabilization of disturbed areas within the floodplain shall immediately follow the construction work. If permanent vegetative measures cannot be applied, temporary controls shall be used until the appropriate planting time.
3. Draws, roadside channels and other drainage easements
- a. The Limit of Disturbance shall be as small as possible, and clearing shall be kept to a minimum. The project development shall be organized so as to minimize long delays during critical erosion periods. Water handling devices such as diversion or interceptor dikes, flexible nylon tubing and bituminized fiber pipe shall be used to provide temporary erosion control during construction. Critical slopes associated with the easement shall be stabilized and protected from surface water runoff, such as with contour furrows. The permanent vegetative restoration or structural drainage measures shall be installed as soon as possible.

**END OF SECTION 311001**

## SECTION 311004

### EXCAVATION AND BACKFILL FOR PIPE TRENCHES

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor shall excavate and backfill all trenches in accordance with the Contract Documents and as described herein.
- B. Excavation also includes the salvaging and stockpiling of topsoil for re-use, material suitable for backfill, temporary erosion and sedimentation controls and the removal and disposal of all material not otherwise provided for so that the project will be completed in a neat and workmanlike manner.

##### 1.2 DEFINITIONS

- A. Non-classified material is material that can be excavated without the use of blasting, drilling or wedging. Boulders or other detached stones removed from the excavation without the use of blasting, drill or wedging shall be considered under this item.
- B. Suitable native material is material excavated on the project that meets the requirements of Type C backfill and which is free from large lumps, ashes, cinders, organic material, or other refuse, clods or rocks except and which can be compacted to the degree specified.

##### 1.3 SUBSURFACE INFORMATION PROVIDED IN THE CONTRACT

- A. The County may have performed subsurface investigations for the purposes of planning and design of the Work. If provided in the Contract, soil boring/rock coring logs indicate conditions and soil types observed at that location during the performance of the soil boring/rock coring. They should not be interpreted to indicate what the Contractor may expect to find during his excavation. The Contractor assumes all risk and responsibility for any interpretation of the data and any extrapolation he makes of the subsurface conditions of the site in non-evaluated area(s) between soil borings/rock corings. The Owner will not be liable for any damages or additional time/expense due to conditions differing from what is indicated on the soil boring/rock coring logs, or the Contractor's use and/or reliance on the information presented in the soil boring/rock coring logs.

##### 1.4 PROJECT CONDITIONS

- A. The Contractor shall minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner, Engineer and/or authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by

Engineer or authorities having jurisdiction.

- B. The Contractor shall be responsible for the exact determination of the location, depth, size, material, etc. of underground structures and utilities.
- C. No activities associated with the Work shall occur outside of the Limit of Disturbance as depicted on the Contract Drawings unless arrangements are made with property owners outside the Limit of Disturbance in written form and provided to the Engineer.

Activities include but are not limited to:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

#### 1.4 RESPONSIBILITY FOR CONDITION OF EXCAVATION

- A. The Contractor shall be responsible for the condition of all excavation. All slides and caves shall be removed without extra cost to the County, at whatever time and under whatever circumstances they may occur.
- B. Sizing and application of methods and procedures employed to incorporate all labor and materials are the responsibility of the Contractor. All work shall be conducted in such a manner as to protect persons and property against injury. The fact that the County or its authorized representatives are involved in performing their respective duties does not relieve the Contractor of his obligations under the contract or applicable regulations of this or other governmental agencies.

### **PART 2 - PRODUCTS**

#### 2.1 OWNERSHIP OF EXCAVATED MATERIAL

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise to remain the County's property, excavated materials shall become Contractor's property and shall be removed from the Work site.
- B. All excess excavated material and/or materials unsuitable for use as backfill shall be removed from the site and disposed of in accordance with the Contract Documents and permits at no additional cost to the County.

#### 2.2 BORROW BACKFILL MATERIAL

- A. If excavated material is unsuitable for backfilling operations, the Engineer will direct the Contractor to use borrow material. Costs associated for using Type C borrow material shall be paid from the "Contingent Borrow Material" item.

- B. The classification, characteristics and uses of borrow materials shall be in accordance with the requirements of AASHTO M145 and M57. Materials having a dry weight less than ninety (90) pounds per cubic foot, materials with natural moisture content in excess of ten percent (10%) or materials which have a liquid limit in excess of 50 shall be excluded from use.
- C. The method of testing materials shall be in accordance with the requirements of AASHTO T88, T89 modified, T90 and T99, Method C.
- D. In addition to the above requirements, which will be applicable for use in all types of construction, the following borrow types will be subject to the requirements below:
1. Borrow Type A – This material shall be bank-run gravel slag, quarry waste, stone screenings or other acceptable granular material, the particles of which will be of such size that not more than five percent (5%) by dry weight shall be retained on the two and one-half (2½) inch sieve and not more than thirty-five percent (35%) by weight shall pass the number two-hundred (200) sieve.
  2. Borrow Type B (Special Fill) – Materials used for special fill shall consist of clean sand, crushed or uncrushed gravel or crushed stone and shall be free from frozen material, wood or other extraneous matter. With the approval of the Engineer, blasted or crushed rock and boulders may be used. Such rock shall have a maximum size of twelve (12) inches and shall have a gradation which is satisfactory to the Engineer. Special fill shall contain not more than ten (10) percent by weight passing the Number two hundred (200) sieve and forty-five percent (45%) by weight passing the Number one hundred (100) sieve. Material for special fill shall be sampled, tested and approved prior to final placement.
  3. Borrow Type C (Backfill) – Material used for backfill shall have a gradation of 85-100 percent by weight passing the one (1) inch sieve and maximum of twenty-five percent (25%) by weight passing the Number 200 sieve.
  4. Borrow Type D – This material shall have one hundred percent (100%) passing the three (3) inch sieve and between eight (8) to thirty (30) percent passing the Number 200 sieve.
  5. Borrow Type E – This material shall be non-plastic and shall have not more than twenty (20) percent nor less than six (6) percent by dry weight passing the Number 200 sieve.
  6. Borrow Type F – Material used for embankment construction shall be free from detrimental quantities of organic material, such as leaves, grass, roots and sewage, and shall be subject to the general requirements herein.
  7. Borrow Type G (Select Borrow) – The Material for select borrow shall be granular soil meeting the following requirements when tested according to AASHTO T88, Modified:



Percentage By Weight Passing Square Mesh Sieves						
Sieve	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F
2"	95-100	95-100	95-100	95-100	95-100	95-100
1"	--	75-95	85-100	85-100	85-100	85-100
3/8"	30-65	40-75	50-85	60-100	--	--
Number 4	25-55	30-60	35-65	50-85	55-100	70-100
Number 10	15-40	20-45	25-50	40-70	40-100	55-100
Number 40	8-20	15-30	15-30	25-45	20-50	30-70
Number 200	2-8	5-20	5-15	5-20	6-20	8-25

Note: The fraction passing the Number 200 sieve shall not be greater than two-thirds (2/3) of the fraction passing the Number 40 sieve. The fraction passing Number 40 sieve shall have a liquid limit not greater than twenty-five (25) and a plasticity index not greater than six (6), when tested according to AASHTO T89, Modified and T90

E. Materials excavated and proposed to be used as backfill material must conform to the requirements for borrow backfill as depicted on the Contract Drawings.

### 2.3 STONE BEDDING MATERIAL

- A. Aggregate material shall be in accordance with AASHTO M43 and shall be used where specified on the Drawings or as required by the Engineer. Aggregate material shall be furnished from a specific source or sources approved by the Engineer.

		Size of Aggregate									
Size number	Nominal size square openings	Amounts finer than each sieve (square openings), percentage by weight									
		1-1/2	1	3/4	1/2	3/8	No. 4	No. 8	No. 18	No. 50	No. 100
57	1 inch to No. 4.	100	95 to 100		25 to 60		0 to 10	0 to 5			
67	3/4 inch to No. 4		100	90 to 100		20 to 55	0 to 10	0 to 5			
8	3/8 inch to No. 8				100	85 to 100	10 to 30	0 to 10	0 to 5		

## 2.4 GEOTEXTILE FABRIC

- A. The Contractor shall furnish non-woven polypropylene geotextile fabric as depicted on the Drawings. The fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis and acids, and meet or exceed the following mechanical properties:
  - 1. Tensile Strength – 120 lbs., per ASTM D4632
  - 2. Tensile Elongation – 50%, per ASTM D4632
  - 3. Trapezoid Tear Strength – 50 lbs., per ASTM D4533
  - 4. CBR Puncture Strength – 310 lbs., per ASTM D6241
  - 5. Permittivity, 1.7 sec-1, per ASTM D4491
  - 6. Flow Rate, 135 GPM/ft<sup>2</sup>, per ASTM D4491
  - 7. UV Resistance (at 500 hours), 70% strength retained, per ASTM D4355

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect structures, utilities, sidewalks, pavements, erosion and sedimentation controls and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and embankment operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.
- D. The Contractor shall clear and grub the surface and remove all surface materials, of whatever nature, over the line of the trench and the site of other structures and shall properly store, guard and preserve said materials as may be required for use in backfilling, resurfacing, repaving or for other purposes.
- E. The Contractor shall remove the paving, curb and gutter for such width only as is necessary for the excavation of the trench, as shown in the Contract Drawings.
  - 1. In the case where surface material is removed to a greater width than is deemed necessary, or in case surface material is removed or disturbed on account of settlement, slides or caves, or in making excavation outside the lines of the work without the written order of the Engineer, the County may retain from any monies, due or become due the Contractor, the cost of permanently replacing the paving damaged.
- F. The Contractor shall be responsible for and bear the cost of general repairs due to but not limited to settlement, damage to materials and property outside the limits of disturbance or other Contractor error. Repairs may include excavation, backfill, compaction and restoration, replacement of materials and property, or other corrective measures as directed by the Engineer. These general repairs shall be completed at no additional cost to the County.

G. Existing Utilities

1. The Contractor shall notify the Engineer not less than two days in advance of proposed utility interruptions or commencement of temporary means to maintain utility service (temporary bypass pumping, power service by generator, etc.).
2. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted by the Engineer and only after arranging and furnishing temporary utility services according to requirements.

3.2 DEWATERING AND CONTROL OF SURFACE WATER

- A. At all times during the excavation period and until completion and acceptance of the Work at final inspection, the Contractor shall provide means and equipment with which to remove promptly and dispose of properly all water entering any excavation or other parts of the Work.
- B. The Contractor shall obtain the necessary permits from local and state authorities having jurisdiction over dewatering operations.
- C. The Contractor shall dispose of water pumped or drained from the Work in a safe and suitable manner without damage to adjacent property or streets or to other work under construction in accordance with the permit. Water shall not be discharged into the sanitary or storm sewer system without approval from the Engineer.
- D. The Contractor shall provide adequate protection for water discharged onto streets. Protect the street surface at the point of discharge.

3.3 TRENCH SHORING AND BRACING

- A. If the Contractor determines trench shoring is required to provide safe working conditions, prevent shifting of material, prevent damage to structures or other work and avoid delay to the work in accordance with applicable laws and regulations, the Contractor shall procure the services of a Professional Engineer, licensed in the State of Delaware and experienced in the design of sheeting and shoring to design the shoring, sheeting and bracing plan.
- B. The Contractor shall take responsibility for the design, adequacy and construction of the sheeting, shoring and bracing plan.
- C. The Contractor shall arrange the trench shoring and bracing plan so as not to place any strain on portions of completed work until the general construction has proceeded far enough to provide ample strength.
- D. If the Contractor or his licensed Professional Engineer is of the opinion that at any time the Contractor's excavation plan, trench shoring or bracing is inadequate or unsuited for the required purpose, the Contractor shall take immediate and appropriate action. The Contractor shall provide a new plan to the Engineer before continuing excavation operations.

- E. The Contractor shall periodically monitor the trench shoring and bracing for any horizontal or vertical deflections.
- F. The Contractor shall obtain the permission of his licensed Professional Engineer prior to the removal of trench shoring and bracing. The Contractor retains the responsibility for injury or damage to structures or other property or persons for failure to leave such trench shoring and bracing in place.
- G. The Contractor shall remove trench shoring and bracing as the excavation is backfilled in a manner to avoid the caving in of the trench wall or settlement of adjacent areas or structures or stone bedding material.
  - 1. The Contractor shall carefully fill voids left by the removal of trench shoring and bracing at no additional cost to the County.
  - 2. If stone bedding material is disturbed, replace or re-compact to meet specified compaction requirements.

#### 3.4 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures in accordance with Section 311001 and the erosion and sedimentation control practices depicted on the Construction Drawings.
- B. Inspect, maintain, and repair erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

#### 3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them at an authorized waste disposal location.

#### 3.6 TRENCH EXCAVATION

- A. Topsoil Stripping
  - 1. Remove sod and grass before stripping topsoil.
  - 2. Strip topsoil four (4) inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 3. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Stabilize or cover to prevent windblown dust and erosion by water.

- B. The Contractor shall excavate all trenches to the subgrade elevation and to lines and dimensions depicted on the Contract Drawings.
- C. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered.
  - 1. Excavation below subgrade elevations or beyond indicated lines and dimensions shall be as authorized by the Engineer. Excavation below subgrade elevations or beyond indicated lines and dimensions without authorization by the Engineer as well as remedial work directed by the Engineer, shall be performed without additional compensation.
- D. Where the bottom of the trench at subgrade is in rock, excavation shall be carried at least six (6) inches below the specified subgrade with a minimum of four (4) inches under bells. The trench bottom shall be restored to subgrade with granular material as approved by the Engineer.
- E. The sides of the trench within the pipe zone shall be vertical to the top of the pipe and practically plumb above this point. Under no circumstances will the sides of the trench within the pipe zone be permitted to be sloped except with the approval of the Engineer. Bell-holes shall be excavated in the bottoms and sides of trenches to permit the proper making of joints, without extra payment therefore.
- F. Any suitable material removed with the cleared and grubbed material but designated to remain shall be replaced by the Contractor at his expense.
- G. The Contractor shall protect all excavations that may be necessary for completing the work under the contract. Pipe construction shall be by open-cut method, except where and to such an extent as the Engineer may permit, authorize or require that the same be done by tunneling, boring or jacking (See Section 33 05 23.13); and no extra compensation will be allowed for tunneling, boring or jacking over open trench unless provided for in the bid item or negotiated by the Engineer. Trenches may be generally excavated and refilled either by hand or by mechanical equipment as the Contractor elects. The Contractor shall have no claim, nor will extra compensation be allowed, due to the fact that hand excavation or refill is required to protect adjacent properties or improvements.
- H. The Contractor may elect, with the permission of the Engineer, to tunnel, bore or jack trees left standing in rights of way in lieu of removing them at no expense to the Owner.

### 3.7 CHANGE OF TRENCH LOCATION

- A. In case the Engineer directs that the location of a trench be changed to a reasonable extent from that proposed on the Contract Drawings due to the presence of an obstruction, or from another cause, or if a changed location shall be authorized upon the Contractor's request, the Contractor shall not be entitled to extra compensation or to a claim for damages, provided that the change is made before the excavation has begun.
- B. If such change made at the direction of the Engineer involves the abandonment of excavation already made, such abandoned excavation, together with the necessary refill,

will be classed as Contingent Excavation and Backfill for Pipe Trenches. Where trenches have been completely excavated, payment will be based on the widths depicted on the Contract Drawings. In the event that the trench is abandoned in favor of a new location, at the Contractor's request, the abandoned excavation and refill shall be at the Contractor's expense.

### 3.8 REMOVAL OF OBSTRUCTIONS

- A. Water mains, storm drains, sanitary sewers, gas mains and other utilities are shown on the drawings in accordance with the best information available, for the information of the Contractor. Neither the County, nor the Engineer, assumes responsibility for the accuracy of the information depicted. Existing mains and services shall be carefully protected and any damage to them caused by the Work shall be immediately repaired to the satisfaction of the Engineer by the Contractor at his expense using materials of the kinds damaged.
- B. It shall be the responsibility of the Contractor to notify all utility companies, all pipe line owners or other parties affected within the Limit of Disturbance prior to the beginning of Work.
- C. Should the position of any pole, pipe, conduit or other structure be such as, in the opinion of the Engineer, to require its removal, realignment or change, it will be done as Extra Work, or will be done by the owner of the obstruction(s) without cost to the Contractor. The bracing of utility poles will be accomplished by their owners as required at no expense to the Contractor. However, the Contractor shall uncover, support and protect the structures in the limit of his excavation at his own expense, before such removal and before and after such realignment or change as constituting part of the Contract; and the Contractor shall not be entitled to any claim for damage or extra compensation on account of the presence of said structure or on account of any delay in the removal or rearrangement of the same.
- D. The Contractor shall without extra compensation, break through and reconstruct, if necessary, the invert or arch of any sewer, culvert or conduit that may be encountered if said structure is in such position, in the judgment of the Engineer, as not to require its removal, realignment or complete reconstruction. This shall be done in such a manner as to not in any way interfere with the flow of water or other liquid which said sewer, culvert or conduit is designed to carry.
- E. In the event that obstructions would hold up the Work, the Contractor with the approval of the Engineer may be permitted to leave a gap and return to fill the gap as the Engineer directs after the obstructions have been removed.
- F. The Contractor shall not interfere with any persons, firms or corporations or with the Owner in protecting, removing, changing or replacing their pipes, conduits, poles or other structures, but shall suffer said person, firms or corporations or the Owner to take all such measures as they may deem necessary or advisable for the purpose aforesaid. The Contractor shall thereby be in no way relieved of any responsibilities under the contract.
- G. In the event that the Owner has entered into any agreements with an affected utility

owner or owners which will have an effect on the operations or financial responsibility of the Contractor, the requirements of these stipulations will be inserted into the Special Provisions of the Contract.

### 3.9 LENGTH OF OPEN TRENCH

- A. Not more than one-hundred and fifty (150) feet of trench shall be opened at any one time or place in advance of the completed placement and backfill of the pipes unless by written permission of the Engineer. The Engineer shall be empowered at any time to require the backfilling of open trenches over completed pipelines if, in his judgment, such action is necessary; and the Contractor shall have no claim for extra compensation, even though to accomplish such refilling, he is compelled to temporarily stop excavation or other work at any place.
- B. If work is stopped on any trench for any reason except by order of the Engineer, and the excavation is left open for an unreasonable length of time, as determined by the Engineer, in advance of construction, the Contractor shall, if so desired, backfill such trench at this own cost and shall not again open said trench until he is ready to complete the structure therein. If the Contractor refuses or fails to backfill such trench completely within forty-eight (48) hours after said notice, the Engineer shall be authorized to do the work and the Owner shall charge the expense thereof to the Contractor and retain the same out of any monies due or to become due to him under the contract.
- C. The excavation of all trenches shall be fully completed at least twenty (20) feet in advance of pipe laying, unless otherwise authorized.

### 3.10 CLASSIFICATION OF EXCAVATION

- A. Classification of excavation shall be as defined in these Contract Documents. Payment for excavation will normally be included in the prices bid for items or at the fixed prices in the proposal.

### 3.11 PLACEMENT OF STONE BEDDING MATERIAL

- A. The placement of stone bedding material shall not commence until the successful completion of excavation operations.
- B. The Contractor shall notify the Engineer of any unexpected subsurface conditions prior to placing stone bedding material.
- C. The Contractor shall place stone bedding material at the dimensions depicted on the Contract Drawings.
- D. Where the bottom of the trench at subgrade is in unstable or unsuitable material as determined by the Engineer, excavation shall be carried to such depth as directed by the Engineer. Such trench bottom shall be restored to subgrade using additional stone bedding material or other material as directed by the Engineer. The Contractor shall be

paid for such operation from the Stone Bedding bid item. Areas over excavated by error or unauthorized excavation shall be corrected by the Contractor at no additional cost to the Owner.

E. Stone Bedding Material

1. When the stone bedding material depicted on the Contract Drawings is a stone aggregate, the Contractor shall place geotextile fabric as required, and an initial lift of stone bedding material to achieve the pipe or manhole invert elevation depicted on the Contract Drawings. Bell holes shall be provided so that the load is carried by the barrel of the pipe only. Bell holes shall be created as needed prior to the placing of the pipe.
2. Once the pipe or manhole is placed, the Contractor shall carefully hand work stone bedding material from the trench wall up and under the pipe to support the haunches. The Contractor shall continue placing stone bedding material by hand up to the spring line of the pipe.
3. The final lift of stone bedding material shall be placed to the height above the pipe as depicted on the Contract Drawings. The Contractor shall carefully compact the stone bedding material with a mechanical compactor to ensure proper structure of the stone bedding material is achieved.

3.12 BACKFILLING

- A. Backfilling operations shall be accomplished using suitable native material. If the Engineer determines suitable material is not available on the project, or if directed by the Engineer, the Contractor shall use Borrow Backfill Type "C" as defined herein, and shall be paid out of the Borrow Backfill Type "C" bid item. Payment limits for these materials shall be in accordance with those shown on Contract Drawings.
- B. No borrow material shall be used until the slopes and ditches have been excavated and all other sources of excavation provided for have been exhausted. If the Contractor places more borrow than is required, causing the waste of excavation, the amount of such waste shall be deducted from the amount of borrow as measured.
- C. The initial lift of backfill shall be carefully placed around and to the depth depicted on the Contract Drawings above the stone bedding of the pipe or structure. Tamping shall be by approved mechanical means. Care should be exercised in this operation to ensure that the alignment of the pipe or structure is not disturbed.
- D. Subsequent lifts of backfill shall be placed and compacted in eight (8) inch layers to the elevation depicted on the Contract Drawings. No trucks or construction equipment will be allowed to pass over any part of the trench until the backfill has been completed and compacted up to a height of not less than two (2) feet above the top of the pipe.
- E. Full trench compaction will be required in all pipe trenches.



- F. The Contractor shall provide for, and assume all costs of engaging an independent testing lab, or engineering firm, to perform compaction testing on this backfill. One test shall be required per lift. Densities required shall be as depicted on the Contract Drawings.
  - 1. If the independent testing lab reports that backfill has not achieved the degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; re-compact and re-test until specified compaction is obtained, at no additional cost to the Owner.
- G. Insofar as the requirements for mechanical compaction equipment or methods, no specific requirements are included in these Contract Documents other than that the use of any particular type or equipment or method is subject to the approval of the Engineer and that he has the sole right to judge what equipment is suitable for the uses intended.
- H. Uniformly grade areas to a smooth surface, free of irregular surface changes to Pre-construction cross sections, lines, and elevations or as depicted on the Contract Drawings.
- I. After the completion of backfilling operations, all material not used therein shall be removed and disposed of in such a manner and at such a point as shall be approved or directed by the Engineer and all roads, sidewalks and other placed on the line of the work shall be left clean and in good order. Said cleaning up shall be done by the Contractor without extra compensation and if he fails to do such work within a reasonable amount of time after receipt of notice, it will be arranged to by the Engineer and the cost shall be retained out of the monies due or to become due the Contractor under the Contract.

### 3.13 MAINTENANCE OF BACKFILLED EXCAVATIONS

- A. The Contractor shall maintain, at his own expense, all backfilled excavation and surfacing in proper conditions as specified herein. Just prior to the termination date for maintaining excavations, the trench surfaces shall be given a final reshaping where necessary. All depressions appearing in the backfilled excavations shall be properly refilled. If the Contractor fails to make repairs within forty-eight (48) hours after the receipt of written notice from the Engineer, the Engineer may refill said depressions and the cost thereof shall be deducted from any monies due the Contractor under the Contract. In case of emergency, the Engineer may refill any dangerous depression or protect wherever necessary without giving previous notice to the Contractor and the cost of so doing shall be retained from any monies due or to become due the Contractor under the Contract.
- B. The Contractor shall be responsible for any injury or damage that may result from lack of maintenance of any backfilled excavation at any time previous to the end of the above mentioned termination date.

END OF SECTION 311004

## **SECTION 311009**

### **LAYOUT**

#### **PART 1 - GENERAL**

##### 1.1 SUMMARY

- A. This Section includes requirements for the topographical survey, Work layout and the establishment of pipe grade and structure elevations for the Work.

##### 1.2 PROJECT BENCHMARK

- A. Project benchmarks and horizontal control points may be depicted on the Contract Drawings. The Contractor is responsible for all other project layouts for line and grade including any additional benchmarks or control deemed necessary.

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### 3.1 CONTRACTOR REQUIREMENTS

- A. Inverts and slopes shall be determined by the Contractor at each manhole. This will insure that manholes are set in accordance with the Contract Drawings and that no discrepancies in slope occur. The Contractor shall be required to check line and grade 25 feet from the manhole, and every 50 feet thereafter or as required by the Engineer.
- B. The Engineer may periodically request that the Contractor's surveyor verify the Contractor's layout. Cost for periodic survey verification will be made at no additional cost to the Owner.
  - 1. Should any discrepancy occur, construction operations shall cease until such discrepancies are resolved. If corrective action is required, the Engineer will so notify the Contractor in writing, and the Contractor shall make said adjustments at no additional cost to the Owner.
- C. All pipes installed shall be placed with the use of a laser-guided pipe alignment device. All pipes shall be placed to the accuracy of the slope specified on the Contract Drawings. The correct settings on the laser(s) for proper grade shall be the responsibility of the Contractor.
- D. As-built elevations shall be provided by the Contractor to the Engineer at intervals not to exceed one week throughout the course of the construction.

**END OF SECTION 311009**

## SECTION 31 22 00

### GRADING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide grading as indicated and in compliance with Contract Documents.
- B. Section Includes:
  - 1. Rough grading.
  - 2. Finish grading.
  - 3. Stockpiling of topsoil and subsoil.
  - 4. Disposal of unsuitable and excess materials.

##### 1.02 DEFINITIONS:

- A. Unsuitable Material: Defined in Section 31 23 00.
- B. Foundation Influence Zone (under foundations, pavements, or sidewalks): Area below base bounded by 1/2H:1V slope extending outward from 1 feet beyond outer edges.
- C. Utility Influence Zone (around piping or ducts): Area below with limits bounded by perpendicular line, 6 inches (150 mm) below pipe or duct with a 1/2H:1V slope extending outward from that line, 1 feet (0.30 m) beyond the edge of pipe or duct.

##### 1.03 SUBMITTALS:

- A. Submit in accordance with Section 013400.

##### 1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.

##### 1.05 SITE CONDITIONS:

- A. Existing Conditions:
  - 1. See Section 011200 for additional requirements.
  - 2. Existing facilities, structures, and utilities are shown in accordance with available surveys and records. The indicated locations of underground utilities and structures are approximate. Other utilities may exist which are not indicated.

3. Verify location of existing underground utilities and structures by contacting utility owners, as required by law. Go to “Call Before You Dig” to receive state-specific information. Access this information by dialing 811 or going to <http://call811.com/state-specific.aspx>.

B. Geotechnical Report (see Attachments): The report is for information only and is not part of the Contract Documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

## PART 2 - PRODUCTS

(Not Used)

## PART 3 - EXECUTION

### 3.01 EXAMINATION:

- A. Verify survey benchmarks and intended elevations for the work are as indicated.
- B. Verify temporary erosion and sediment control measures are installed before commencing with any other work at the site.
- C. Immediately notify the Engineer if suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.
- D. Identify areas loosened by frost action, softened by flooding or weather, or containing unsuitable material.

### 3.02 PREPARATION:

- A. Remove material loosened by frost action, softened by flooding or weather, or containing unsuitable material. Replace and compact to same requirements as for specified fill in Section 31 23 00.
- B. Identify required lines, levels, grades, and datum.
- C. Stake and flag locations of known utilities.
- D. Locate, identify, and protect from damage all above- and below-ground utilities to remain.
- E. Notify utility owner prior to removal or relocation of utility. See Sections 011200 for notification requirements.

- F. When necessary to excavate through roots of trees or vegetation to remain – perform work by hand and cut roots with sharp axe.

### 3.03 ROUGH GRADING:

#### A. Topsoil removal and stockpiling:

1. Strip topsoil from areas that are to be excavated, landscaped, or graded.
2. Separate organic matter (e.g. root zones) from topsoil. Dispose of organic material off site.
3. Do not strip topsoil while wet.
4. Stockpile excavated topsoil on site. Do not mix topsoil with foreign materials.

#### B. Subsoil removal and stockpiling:

1. Remove subsoil from areas that are to be excavated, landscaped, or graded.
2. Do not remove wet subsoil unless it is subsequently processed to obtain optimum moisture content.
3. Stockpile suitable subsoil on-site.

#### C. Provide for free drainage of construction site.

#### D. Benching Slopes: Horizontally bench existing slopes greater than 4H:1V to key fill material to slope for firm bearing.

#### E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill in Section 31 23 00.

#### F. Disc level surfaces.

#### G. Rough grade site to achieve lines and grades indicated with allowances for imported fill thicknesses.

#### H. Provide positive drainage away from buildings and structures by sloping minimum of 3 inches (75 mm) over 10 feet (3 m).

### 3.04 FINISH GRADING:

#### A. Before finish grading:

1. Verify subgrade is contoured and compacted.
2. Verify backfill has been inspected.

- B. Fine grade to eliminate uneven areas and depressions. Follow profiles and contours of subgrade and bring to finish grade as indicated.

3.05 STOCKPILING:

- A. Location: As indicated or directed. Do not locate stockpiles over existing or new utilities unless directed.
- B. Height: 8 feet (2.4 m) maximum.
- C. Slope: 2H:1V, maximum
- D. Drainage: Grade to prevent standing water.
- E. Provide erosion and sediment control around downhill-side of stockpile perimeter.
- F. Immediately stabilize dormant stockpiles within 7 days. Stockpiles and portions of stockpiles that will not be actively used for at least 30 days shall be considered dormant.

3.06 EXCESS MATERIAL:

- A. Excess grading material, suitable for backfilling or site grading, that is not necessary to complete the work at the project site belongs to the Owner and shall be delivered to an off-site designated location.
- B. Dispose off site, unsuitable materials and excess materials not received by Owner.

3.07 TOLERANCES:

- A. Subgrade:
  - 1. Elevation: 2 inches (50 mm), from required elevation.
  - 2. Grade: 1 inch (25 mm) per 10 feet (3 m).
- B. Finish Grade:
  - 1. Elevation: 1/2 inch (13 mm), from required elevation.

3.08 FIELD QUALITY CONTROL:

- A. See Section 011006 for compaction and testing requirements.

3.09 CLEANING:

- A. See Sections 017400 for additional requirements.
- B. Remove unused stockpiles, grade area to prevent standing water, protect from erosion, and stabilize.

C. Leave site clean and raked, ready to receive landscaping.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 017400.

B. Submit existing utility location information as part of record drawings. Include ticket numbers and original information from utility owners.

END OF SECTION



SECTION 31 23 00

EXCAVATION AND FILL

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide excavation and fill as indicated and in compliance with Contract Documents.
- B. Excavation also includes the salvaging and stockpiling of topsoil for re-use, material suitable for backfill, temporary erosion and sedimentation controls and the removal and disposal of all material not otherwise provided for so that the project will be completed in a neat and workmanlike manner.
- C. Section includes:
  - 1. Excavation and fill for: Foundations, structures, and pavement; site drainage, structures, and features.
  - 2. Refer to Section 31 10 04 for other utility trenching and backfill.
  - 3. Controlled fill using materials from imported and on-site sources.
  - 4. Soil and aggregate materials.
  - 5. Compaction and testing.

1.02 REFERENCES:

- A. American Association of State and Highway Transportation Officials (AASHTO):
  - 1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
- B. ASTM International (ASTM):
  - 1. C33: Specification for Concrete Aggregates.
  - 2. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
  - 3. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.
  - 4. D422: Test Method for Particle-Size Analysis of Soils.
  - 5. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup>).

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6. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
  7. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
  8. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
  9. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
  10. D2940/D2940M: Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.
  11. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
  12. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- C. Occupational Safety and Health Administration (OSHA) Standards and Regulations: 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

#### 1.03 CLASSIFICATION OF EXCAVATION:

- A. Excavation is part of the lump sum contract price for the entire project. Excavation is not classified, except where rock excavation is authorized outside specified or indicated limits of excavation.
- B. Non-classified material is material that can be excavated without the use of blasting, drilling or wedging. Boulders or other detached stones removed from the excavation without the use of blasting, drill or wedging shall be considered under this item.
- C. Suitable native material is material excavated on the project that meets the requirements of Type C backfill and which is free from large lumps, ashes, cinders, organic material, or other refuse, clods or rocks except and which can be compacted to the degree specified.

#### 1.04 DEFINITIONS

- A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.
- B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method), ASTM D2167 (Rubber Balloon Method), or ASTM D6938 (Nuclear Method).

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- C. Maximum Dry Density: Laboratory density as determined by ASTM D698 (Standard Proctor) and occurring at the optimum moisture content of the material being tested.
- D. Proof Roll: Single pass of a drum or rubber tire roller, having a gross load between 25 to 50 tons. Rubber tire rollers shall have tires capable of operating at inflation pressures ranging from 90 to 150 psi.

1.05 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00.
  - 1. Temporary excavation and shoring drawings for worker protection in accordance with the General Provisions.
  - 2. Gradation analysis.
  - 3. Dewatering plan including disposition of groundwater.
  - 4. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics.
  - 5. Test and Evaluation Reports:
    - a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.
    - b. Grain-size analysis.
    - c. Laboratory compaction characteristics of soils.
    - d. Water content.
  - 6. Geotextile:
    - a. At least two weeks prior to shipment, submit manufacturer's certificate of compliance and physical property data sheet indicating that requirements for materials and manufacture are in conformance as specified.
    - b. For informational purposes only, submit manufacturer's printed installation instructions.

1.06 OWNERSHIP OF EXCAVATED MATERIAL:

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise to remain the County's property, excavated materials shall become Contractor's property and shall be removed from the Work site.

- B. All excess excavated material and/or materials unsuitable for use as backfill shall be removed from the site and disposed of in accordance with the Contract Documents and permits at no additional cost to the County.

1.07 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Sustainability Standards Certifications.
- C. Testing will be provided by the Owner as specified. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.
- D. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.08 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01 10 06.
- B. Geotextile Fabric:
  - 1. Provide rolls wrapped with protective covering to protect from mud, dirt, dust, and debris. Label each roll with number or symbol to identify production run.
  - 2. Protect from sunlight during transportation and storage. Do not leave exposed to sunlight for more than two weeks during installation operations.

1.09 SITE CONDITIONS:

- A. Existing Conditions:
  - 1. Geotechnical Report: The report is attached to these documents is for information only and is not part of the contract documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.
  - 2. The Geotechnical Report should not be interpreted to indicate what the Contractor may expect to find during his excavation. The Contractor assumes all risk and responsibility for any interpretation of the data and any extrapolation he makes of the subsurface conditions of the site in non-evaluated area(s) between soil borings/rock corings. The Owner will not be liable for any damages or additional time/expense due to conditions differing from what is indicated on the soil boring/rock coring logs, or the Contractor's use and/or reliance on the information presented in the soil boring/rock coring logs.

## PART 2 - PRODUCTS

### 2.01 FILL MATERIALS:

- A. Suitable Material: Material from on-site excavation or permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.
- B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:
  - 1. Organic clay, organic silt, or peat; as defined in ASTM D2487.
  - 2. Vegetation, wood, roots, leaves, and organic, degradable material.
  - 3. Stones or rock fragments over 6 inches (15 cm) in any dimension.
  - 4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.
  - 5. Ice, snow, frost, or frozen soil particles.
- C. If excavated material is unsuitable for backfilling operations, the Engineer will direct the Contractor to use borrow material. Costs associated for using Type C borrow material shall be paid from the "Contingent Borrow Material" item.
- B. The classification, characteristics and uses of borrow materials shall be in accordance with the requirements of AASHTO M145 and M57. Materials having a dry weight less than ninety (90) pounds per cubic foot, materials with natural moisture content in excess of ten percent (10%) or materials which have a liquid limit in excess of 50 shall be excluded from use.
- C. The method of testing materials shall be in accordance with the requirements of AASHTO T88, T89 modified, T90 and T99, Method C.
- D. In addition to the above requirements, which will be applicable for use in all types of construction, the following borrow types will be subject to the requirements below:
  - 1. Borrow Type A – This material shall be bank-run gravel slag, quarry waste, stone screenings or other acceptable granular material, the particles of which will be of such size that not more than five percent (5%) by dry weight shall be retained on the two and one-half (2½) inch sieve and not more than thirty-five percent (35%) by weight shall pass the number two-hundred (200) sieve.
  - 2. Borrow Type B (Special Fill) – Materials used for special fill shall consist of clean sand, crushed or uncrushed gravel or crushed stone and shall be free from frozen material, wood or other extraneous matter. With the approval of the

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Engineer, blasted or crushed rock and boulders may be used. Such rock shall have a maximum size of twelve (12) inches and shall have a gradation which is satisfactory to the Engineer. Special fill shall contain not more than ten (10) percent by weight passing the Number two hundred (200) sieve and forty-five percent (45%) by weight passing the Number one hundred (100) sieve. Material for special fill shall be sampled, tested and approved prior to final placement.

3. Borrow Type C (Backfill) – Material used for backfill shall have a gradation of 85-100 percent by weight passing the one (1) inch sieve and maximum of twenty-five percent (25%) by weight passing the Number 200 sieve.
4. Borrow Type D – This material shall have one hundred percent (100%) passing the three (3) inch sieve and between eight (8) to thirty (30) percent passing the Number 200 sieve.
5. Borrow Type E – This material shall be non-plastic and shall have not more than twenty (20) percent nor less than six (6) percent by dry weight passing the Number 200 sieve.
6. Borrow Type F – Material used for embankment construction shall be free from detrimental quantities of organic material, such as leaves, grass, roots and sewage, and shall be subject to the general requirements herein.
7. Borrow Type G (Select Borrow) – The Material for select borrow shall be granular soil meeting the following requirements when tested according to AASHTO T88, Modified:

Percentage By Weight Passing Square Mesh Sieves						
Sieve	Grading A	Grading B	Grading C	Grading D	Grading E	Grading F
2"	95-100	95-100	95-100	95-100	95-100	95-100
1"	--	75-95	85-100	85-100	85-100	85-100
3/8"	30-65	40-75	50-85	60-100	--	--
Number 4	25-55	30-60	35-65	50-85	55-100	70-100
Number 10	15-40	20-45	25-50	40-70	40-100	55-100
Number 40	8-20	15-30	15-30	25-45	20-50	30-70
Number 200	2-8	5-20	5-15	5-20	6-20	8-25

Note: The fraction passing the Number 200 sieve shall not be greater than two-thirds (2/3) of the fraction passing the Number 40 sieve. The fraction passing Number 40 sieve shall have a liquid limit not greater than twenty-five (25) and a

plasticity index not greater than six (6), when tested according to AASHTO T89, Modified and T90

- E. Materials excavated and proposed to be used as backfill material must conform to the requirements for borrow backfill as depicted on the Contract Drawings.

2.02 STONE BEDDING MATERIAL

- A. Aggregate material shall be in accordance with AASHTO M43 and shall be used where specified on the Drawings or as required by the Engineer. Aggregate material shall be furnished from a specific source or sources approved by the Engineer.

		Size of Aggregate									
Size number	Nominal size square openings	Amounts finer than each sieve (square openings), percentage by weight									
		1-1/2	1	3/4	1/2	3/8	No. 4	No. 8	No. 18	No. 50	No. 100
57	1 inch to No. 4.	100	95 to 100		25 to 60		0 to 10	0 to 5			
67	3/4 inch to No. 4		100	90 to 100		20 to 55	0 to 10	0 to 5			
8	3/8 inch to No. 8				100	85 to 100	10 to 30	0 to 10	0 to 5		

2.03 EQUIPMENT:

- A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

2.04 ACCESSORIES:

- A. Geotextile: Section 31 32 19.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify that dewatering support systems are in place before commencing with excavation.
- B. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.
  2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.
- C. Verify that fill materials submittals have been accepted by CM before commencing with work requiring the use of these materials.
- D. Verify that erosion and sediment control measures are in place and functioning properly.
- E. Immediately notify the CM if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.
- F. Test Pits:
1. Comply with the requirements in Section 01 14 14.
  2. Excavate test pits to field verify the locations of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the CM if conflicts are encountered.

### 3.02 PREPARATION:

- A. Remove boulders within excavation limits.

### 3.03 PROTECTION OF IN-PLACE CONDITIONS:

- A. Comply with the requirements specified in Section 01 10 06.
- B. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.
- C. Excavation Near Existing Structures:
1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.
  2. Excavate test pits near, or at intersection with, existing utilities or underground structures to determine the exact location of existing features.
- D. Excavation Near Private Property:



1. Record existing condition of features on adjacent property by means of dated photographs or cameras. Provide construction photographs according to Section 02 10 03.
2. Enclose uncut tree trunks adjacent to work in wooden boxes of such height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes so as to prevent injury to overhanging branches and limbs.
3. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.
4. Where protection of vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re-established.
5. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces. Provide protection on pavement or tracks if construction traffic is unavoidable.

3.04 RESTORATION:

- A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.
- B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.
- C. Damaged Trees To Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage, 1 year after substantial completion.
- D. Cultivated Vegetation: Includes, but is not limited to: hedges, shrubs, and plants. Vegetation that is damaged shall be replaced with equal kind and of at least the quality before work began.

3.05 EXCAVATION:

- A. Excavate to accommodate new structures and construction operations.
- B. Excavate to lines and grades necessary to provide finish grades.
- C. Excavations that are not shored and deeper than 4 feet (1.2 m) shall have banks laid back to a minimum stable slope matching the angle of repose of the excavated material.

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- D. Workers shall have an adequate means of exit from excavations that are 4 feet (1.2 m) or greater in depth. The means of exit shall not require more than 25 feet (7.5 m) of lateral travel.
- E. Establish limits of excavation to allow adequate working space for installing forms and for safety of personnel.
- F. Carry out program of excavation, dewatering, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or the work.(NTS: Add the following if dewatering is required for project. Use and coordinate with Section 31 23 19 (02240) if section is included in project.)
- G. Provide dewatering system in accordance with Section 31 23 19.
- H. Provide sheeting and shoring in accordance with Section 31 50 00.
- I. Preserve material below and beyond the lines of excavations.
- J. Locate stockpiled excavated material at least 3 feet (90 cm) from edge of excavations to prevent cave-ins or bank slides.
- K. Excavate for depressed mat foundations so that adjacent sections of foundation mat will rest on undisturbed ground.

#### 3.06 SUBGRADE PREPARATION:

- A. The exposed surface shall be examined by an engineering geologist or soils engineer to determine that the proper bearing material has been exposed.
- B. Materials which are determined to be unsuitable by visual inspection shall be over-excavated below the foundation subgrade and backfilled with Stone Bedding Material.
- C. Backfill with compacted Stone Bedding Material wrapped with nonwoven geotextile fabric. In no case shall the aggregate be placed directly on the exposed subgrade prior to placing the geotextile fabric.
- D. Compact subgrade and proof roll to identify soft spots or other deficiencies prior to filling operations or placing foundations. Correct deficiencies as specified for AUTHORIZED OVER-EXCAVATION and repeat proof roll procedure until successful.
- E. When subgrade is below controlled fill, scarify subgrade to bond with subsequent material lifts.
- F. Proof roll foundation subgrade prior to filling operation or placing foundation concrete. Continue until successful proof test is attained.

3.07 AUTHORIZED OVER-EXCAVATION:

- A. If proof roll test fails then remove unsuitable material plus an additional 6 inches (150mm), and backfill with structural fill.

3.08 UNAUTHORIZED EXCAVATION:

- A. Contractor is responsible for backfilling unauthorized excavations with structural fill.

3.09 FILL:

- A. Fill to lines and grades necessary to provide finish grades.
- B. Use a placement method that does not disturb or damage other work or existing features.
- C. Maintain fill materials within 3 percent of optimum moisture, to attain required compaction density.
- D. Place and compact material in equal continuous layers.
- E. General fill may be used in open areas, over lot fill, and areas which are not load bearing.
- F. Use structural fill beneath and adjacent to buildings and structures, and beneath pavements.
- G. Use concrete fill where footing bearing surfaces are over-excavated or footing is otherwise not bearing on undisturbed soil.
- H. Maximum compacted depth is 6 inches for aggregate materials and 8 inches for soil materials, unless noted otherwise.
- I. Do not backfill against or on hydraulic structures until testing is completed. See Section 03 05 10 for leakage testing requirements of concrete containment structures. Conduct hydraulic testing as soon as practicable after structures are constructed and other necessary work has been done. Start backfilling promptly after completion of tests.
- J. Deposit material evenly around structure to avoid unequal soil pressure.
- K. Do not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking, or other damage.

3.10 COMPACTION:

- A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified, or if not specified - at a level slightly lower than optimum.

- B. Compaction Density: Provide densities in Table 31 23 00-3. The values listed are minimum percentages, unless noted otherwise.

<b>Table 31 23 00-3</b>	
<b>Area</b>	<b>Percentage of Maximum Dry Density as defined by ASTM D698 (Standard Proctor)</b>
Scarified subgrades	<b>95</b>
Under pavement, slabs	<b>98</b>
Under structures or within 25 feet (7.5 m) of structures	<b>98</b>
Stormwater Management (SWM) basin embankment	<b>100</b>
Under exterior concrete slab and sidewalks	<b>95</b>
Open or grassed areas	<b>90</b>
Topsoil	<b>90 (maximum)</b>

3.11 BACKFILLING AGAINST STRUCTURES:

- A. Backfill shall not be placed against foundation walls until all interior floors have been placed and the concrete has attained design strength. This includes the floor level at grade or the next level above grade if no floor is within 2 feet (0.6 m) of finished grade.
- B. Backfill shall not be placed against cantilever walls until the concrete has attained design strength.

3.12 EMBANKMENT FILL AND COMPACTION:

- A. Begin filling in lowest section of work area. Grade surface of fill approximately horizontal but provide with sufficient longitudinal and transverse slope to allow for runoff of surface water from every point.
- B. Install temporary dewatering sumps in low areas during filling operation where excessive amounts of rain runoff collect.
- C. Reduce moisture content of fill material, if necessary, in source area by aerating it over during warm and dry atmospheric conditions. A large disc harrow with two to three foot diameter disks may be required for working soil in a drying operation.
- D. Compact uniformly throughout. Keep fill surfaces sufficiently smooth and free from humps and hollows to allow for proper and uniform compaction. Do not permit hauling equipment to follow a single track on the same layer but direct equipment to spread out to prevent over compaction in localized areas. Take care in obtaining thorough compaction at edges of fill.

- E. Slightly slope surface of fill to ensure drainage during periods of wet weather. Do not place fill while rain is falling or after a rain-storm until the CM considers conditions satisfactory. During such periods and upon suspension of filling operations for periods in excess of 12 hours, roll smooth the surface of fill using a smooth wheel static roller to prevent excessive absorption of rainfall and surface moisture. Prior to resuming compaction operations, remove muddy material off surface to expose firm, compacted material, as determined by the CM.
- F. When fill is placed against an earlier fill or against in-situ material under and around structures, including around piping beneath structures or embankments, slope junction between two sections of fill at 1.5 to 1 (horizontal to vertical). Bench edge of existing fill 24 inches (60 cm) to form a serrated edge of compact stable material against which to place the new fill. Ensure that rolling extends over junction between fills.
- G. Clean debris, remove loose material, and proof roll previously placed fill which has had time to become desiccated or littered with debris.
- H. After spreading each loose lift to the required thickness and adjusting its moisture content, roll with sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will insure complete coverage and uniform compaction of an entire lift. Do not make additional passes until previous pass has been completed.
- I. Fill surface shall be firm and hard when rolled. Reduce moisture content when fill material sinks and weaves under rollers and equipment. Spread out rolling operations over the maximum practicable area to minimize condition of sinking and weaving. Suspend fill operations on portions of embankment where inundations produce surface cracks.
- J. Remove material which fails testing requirements and replace work.

### 3.13 GEOTEXTILE:

- A. Install geotextile fabric in accordance with manufacturer's printed instructions and Section 31 05 19.
- B. Place geotextile fabric on the foundation subgrade prior to placing aggregate material.
- C. Overlap geotextile fabric 18 inches (45 cm) minimum for unsown lap joint. Overlap fabric 6 inches (15 cm) at seam for sewn joint.
- D. Do not permit traffic or construction equipment to travel directly on geotextile fabric.
- E. Place geotextile fabric in relatively smooth condition to prevent tearing or puncturing. Lay geotextile fabric loosely but without wrinkles or creases so that placement of the backfill materials will not stretch or tear geotextile fabric. Leave sufficient slack in geotextile fabric around irregularities to allow for readjustments.

- F. Patch all tears in geotextile fabric by placing additional section of geotextile fabric over tear with a minimum of 3 feet (90 cm) overlay.
- G. Extend the geotextile fabric and wrap around aggregate material along the perimeter of the foundation.

3.14 FIELD QUALITY CONTROL:

- A. See Section 01 40 00 for general requirements for field inspection and testing.
- B. Perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.
- C. Perform particle size distribution and gradation analyses using ASTM D422 and following standard practices in ASTM D421. Perform [1] test for every source and submit results to CM for acceptance. Repeat the moisture density test for every 5,000 cubic yard (3,825 cubic metre) of material used.
- D. Perform field density testing in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
- E. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with [**ASTM D698 (Standard Proctor)**] [**ASTM D1557 (Modified Proctor)**].
- F. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 5,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.
- G. Location of field density tests shall be mutually acceptable to testing laboratory and the Engineer.
- H. In the event compacted material does not meet specified in-place density, re-compact material and re-test area until specified results are obtained.
- I. Frequency of field density tests:

<b>Table 31 23 00-4</b>	
<b>Area</b>	<b>Frequency</b>
Roadways	1 per lift for each 250 linear feet of fill placed
Paved Areas	1 per lift for each 10,000 square of fill placed
Open Areas	1 per lift for each 25,000 square feet of fill placed
Isolated Footing Perimeter	1 per alternate lift for each 25 linear feet
Footing and Wall Backfill	1 per alternate lift for each 50 linear feet (both sides of wall)
<b>[Basin]</b> Embankment Fills	1 per lift for each 5,000 square feet of fill placed
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

<b>Table 31 23 00-5</b>	
<b>Area</b>	<b>Frequency</b>
Roadways	1 per lift for every 200 linear feet of roadway
Paved Areas	1 per lift for every 3,500 square feet of pavement
Open Areas	1 per lift for each 25,000 square feet of open area
Isolated Footing Perimeter	1 per alternate lift for each 25 linear feet
Footing and Wall Backfill	1 per alternate lift for each 50 linear feet (both sides of wall)
Under Structures	1 per lift for every 1,000 square feet of structure
Around Structures	1 per lift for every 1,500 square feet of structure
<b>[Basin ]</b> Embankment Fills	1 per lift for every 10,000 square feet of embankment
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

3.15 ADJUSTING:

A. Shrinkage:

1. Build backfill to a height above finished grade which will, in the opinion of the CM, allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.
2. Supply specified materials to build up low places when embankment or backfill settles below the finished grade at any time before substantial completion.

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3.16 TOLERANCES:

- A. Construct finished surfaces to plus or minus 1 inch of the elevations indicated.
- B. Grade areas of cut and fill to plus or minus 0.20 foot of the grades indicated.
- C. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.
- D. Provide the Engineer with adequate survey information to verify compliance with above tolerances.

3.17 PROTECTION

- A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.18 CLOSEOUT ACTIVITIES:

- A. Provide in accordance with Section 01 74 00.

END OF SECTION



## SECTION 31 23 16

### ROCK EXCAVATION AND DISPOSAL

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide rock excavation and disposal as indicated and in compliance with Contract Documents.
- B. Remove and dispose of rock, as defined in Section 01 29 01, Measurement and Payment, and furnish acceptable material for backfill in place of excavated rock as indicated.
- C. Rock excavation shall be performed by any of the following methods typically used in the construction industry:
  - 1. Expansive agents or tools.
  - 2. Mechanical means.
  - 3. Blasting.
  - 4. Combinations of the above.

##### 1.02 REFERENCES:

- A. National Fire Protection Association (NFPA):
  - 1. 495: Explosive Materials Code.

##### 1.03 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 013400.
  - 1. For each kind of blasting agents and explosives to be used, submit the perchlorate content provided by the suppliers and/or manufacturers. The Contractor has to obtain written permission from the Engineer to use perchlorate-containing explosive products.
  - 2. Submit the blasting program and distance-quantity tables to the Engineer 21 days prior to commencement of production blasting.
  - 3. Keep and submit to Engineer and at time specified by Engineer, a record of each blast showing general location of blast, depth and number of drillholes, kind and quantity of explosive used, kind and number and interval of delay periods used, and all monitoring data required for a complete record.

1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.
- B. If rock is excavated beyond the limits of payment indicated on the drawings, specified, or authorized in writing by the Engineer, backfill excess excavation, whether resulting from over breakage or other causes, at no additional compensation and as specified in Part 3 - EXECUTION.

1.05 SITE CONDITIONS:

- A. Protect structures, underground utilities, and other construction from damaged caused by pile driving.
- B. Geotechnical Report (see Attachments): The report is for information only and is not part of the Contract Documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the Contract Documents shall be construed as a guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings..

PART 2 - PRODUCTS

2.01 CONCRETE:

- A. Section 03 30 00.

2.03 GRANULAR FILL:

- A. Sections 31 23 00 and 31 23 33.

PART 3 - EXECUTION

3.01 ROCK REMOVAL – MECHANICAL METHODS:

- A. Excavate and remove rock by the mechanical methods.
  - 1. Drill holes and utilize expansive agents, tools or wedges, mechanical disintegration compound to fracture rock.
- B. Cut away rock at bottom of excavation to form level bearing.
- C. Remove shaled layers to provide sound and unshattered base for footings and foundations.
- D. In utility trenches, excavate to 6 inch (150 mm) below invert elevation of pipe and 24 inch (600 mm) wider than pipe diameter.

- E. Remove excavated materials from site and reuse for site landscaping.
- F. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Sections 31 23 00 and 31 23 33 with lean concrete fill in accordance with Section 03 30 00 as specified.

3.02 PROCEDURE:

- A. Excavate rock in pipe trenches to no less than 6 inches (15 cm) below the proposed invert of the pipe. Backfill trench, before pipe is laid, to correct subgrade elevation. Use compacted, specified material indicated on drawings, or the material specified for bedding pipe to backfill excess excavation. Furnish and place at no additional compensation.
- B. Fill excess excavation below elevation of the top of bedding, cradle, or envelope when in pipe trenches with material of same type and placed and compacted in same manner as specified for bedding, cradle, or envelope.
- C. At option of Contractor, fill excess excavation in rock beneath foundations with Class C concrete in accordance with Section 03 30 00.
- D. Drill and blast a single line of holes in vertical face of rock at end of trench, when shattering rock at ends of pipe or elsewhere as indicated. Provide minimum depth drillholes of 4 feet (1.2 m) and maximum spacing of 18 inch (45 cm) centers. Use sufficient explosive to shatter rock for future excavation. Complete shattering before any pipe or fitting is placed within 50 feet (15 m) of rock to be shattered.
- E. When the use of perchlorate-containing products is necessary and is reviewed by the Engineer:
  - 1. Institute rigorous “housekeeping” practices: The explosive products shall be properly detonated so that perchlorates are destructed to the maximum degree possible. Also, minimize the loss of product via spills or debris that could cause environmental pollution. In the event of spills or debris, reasonable effort should be made to collect and properly manage or dispose of perchlorate-containing materials.
  - 2. Take reasonable steps to prevent and address misfires: In cases where explosives or blasting agents are washed or removed for a borehole following a misfire, reasonable efforts should be made to collect and properly manage or dispose of perchlorate-containing materials.
- F. Remove shattered rock. If rock below normal depth is shattered due to drilling or blasting operations of Contractor and Engineer considers such shattered rock to be unfit for foundations, remove it and backfill excavation with concrete as specified, except that in pipe trenches, use granular fill for backfill. Do such removal and backfilling at no additional compensation.

- G. Remove dirt and loose rock, as directed, from designated areas and clean surface of rock using steam to melt snow and ice, if necessary. Remove water in depressions, so that whole surface of designated area can be inspected to determine whether seams or other defects exist.
  - H. Roughen surfaces of rock foundations sufficiently, cut into benches or steps to bond well with masonry and embankments to be built thereon.
  - I. Remove from the rock surface to remain all vegetation, dirt, sand, clay, boulders, scale, excessively cracked rock, loose fragments, ice, snow, and other objectionable substances. Use picking, barring, wedging, streams of water under sufficient pressure, stiff brushes, hammers, steam jets, and other effective means to accomplish this cleaning, and remove free water left on the surface of rock. Perform all of above before any masonry or embankment is built on or against rock.
  - J. Remove piles of boulders or loose rock encountered within limits of earth embankments for disposal.
  - K. Use excavated rock in backfilling trenches subject to following limitations:
    - 1. Do not use pieces of rock larger than permitted under subsection "Backfilling Pipe Trenches" of Section 31 23 33.
    - 2. Do not allow rock quantities used in backfill in any location to result in formation of voids.
    - 3. Do not place rock backfill within 16 inches (400 mm) of surface of finish grade.
  - L. Backfill with material obtained from outside sources at no additional compensation, when material specified for backfilling is not available in sufficient quantity from other excavations.
- 3.03 CONTRACT CLOSEOUT:
- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 31 23 19

### DEWATERING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide dewatering as indicated and in compliance with Contract Documents.
- B. Design, furnish, operate, maintain, and remove temporary dewatering systems to control groundwater and surface water to maintain stable, undisturbed subgrades, and permit work to be performed under dry and stable conditions. Work to be done as part of dewatering includes, but is not limited to:
  - 1. Lower the groundwater level.
  - 2. Lower hydrostatic pressure.
  - 3. Prevent surface water from entering the excavation during construction.
  - 4. Implement erosion control measures for disposing of discharge water.
- C. Groundwater within the excavation area shall be lowered to at least 2 feet (60 cm) below the lowest excavation levels as specified and as indicated.
- D. Common dewatering methods include, but are not limited to, sump pumping, deep wells, well points, vacuum well points or combinations thereof.
- E. The Contractor shall obtain the required permits for discharge from the Contractor's dewatering systems in accordance with 40 CFR Part 122. The discharge location shall be in accordance with permit requirements.

##### 1.02 REFERENCES:

- A. Code of Federal Regulations, Title 40 – Protection of Environment (CFR):
  - 1. 40 CFR Part 122: EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 013400.
  - 1. Qualification of the Contractor's dewatering specialist's or firm's qualifications a minimum of 4 weeks prior to dewatering work. The submittal shall include, but not be limited to:

- a. Qualifications of specialist's or firm's Registered Professional Engineer.
  - b. Qualifications of specialist's or firm's field representative who will oversee the installation, operation and maintenance of the dewatering system.
2. Submit a dewatering plan at least 2 weeks prior to start of dewatering work. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:
- a. Dewatering plan and details stamped and signed by a Registered Professional Engineer registered in the state where the project resides.
  - b. Certificate of Design: Refer to Section 013400.
  - c. A list of equipment including, but not limited to, pumps, prime movers, and standby equipment.
  - d. Detailed description of dewatering, maintenance, and system removal procedures.
  - e. Erosion and sedimentation control measures, and methods for disposal of pumped water.
  - f. List of all applicable laws, regulations, rules, and codes to which dewatering design conforms.
  - g. List of assumptions for design of dewatering systems, including but not limited to groundwater levels, soil profile, permeabilities, and duration of pumping.
3. A modified dewatering plan if, within 24 hours, open pumping from sumps and ditches results in boils, loss of fines or softening of the ground.

#### 1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.
- B. Employ the services of a dewatering specialist or firm having the following qualifications:
  1. Have completed at least 5 successful dewatering projects of equal size and complexity and with equal systems within the last 5 years.

2. Retain the services of a Registered Professional Engineer (in the state where the project is located) having a minimum of 5 years experience in the design of well points, deep wells, recharge systems, or equal systems.
  3. Retain the services of a field representative having a minimum of 5 years experience in installation of well points, deep wells, recharge systems, or equal systems.
- C. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the Engineer, stabilize the subgrade, and modify system to perform as specified.
  - D. Notify the Engineer immediately if settlement or movement is detected on structures. If the settlement or movement is deemed by the Engineer to be related to the dewatering, take actions to protect the adjacent structures and submit a modified dewatering plan to the Engineer within 24 hours. Implement the modified plan and repair damage incurred to adjacent structures.
  - E. Immediately notify the Engineer if oil or other hazardous materials are encountered after dewatering begins.

#### 1.05 HYDRAULIC UPLIFT OF STRUCTURES:

- A. The Contractor shall be responsible for the protection of all structures against hydraulic uplift until such structures have been accepted finally by the Owner.
- B. In this regard, the Contractor is advised that all tanks when completed are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings when the structure is completed. The concrete slab bottoms shall be placed in the dry, with the use of wellpoints or other dewatering means to keep the water elevation sufficiently low to carry on the work.
- C. Buildings with basements are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings against the weight of the completed structure, including all masonry, structural steel frames and cladding.

#### 1.06 PRECAUTIONS AGAINST HYDROSTATIC UPLIFT DURING CONSTRUCTION:

- A. The Contractor shall maintain a low groundwater elevation in the vicinity of the structures until they are complete. In case of extremely high water during construction of the structures, it may be necessary to flood the structures to maintain stable conditions.

#### 1.07 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.

1.08 SITE CONDITIONS:

A. Existing Conditions:

1. Geotechnical Report (see Attachments): The report is for information only and is not part of the contract documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Provide settlement markers, piezometers and other geotechnical instruments in accordance with the submitted dewatering plan or as specified.
- B. Provide casings, well screens, piping, fittings, pumps, power and other items required for dewatering system.
- C. Provide sand and gravel filter around the well screen. Wrapping geotextile fabric directly around the well screen shall not be allowed.
- D. When deep wells, well points, or vacuum well points are used, provide pumping units capable of maintaining high vacuum and handling large volumes of air and water at the same time.
- E. Provide auxiliary dewatering equipment in the event of breakdown. Equipment shall consist of pumps and hoses and be stored on site. Provide at least 1 pump for every 5 pumps used.
- F. Provide and maintain erosion and sedimentation control devices as indicated or specified and in accordance with the dewatering plan.
- G. Provide temporary pipes, hoses, flumes, or channels for the transport of discharge water to the discharge location.
- H. Provide cement grout having a water cement ratio of 1 to 1 by volume.

3.01 INSTALLATION:

- A. Execution of earth excavation, installing earth retention systems, and dewatering shall not commence until the related submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed.
- B. Provide and maintain dewatering system in accordance with the dewatering plan.



- C. Carry out dewatering program in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.
- D. Do not excavate until the dewatering system is operational.
- E. Unless otherwise specified, continue dewatering uninterrupted until all structures, pipes, and appurtenances below groundwater level have been completed such that they will not be floated or otherwise damaged by an increase in groundwater elevation.
- F. Discontinue open pumping from sumps and ditches when such pumping results in boils, loss of fines, softening of the ground, or instability of the slopes. Modify dewatering plan and submit revised plan to the Engineer for approval.
- G. Where subgrade materials are disturbed or become unstable due to dewatering operations, remove and replace the materials in accordance with Section 31 23 00.
- H. Dewatering Discharge:
  - 1. Install and monitor systems in accordance with the submitted dewatering plan.
  - 2. Install sand and gravel filters in conjunction with well points and deep wells to prevent the migration of fines from the existing soil during the dewatering operation.
  - 3. Transport pumped or drained water to discharge location without interference to other work, damage to pavement, other surfaces, or property.
  - 4. Provide separately controllable pumping lines.
  - 5. The Engineer reserves the right to sample discharge water at any time.
  - 6. Immediately notify the Engineer if suspected contaminated groundwater is encountered. Do not pump water found to be contaminated with oil or other hazardous material to the discharge locations.
- I. Install and maintain erosion/sedimentation control devices at the point of discharge as indicated or specified and in accordance with the dewatering plan.
- J. Removal:
  - 1. Do not remove dewatering system without written acceptance from the Engineer.
  - 2. Backfill and compact sumps or ditches with granular fill wrapped with geotextile fabric in accordance with Section 31 23 00.
  - 3. All dewatering wells shall be abandoned upon completion of the work, and completely backfilled with cement grout.

3.02 CLOSEOUT ACTIVITIES:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 31 50 00

### EXCAVATION SUPPORT SYSTEMS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide excavation support systems as indicated and in compliance with Contract Documents.
- B. Design, furnish and install excavation support systems to maintain lateral support, prevent loss of ground, limit soil movements to acceptable limits and protect from damage existing and proposed improvements including pipelines, utilities, structures, roadways, railroads and other facilities.
- C. The requirement of specified excavation support systems in areas indicated on the drawings does not relieve the Contractor from the responsibility of furnishing and installing proper temporary excavation support systems in other areas.
- D. Common types of excavation support system include, but are not limited to; singular or multiple stages comprised of cantilevered or internally braced soldier piles and lagging, steel sheetpile wall, timber sheetpile wall, trench box, or combinations thereof. Trench box temporary excavation support system is only acceptable for pipe or utility trench excavations approved by the Engineer. Temporary unsupported open cut excavation with stable sloping sides is allowed where applicable.
- E. Extraction of steel sheetpile wall, timber sheetpile wall, or soldier piles are not permitted unless otherwise indicated, specified or approved by the Engineer.
- F. Wherever the word "sheeting" is used in this section or on the contract drawings, it shall be in reference to any type of excavation support system specified except trench box.
- G. Construction of the excavation support systems shall not disturb the existing structures or the completed proposed structures. Damage to such structures shall be repaired at Contractor's expense.
- H. Adjacent structures are those that are bear upon soils above the proposed excavation depth and within a distance equal to twice the total depth of the excavation away from the closest edge of the excavation. Monitor and protect adjacent structures as specified and indicated.
- I. Vibration monitoring for excavation support systems shall be performed as specified in Section 02 32 14.
- J. Construction operations not to exceed specified noise limits in accordance with Section 22.02.008 Noise Control, of the New Castle County Code.

- K. Bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design of the excavation support systems. Pay for all claims, costs and damages that arise as a result of the Work performed at Contractor's expense.

## 1.02 REFERENCES:

### A. American Concrete Institute (ACI):

- 1. 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

### B. ASTM International (ASTM):

- 1. A36: Standard Specification for Structural Steel.
- 2. A416: Standard Specification for Strand Steel, Uncoated Seven Wire for Prestressed Concrete.
- 3. A572: Standard Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
- 4. A615: Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
- 5. A722: Specification for Uncoated High Strength Steel Bar for Prestressing Concrete

### C. American Wood-Preserves Association (AWPA) Standards.

- 1. P23-10: Standard for Chromated Copper Arsenate Type C (CCA-C).
- 2. P50-10: Standard for Fire Retardant FR-2 (FR-2).

### D. American Welding Society (AWS)

- 1. D1.1: Structural Welding Code.

### E. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Part 1926 Subpart P - Excavations.

## 1.03 SUBMITTALS

### A. Submit the following in accordance with Section 013400.

- 1. Submit the following qualifications four (4) weeks prior to the construction:
  - a. Qualifications of Contractor's excavation support system designer as specified in Paragraph 1.04.G.

- b. Qualifications of Contractor's excavation support system installer as specified in Paragraph 1.04.H.
  - c. Qualifications of Contractor's independent tieback testing laboratory as specified in Paragraph 1.04.I, if a tieback system is utilized.
  - d. Qualifications of Contractor's excavation support system installation supervisor as specified in Paragraph 1.04.J.
  - e. Qualifications of vacuum excavation subcontractor as specified in Paragraph 1.04.F, if DMPs for utilities are utilized.
2. Submit an excavation support plan stamped and signed by a Registered Professional Engineer at least two weeks prior to start of the construction. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor remains responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:
- a. Proposed excavation support system(s), details, location, layout, depths, extent of different types of support relative to existing features and the permanent structures to be constructed, and methods and sequence of installation and removal.
  - b. Certificate of Design: Refer to Section 013400.
  - c. A list of all design assumptions, including safety factors used for the excavation support system(s) and all lateral pressures used for each system.
  - d. If utilizing a tieback system, include tieback installation procedures and criteria for acceptance of tiebacks for performance and proof tests. Submit the tieback testing results to the Engineer for information only.
  - e. Requirements of dewatering during the construction.
  - f. Minimum lateral distance from the edge of the excavation support system for use for vehicles, construction equipment, and stockpiled construction and excavated materials.
  - g. List of equipment used for installing the excavation support systems.
  - h. Monitoring schedule, installation procedures and location plans for vibration/noise monitoring, geotechnical instrumentation (deformation monitoring points and inclinometers) and observation wells/piezometers to monitor ground, excavation support system, adjacent structures and groundwater fluctuation during the entire construction period.

3. Submit a Construction Contingency Plan specifying the methods and procedures to maintain excavation support system stability if the allowable movement of the adjacent ground and adjacent structures is exceeded.
4. Monitoring data within one (1) day of data collection from vibration and noise recording equipment, observation wells, deformation monitoring points and offset lines. Data shall include:
  - a. Horizontal and vertical movements of geotechnical instruments and groundwater readings.
  - b. New movements since the initial readings of the geotechnical instruments.
  - c. Weekly summary in tabular and graphic form at the end of each week.
  - d. A schematic plan of excavation and/or relevant construction activities at the time of monitoring.
5. For excavation support systems left in place, submit the following as-built information prior to backfilling and covering the excavation support systems:
  - a. Survey locations of the excavation support systems, including coordinates of the ends and points of change in direction.
  - b. Type of the excavation support system.
  - c. Elevations of top and bottom of the excavation support systems left in place.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 011006.
- B. Conform to the requirements of the OSHA Standards and Regulations: "Part 1926 Subpart P - Excavations".
- C. Construction operations to conform to noise regulations provided in the Noise Control Plan and this Section.
- D. Retain the services of an independent vibration consulting firm meeting the requirements as specified in Section 02 32 14.
- E. The peak particle velocity for pile driving, or other vibration-inducing operations, shall meet the requirements as specified in Section 02 32 14.
- F. If utilizing deformation monitoring points (DMPs) for utilities, vacuum excavation shall be performed by subcontractor having five (5) years of experience in non-destructive vacuum excavation methods for utilities.

- G. Prepare design, including calculations and drawings, under the direction of a Professional Engineer registered in the state where the project is located and having the following qualifications:
    - 1. Not less than ten (10) years experience in the design of specific excavation support systems to be used.
    - 2. Completed not less than five (5) successful excavation support system projects of equal type, size, and complexity within the last five (5) years.
  - H. Excavation Support System Installer's Qualifications:
    - 1. Not less than three (3) year experience in the installation of similar types and equal complexity as the proposed system.
    - 2. Completed not less than three (3) successful excavation support systems of similar type and equal complexity as the proposed system.
  - I. If utilizing a tieback system, employ an independent testing laboratory to test the tieback system with the following qualifications:
    - 1. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.
    - 2. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor tieback systems of similar type and equal complexity, as the proposed system.
    - 3. Have not less than five (5) years experience in testing of tieback systems of similar type and equal complexity as the proposed system.
    - 4. Have successfully tested at least three (3) tieback systems of similar type and equal complexity as the proposed system.
  - J. Install all excavation support systems under the supervision of a supervisor having the following qualifications:
    - 1. Not less than five (5) years experience in installation of systems of similar type and equal complexity as the proposed system.
    - 2. Completed at least five (5) successful excavation support systems of similar type and equal complexity as the proposed system.
  - K. All welding shall be performed in accordance with AWS D1.1.
- 1.05 DESIGN CRITERIA:
- A. Design of excavation support systems shall meet the following minimum requirements:

1. Support systems shall be designed for earth pressures, hydrostatic pressure, equipment, temporary stockpiles, construction loads, roadways, railroads, and other surcharge loads.
2. Design a bracing system to provide sufficient reaction to maintain stability.
3. Limit movement of ground adjacent to the excavation support system to be within the allowable ground deformation as specified.
4. Design the embedment depth below bottom of excavation to minimize lateral and vertical earth movements and provide bottom stability. Toe of braced temporary excavation support systems shall not be less than 5 feet below the bottom of the excavation.
5. Design excavation support systems to withstand an additional 2 feet of excavation below proposed bottom of excavation without redesign except for the addition of lagging and/or bracing.
6. Maximum width of pipe trench excavation shall be as indicated on the drawings.
7. Do not cast permanent structure walls directly against excavation support walls.
8. The design location of the excavation support wall shall be determined such that the installed wall and bracing system components are all located outside the limits of the permanent structure. Construction tolerances (e.g. wall verticality) shall be considered in determining the plan location.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Sections 01 66 10 and as specified.
- B. Store sheeting and bracing materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

1.07 SITE CONDITIONS:

- A. Existing Conditions:
  1. Geotechnical Report ([see Attachments](#)): The report is for information only and is not part of the contract documents. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.



## PART 2 - PRODUCTS

### 2.01 MATERIALS:

- A. Structural Steel: All soldier piles, wales, rakers, struts, wedges, plates, waterstop and accessory steel shapes shall conform to ASTM A36.
- B. Steel Sheet Piling: ASTM A572, continuous interlocking type.
- C. Timber Lagging Left in Place: Pressured treated per AWWA standards.
- D. Tieback Tendons: Tieback tendons shall be high strength steel wire strand cables conforming to ASTM A416, or bars conforming to ASTM A722. Splicing of individual cables shall not be permitted.
- E. Raker Ties: ASTM A615 Grade 60.
- F. Cement Grout Materials And Admixtures For Tieback Anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.
- G. Concrete: Section 03 30 00.
- H. Tamping tools adapted for backfilling voids after removal of the excavation support system.
- I. Provide specific trench box sizes for each pipe and utility excavation with structural capacity of retaining soil types as described in OSHA's 29 CFR Part 1926 Subpart P.

### 2.02 EQUIPMENT:

- A. A vibratory hammer shall be utilized for driving the sheet piling providing that such operations do not exceed vibration/noise requirements of the specifications. Impact hammer shall be utilized when vibratory hammer is unable to drive sheet piling to required depth and/or unable to meet vibration requirements. Impact hammer shall also meet noise requirement.

## PART 3 - EXECUTION

### 3.01 INSTALLATION:

- A. Installation of the excavation support systems shall not commence until the related earth excavation and dewatering submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed.
- B. Install excavation support systems in accordance with the excavation support plan.

- C. If utilizing a tieback system, all performance and proof tests shall be conducted in the presence of the Engineer. Testing performed without the Engineer present is considered invalid. Repeat testing in the Engineer's presence at Contractor's expense.
- D. Do not drive sheeting within 100 feet of concrete less than seven (7) days old.
- E. Carry out program of excavation support in such a manner as to prevent undermining or disturbing foundations of existing structures of Work ongoing or previously completed.
- F. Bottom of the trench box excavation support system shall be above the pipe invert prior to installing the pipe.
- G. Install and read geotechnical instrumentation in accordance with the excavation support plan. Notify the Engineer immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at Contractor's expense.
- H. Continuously monitor movements of the ground adjacent to excavation support systems and adjacent structures. In events of the measured movements approaching or exceeding the allowable movements, take immediate steps to arrest further movement by revising procedures such as providing supplementary bracing, filling voids behind the trench box, supporting utilities or other measures (Construction Contingency Plan).
- I. Notify utility owners if existing utilities interfere with the excavation support system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at Contractor's expense.

### 3.02 GROUND DEFORMATION ADJACENT TO EXCAVATION SUPPORT SYSTEMS:

- A. Allowable Vertical (heave/settlement) and Lateral Movements: 2 inches maximum for the trench box excavation support system, and 1 inch maximum for other types of excavation support systems at any location behind the excavation support system.
- B. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to eliminate spurious readings.
- C. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.
- D. Notify the Engineer when the allowable ground deformation is exceeded.
- E. Implement Construction Contingency Plan under direction of the temporary excavation support system designer and the Engineer.

3.03 REMOVAL OF EXCAVATION SUPPORT SYSTEMS:

- A. Sheeting shall be left in place unless otherwise indicated.
- B. When indicated, remove the excavation support system without endangering the constructed or adjacent structures, utilities, or property. Immediately backfill all voids left or caused by withdrawal of excavation support systems with bank-run gravel, screened gravel or select borrow by tamping with tools specifically adapted for that purpose.
- C. When tiebacks are used, release tension in tiebacks as the excavation is backfilled. Do not leave tensioned tieback in place at the completion of the Work.
- D. The excavation support system left-in-place shall be cut-off a minimum of 2 feet below the bottom of the next higher foundation level or a minimum of 5 feet below finished grade.
- E. Conduct survey of the locations and final cut-off elevations of the excavation support systems left in place.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

**DIVISION 32 – EXTERIOR IMPROVEMENTS**

## SECTION 321001

### PLANTING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. The Contractor shall restore or replace, when and as directed, any public or private property disturbed or damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations unless specified otherwise in the Contract Documents. To this end, the Contractor shall do as required all necessary landscaping work. Suitable materials, equipment, and methods shall be used for such restoration. The restoration of existing property or structures shall be done as promptly as practicable as work progresses and shall not be left until the end of the contract period.
- B. Restoration may include agreements made between the Owner and property owners, specifying materials and/or methods. Such agreements shall be made part of the Contract Documents.

##### 1.2 SUBMITTALS

- A. Provide the required information for each type of product indicated.
- B. Certification of grass seed.
  - 1. Certification of each seed mixture for turf grass sod.

#### PART 2 - PRODUCTS

##### 2.1 TOPSOIL

- A. Topsoil for planting shall be original surface, friable loam topsoil of good, rich, uniform quality, free from heavy clay, coarse sand, stones over two inches, lumps, frozen clods, plants, roots, sticks and foreign materials harmful to plant growth. Topsoil shall be reasonably free from perennial weeds and shall not contain objectionable plant material, or vegetable debris undesirable or harmful to plant life.
- B. Topsoil shall be reasonably free of noxious perennial weeds or woody vegetation and completely void of Johnsongrass (*Sorghum halapense*) as determined through prior inspection by the Engineer or authorized representative of the Owner.
- C. Topsoil shall have an acidity range of pH 6.0 to pH 6.8.
- D. Topsoil shall contain between five (5) percent and twenty (20) percent organic matter as determined by loss on ignition of samples oven dried to constant weight at two-hundred twelve (212) degrees Fahrenheit, plus or minus five (5) degrees.

E. Grading Analysis

Sieve	Minimum Percent Passing
2"	100
Number 4	90
Number 10	80

1. Topsoil shall meet the following analysis as determined by the AASHTO Designation T-88, Standard Hydrometer Test. Sand, Silt and clay are as defined by AASHTO Designation M-146.

Minimum Percent	Minimum Percent Passing
Sand 20	75
Silt 10	60
Clay 5	30

2. The Engineer shall approve material prior to delivery.

F. Source

1. Topsoil shall be secured from areas from which topsoil has not been previously removed either by erosion or mechanical methods, and it shall not be removed to a depth in excess of the depth approved.
2. The area(s) from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage and other characteristics as to offer assurance that when removed in commercial

2.2 SEED

A. Grass and Agricultural Seeds

1. All seeds shall be fresh, clean from new crop seed and delivered to the site unopened in original packages which have affixed to the packages the date guaranteed analysis.
2. All seed shall be mixed at the blending and/or seed source and certified as appropriate. All seed mixed shall be used within nine (9) months of the date of certification.
3. Provide seed mixes as set forth in the State of Delaware Erosion and Sediment Handbook:
  - a. Full Sun: Figure 3.4.3.3a - Seed mix No. 11
  - b. Sun and Partial Shade: Figure 3.4.3.3a - Seed mix No. 13
  - c. Full Shade: Figure 3.4.3.3a - Seed mix No. 14
4. No Johnsongrass (*Sorghum halapense*) shall be allowed under the maximum allowable percentage of weed seeds as specified herein.

B. Seed Inoculant

1. The inoculant for Crownvetch seeding shall be a pure culture of nitrogen fixing bacteria selected for maximum vitality and for the ability to transform nitrogen from the air into soluble nitrates and deposit them in the soil. Inoculants shall consist of pure bred cultures and shall not be used later than the date indicated on the container. Four times the normal amount of inoculant as indicated on packaging shall be used for wet application. The inoculant shall be kept as cool as possible until used. Temperatures about seventy-five (75) degrees through eighty (8) degrees Fahrenheit will weaken the bacteria and the Contractor shall take every precaution possible while handling the inoculant.

2.3 INORGANIC SOIL AMENDMENTS

A. Fertilizer

1. Plant fertilizer shall be a 10-6-4 analysis with seventy-five (75) percent of the available nitrogen from a urea formaldehyde source.
2. The fertilize shall conform to all State and Federal regulations and to the standards for the Association of Official Agricultural Chemists. Commercial fertilize shall provide the minimum percentage of available nutrients as specified. The Engineer shall require the Contractor to furnish an affidavit from the vendor or a testing laboratory as to the available nutrients contained therein.
3. Fertilize shall be furnished in new, clean, sealed and properly labeled bags. Fertilizer failing to meet the specified analysis may be used as determined by the Engineer, providing sufficient materials are applied to comply with the specified nutrients per unit of measure with no additional cost to the Owner.
4. The fertilizer analysis for use when seeding as specified herein shall yield the following values in pounds of actual plant food per acre.
  - a. Standard Roadside and Temporary Seeding Mix
    - 1) 70 pounds nitrogen (N), 50 percent by weight of the nitrogen content shall be available from urea formaldehyde.
    - 2) 42 pounds available phosphoric acid (P<sub>2</sub>O<sub>5</sub>)
    - 3) 28 pounds water soluble potash (K<sub>2</sub>O)
  - b. Crownvetch Mix
    - 1) 152 pounds nitrogen (N), 10 percent by weight of the nitrogen content shall be available from urea formaldehyde.
    - 2) 100 pounds available phosphoric acid (P<sub>2</sub>O<sub>5</sub>)
    - 3) 100 pounds water soluble potash (K<sub>2</sub>O)
5. Commercial fertilizer shall be furnished in containers plainly marked with the chemical analysis of the product or, if provided in bulk, a certificate guaranteeing the fertilizer analysis must accompany each delivery to the project. No fertilizer shall be used which has not been marketed in accordance with state and federal laws. Fertilizer shall be stored in a dry area.

6. The unreaformaldehyde specified above shall meet the following requirements

Total Nitrogen (TN), cold water soluble	38 Percent Minimum
Nitrogen (IN 25°)	25 Percent Minimum
Activity index (AI)	45 Percent Minimum
Urea nitrogen	3.5 Percent Minimum

7. Chemical binder shall be fifty (50) percent solids in water emulsion containing or composed of Polyalkyleneoxide Modified Vinylolefin. The chemical binder shall be miscible with all normally available water. After an adequate drying period of two to six hours, the chemical binder shall no longer be soluble or dispersible in water.

2.4 MULCHES

- A. Provide straw mulch as set forth in the State of Delaware Erosion and Sediment Handbook, Section 3.4.5-1.

2.5 SOD

- A. Sod shall be well rooted from high quality seed of known origin and native to the locality of the work. No sod shall be removed until the proposed area from which the sod is to be transplanted has been approved by an authorized representative of DELDOT. Sod shall be stripped, delivered and laid within a period of thirty-six (36) hours. Sod stripped and/or delivered but not laid within this period shall be re-inspected and approved by the Engineer prior to its use.

B. Bluegrass Sod

1. Bluegrass sod shall contain not less than sixty (60) percent common Kentucky Bluegrass (*Poa pratensis*, domestic origin) and not more than thrity (3) percent Red Fescue (*Festuca rubra*) and not more than ten (10) percent other grasses and legumes.

C. Tall Fescue Sod

1. Tall Fescue sod shall contain not less than eighty (80) percent tall Kentucky 31 Fescue (*Fescue elatior arundinacea*) with no mre than twenty (2) percent of other grasses and legumes.

- D. Grass sod shall be tall fescue sod unless otherwise specified in accordance with the above requirements.

- E. Sod shall be free of objectionable grassy and broadleaf weeds. Sod shall be considered free of such weeds if less than five (5) such plants are found per one hundred (100) square feet of area. Sod shall not be acceptable if it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel and bromegrass.



- F. Sod shall be reasonably free of thatch, diseases, nematode and soil-borne insects. All sod entering the project inter-state must display inspection tags affixed at the sod source. The same shall apply to all sod shipped intra-state with prior inspection and tagging through the Crop Improvement Association, University of Delaware.
- G. Before stripping, sod shall be mowed uniformly at a height of one (1) to two and one-half (2-1/2) inches. Sod shall be machine cut at a uniform soild thickness of 5/8 inches plus or ¼ inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch. The sod pad size shall be cut to a minimum uniform width of twelve (12) inches and a minimum length of twelve (12) inches.

## 2.6 PLANT MATERIAL

- A. Plant material includes trees, shrubs, vines, and plants of all description. All materials and living plants shall be subject to approval at the source of supply prior to shipment to the site of the project.
- B. All plant material shall be true to type and nomenclature and typical of their species or variety. They shall have a normal habit of growth with well-developed branch systems and vigorous plants, free from defects, disfiguration, injury, disease of any kind, insect eggs, borers and any infestation.
- C. All plants shall be nursery grown. Plants shall have been growing under similar climatic conditions to those in the locality of the project for at least two (2) years prior to planting. All plant material shall have been grown in a soil that is similar to the project area, and shall not have been grown in a muck type soil or other foreign type. All plants shall be freshly dug and no plants heeled in or held in cold storage between the dates of April 1<sup>st</sup> and October 31<sup>st</sup> will be accepted. Heeling-in is acceptable during plating operations during the above dates for a period of hours or even up to thirty (30) consecutive calendar days when in the opinion of the Engineer the plants will not become damaged or in any way of lesser than freshly dug quality. Plant material that are weak or which have been cut back from larger sizes to meet specifications will be rejected.
- D. All plants shall conform to the sizes and measurements as specified on the plans. Plants for use where symmetry is required shall be matched as closely as possible. All plants shall be measured for height and spread with the branches in their natural positions. Caliper measurements for trees shall be taken six (6) feet above the ground level up to and including four (4) inches caliper size and twelve (12) inches above the ground level for larger sizes. Trees shall have straight trunks according to their habit of growth and shall be well branched and rooted. Height of branching of trees and all other measurements shall be taken in accordance with the current edition of the American Standard for Nursery Stock, unless otherwise specified.
- E. Plants of larger size than specified may be used if approved in writing; however, no additional payments will be granted the Contractor for the larger size plant. If larger sizes of plants are approved, the earth ball or root spread will be proportionally increased. Where a minim and maximum size or range is specified, an average size is required. Plant material shall not be pruned prior to delivery at the planting site. No change in size, quantity, kind or quality of plant material from those specified will be permitted without written approval from the Engineer.

- F. In cases where specified plant material is not available at the time of planting, the Contractor shall submit proof from a minimum of five (5) competent sources that the plant material is not available. If the Engineer and the Contractor can agree on a suitable alternate plant variety at the same bid price as the unavailable variety, the Engineer may allow the Contractor to make the substitution.
- G. The Contractor shall be responsible for securing and furnishing to the Engineer all certificates of inspection of plant material that may be required by Federal, State or other authorities to accompany shipments of plants. The successful Bidder shall furnish a completing listing of the locations and the types of material at that location of all plant material he intends to use on the project. The Engineer reserves the right to inspect plant material at any time and at any place. If inspection is made at the source of supply, subsequent inspections will also be made at the planting site. All plant material shall be inspected prior to planting.
- H. Any plants placed without prior inspection will be subject to inspection and possible rejection at no additional cost to the Owner. Plant material shall be protected according to best horticultural practice while in transit in such a way as to prevent the drying or possible dehydration of plant tissue. Plant material arriving at the site with broken or loose balls, insufficient top or root protection while in transit, shriveled, dry or insufficiently developed roots or which are weak or thin, or damaged or defective or which do not comply with the specifications, will not be accepted. The Engineer reserves the right to reject all stock that is found to be unsatisfactory. All plant material determined as unsatisfactory by the Engineer shall not be planted and shall be removed from the project site. Failure on the part of the Contractor to comply with any of the above procedures will require an immediate suspension of all work.
- I. Plants shall conform to the nomenclature of "Standard Plant Names" as accepted by the American Joint Commission of Horticulture Nomenclature, 1942 Edition. Names of varieties not include shall conform to names accepted in Nursery trade. Size and grading shall conform to those of the American Association of Nurserymen, Inc., as published in "USA Standards for Nursery Stock." No substitution shall be permitted except by written permission of the Engineer.
- J. Trees shall have straight trunks according to their habit of growth and shall be well branched and rooted. Shade trees of standard variety shall have a single leader and shall be branched at six (6) foot to eight (8) foot height unless otherwise directed.
- K. Shrubs shall be well branched, with full and compact growth and have ample well branched root systems capable of sustaining vigorous plant growth.
- L. Ground cover shall be two (2) years old, container grown plant, unless otherwise approved or specified on the Contract Documents and shall have been growing for at least six (6) months in the size specified.

## 2.7 STAKES, GUYS AND RELATED MATERIALS

- A. Guy Wire
  - 1. Guy wire shall be Number 12 or Number 12 gauge annealed galvanized steel wire, free of bends or kinks.

2. Anchors for guy wire shall be four (4) inch malleable iron ground anchors, one pound each three thousand (3,000) pounds holding strength, triangular in shape with hoops or slots for attaching guy wires, stem for receiving driving rods. The anchor assembly shall have preloading capacity so that it will rise two (2) inches to six (6) inches, and this movement shall occur as the anchor turns in the ground to its permanent position of approximately a ninety-degree angle to the line of force applied. Anchors shall be preloading and installed in the ground with the use of driving rods.
- B. Turnbuckles shall be galvanized with 4-1/2 inch openings and 5/16 inch threaded ends with screw eyes. Zinc coating when tested shall meet ASTM A 153 for galvanization.
  - C. Tree stakes shall be vertical, rough sawn, straight grain oak or other wood approved by the Engineer, reasonable free from knot holes, bark, wane, warp and splits. Stakes for major trees and evergreen trees shall be two (2) inches by two (2) inches by ten (10) feet long, and stakes for minor trees and evergreen trees shall be two (2) inches by two (2) inches by five (5) to eight (8) feet long.
  - D. Rubber hose shall be new, 2-ply rubber (reinforced) hose at least 5/8 inch in diameter.
  - E. Wrapping material shall be clean new burlap, seven (7) or eight (8) ounce weight per square yard, in strips four (4) to six (6) inches wide or approved waterproof wrapping paper 30-30-30 ratings in four (4) inch strips.
  - F. Dressing for treating tree wounds or cuts shall be an approved black asphaltum base antiseptic paint, an approved black paint consisting of Bordeaux Mixture, raw linseed oil, and lamp black or an approved black paint consisting of zinc oxide, raw linsseed oil and lamp black.

### **PART 3 - EXECUTION**

#### **3.1 PLACEMENT OF TOPSOIL**

- A. Prior to placing or depositing topsoil upon any section as shown on the Contract Drawings, the subgrade upon which the topsoil is to be placed shall be approved by the Engineer. Topsoil shall be spread on these areas to a depth sufficiently greater than that depicted on the Contract Drawings such that after natural settlement has taken place, the work will be in reasonably close conformity to the pre-construction lines, grades and elevations or as depicted on the Contract Drawings.
- B. All areas from which topsoil is to be secured shall be cleaned of all brush, sticks, weeds, stones, bricks, ashes and other refuse or debris which will hinder or prevent growth.
- C. The Contractor shall maintain the topsoil as his own expense until final completion and acceptance of the Contract. Maintenance shall consist of preserving, protecting, replacing and such other work as may be necessary to keep the topsoil in a satisfactory condition.

### 3.2 PLACEMENT OF GRASS SEED

- A. Prior to applying seed, the Contractor shall determine which designation (full sun, sun and partial shade, or full shade) is appropriate for a given area, if not specified on the Contract Drawings.
- B. The Engineer may require testing of the soil to determine the proper texture, topsoil pH, percentage available chemicals. The Contractor shall perform these tests and any corrective measures without additional cost to the Owner.
- C. Seeding operations shall be carried out between March 1 and May 15 and between August 15 and October 20.
- D. No seeding will be permitted on frozen ground or when the temperature is thirty-two (32) degrees Fahrenheit or lower. No changes or extensions of the above seeding periods will be made unless approved in writing by the Engineer.
- E. Seeding operations for Crownvetch Mix as specified herein shall be carried out anytime during the year except October and November.
- F. Seeding Flat Areas (4:1 slopes or less)
  - 1. All topsoil placement and grading shall be completed prior to seeding.
  - 2. The area to be seeded shall be thoroughly loosened to a depth of not less than six (6) inches, and top three (3) inches of soil shall be loose, friable and free of large clods, rocks or other extraneous matter one (1) inch or more in diameter measure at the widest dimension and shaped to the prescribed grade.
    - a. When that area to be seeded is partially sodded, barren, weedy, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily remove and the soil shall then be scarified or otherwise loosened to a depth of not less than four (4) inches. Clods and lumps shall be broken, rubbish, rocks and other extraneous matter removed from the site and the upper two (2) to three (3) inches shall be disced or otherwise worked into a satisfactory seedbed.
  - 3. The Contractor shall apply limestone and seed mix in accordance with the Delaware Erosion and Sediment Control Handbook, Section 3.4.3.
  - 4. The Contractor shall apply fertilizer according to the quantities of actual plant food per acre required as specified in this Paragraph 2.4.A, sub-paragraph 4.a, "Standard Roadside Mix."
  - 5. The seeding applicator shall have a water tank equipped with a liquid level gauge calibrated to read increments not greater than fifty (50) gallons over the entire range of the tank capacity, and the gauge shall be mounted an visible to the nozzle operator. The tank shall also be equipped with an agitation system capable of keeping all the solids in a state of completed suspension at all times during the seeding operation.
  - 6. The Contractor shall apply the seed, lime and fertilizer by mixing them in an aqueous solution and spraying them on the properly prepared seedbed. The Contractor shall apply

straw mulch as set forth in the State of Delaware Erosion and Sediment Handbook, Section 3.4.5-1.

7. The limestone, fertilizer and seed mix shall be added to the seeding applicator after the unit has been completely filled with water. A minimum of 1,000 gallons of water shall be required per acre. When wood cellulose fiber is chosen as the mulch for placement over seeded areas, it shall be applied through wet application equipment at the rate of 1,800 pounds per acre. The Contractor may choose to incorporate the wood cellulose fiber as an integral part of the slurry or separately as specified herein. In the event the Contractor chooses to apply the wood cellulose fiber as a part of the seed slurry, the mulch shall be added after the seed, fertilizer and lime are thoroughly mixed in the seeding applicator. Where areas of less than one acre are involved, the seed, limestone, fertilizer and mulch (when included) shall be mixed together in the relative proportions specified above with not more than 300 pounds of these combined materials mixed with each 100 gallons of water.
8. Where the use of a chemical binder is specified, the chemical binder shall be diluted in a minimum of 1,500 gallons of water per acre when applied on rain wet soil; and a minimum of 2,500 gallons when applied on dry soil. Both the application rate of the chemical binder and of the dilution water may be varied by the Engineer, in accordance with the construction site and particular soil requirements. The limestone, fertilizer, seed and mulch (when included) and chemical binder shall comprise the seeding slurry to be applied with wet application equipment as described above. The quantities of limestone, seed and fertilizer shall be applied at the rates specified in sub-paragraph 3 above. The chemical binder shall be applied at a minimum rate of 45 gallons per acre as determined by the Engineer. The wood cellulose fiber shall be applied at the rate of 600 pounds per acre. The seeding slurry shall not be applied during heavy rain fall or at temperatures below 34 degrees Fahrenheit. Following the final application, all surfaces consolidated shall not be disturbed in any manner by vehicular, pedestrian, or other traffic.
9. All mixtures shall be kept constantly agitated from the time they are mixed until they are finally applied to the seedbed. All mixtures shall be used within 8 hours of the time they are mixed. When the solutions are sprayed over the designated areas, the resultant deposits of lime, fertilizer and seed shall be evenly placed and equal to the quantities specified herein.
10. After the lime has been properly spread over the designated areas and has dried, the lime shall be worked into the upper 2 to 3 inches of the seedbed, after which the seedbed shall be properly graded and smoothed.
11. Mixtures of fertilizer and seed shall only be applied to prepared seedbeds on which lime shall have been worked in, unless otherwise specified or directed. Seed and commercial fertilizer applied by the spray method need not be raked into the soil.
12. Particular care shall be taken to insure complete and accurate coverage at the prescribed rates. Proper predetermined quantities of mixture in accordance with specifications shall be used to cover specified sections of known surface area.
13. The spray method shall not be used during periods of high wind.

14. The Contractor shall be required to mow and maintain vegetation between 4 and 6 inches in height until the project is finally accepted. The Contractor may be required to repair or replace any seeding or mulching that is defective or becomes damaged.
15. When seeding is approved and accomplished out of season and all other work on the contract has been satisfactorily completed but a determination cannot be made as to whether or not an established stand of grass has or may result, then payment for the areas seeded out of season will be withheld until such time as this requirement has been met.
16. A satisfactory stand of grass as determined by the Engineer shall be required. To be acceptable, a stand must have at least a uniform count of 80 to 100 plants per square foot.

G. Seeding Slopes (3:1 and greater)

1. Crownvetch seeding and mulching or seed mix number 1 shall be completed on all slopes 3:1 or greater as depicted on the Contract Drawings. Topsoil, except in highly urbanized areas, shall not be required when applying the Crownvetch mix and mulch.
2. All slopes shall be tilled and scarified across the slope to prevent gully and sheet erosion to the satisfaction of the Engineer.
3. The seeding applicator shall have a water tank equipment as described in sub-paragraph F.5.
4. Limestone and seed mix application shall be according to Section 3.4.3 of the Delaware Erosion and Sediment Control Handbook.
5. Apply straw mulch as set forth in the State of Delaware Erosion and Sediment Handbook, Section 3.4.5-1.
6. Wet Application Procedure
  - a. Add the limestone, fertilizer, seed, inoculant and 300 pounds per acre of wood cellulose fiber to 1000 gallons of water. The Contractor shall see that the slurry of material is continuously stirred during application.
  - b. Where areas of less than one acre are involved, the lime, fertilizer, Crownvetch seed, inoculant, complain grass and wood cellulose fiber shall be mixed together in the relative proportions specified above with not more than 300 pounds of these combined materials mixed with each 100 gallons of water.
  - c. The Contractor shall immediately apply the mulch to offset the drying effects of the sun and wind. Much may be wood cellulose fiber at the rate of 1,500 pounds per acre. Hay or straw may also be used at the rate of 2-1/2 tons per acre with an MS-1 or MS-2 asphaltic emulsion applied with the mulch by mixing at the blower discharge spout at a rate of not less than 75 gallons per ton of mulch. The Contractor shall be responsible for any damage resulting from the asphalt spraying operation.

7. Following the shaping, seeding, fertilizing and mulching, the area shall be watered sufficiently to saturate the seedbed, unless otherwise directed by the Engineer. Water shall be applied as a spray. Three additional waterings shall be applied at approximately one-week intervals at the discretion of the Engineer subject to weather conditions. Each additional watering shall moisten the soil to a depth of 2 inches. The initial watering of seeded areas shall be done not later than the day following seeding. The cost of watering shall be included in the price bid for the item.
8. The Contractor's responsibility for treated areas shall be the same as specified in subparagraphs F.14 through 16.

**END OF SECTION 321001**

SECTION 32 12 00  
FLEXIBLE PAVING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide flexible paving as indicated and in compliance with Contract Documents.

1. Scope includes:

- a. Aggregate base course.
- b. Asphalt concrete pavement.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
2. M226: Standard Specification for Viscosity-Graded Asphalt Cement.
3. M320: Standard Specification for Performance-Graded Asphalt Binder.
4. T89: Standard Method of Test for Determining the Liquid Limit of Soils.
5. T90: Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.
6. T99: Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
7. T104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.

B. ASTM International (ASTM):

1. C125: Standard Terminology Relating to Concrete and Concrete Aggregates.
2. D242: Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
3. D946: Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
4. D977: Standard Specification for Emulsified Asphalt.



5. D2027: Standard Specification for Cutback Asphalt (Medium-Curing Type).
6. D3381: Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
7. D6373: Standard Specification for Performance Graded Asphalt Binder.

C. State Department of Transportation (DOT):

1. DelDOT Specifications: Delaware Department of Transportation, Standard Specifications for Road and Bridge Construction, current edition.

1.03 DEFINITIONS:

- A. Gravel: Coarse aggregate resulting from natural disintegration and abrasion of rock or processing of weakly bound conglomerate.
- B. Crushed Gravel: The product resulting from the artificial crushing of gravel with substantially all fragments having at least one face resulting from fracture.
- C. Crushed Stone: The product resulting from the artificial crushing of rocks, boulders, or large cobblestones, substantially all faces of which have resulted from the crushing operation.
- D. Graded Aggregate Base Course (GABC): in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 30 and the Construction Details, or latest revision.

1.04 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 013400.
  1. Sustainable Design Submittals.
- B. Test Results:
  1. Base course testing results.
- C. Submit haul route, procedures, and schedule of operation times.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 011006.
- B. Sustainability Standards Certifications.
- C. Codes and Standards: Comply with the latest edition of State highway or transportation department standard specifications and with local governing regulations.

1.06 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. Transport bituminous mixtures in covered trucks whenever:
  - 1. Rainy weather, or
  - 2. Air temperature is less than 60 degrees F (16 degrees C).
- C. Adjust weight, type, capacity, haul routes, and method of operation of hauling vehicles so that:
  - 1. No damage results to existing streets, subgrade or base course, and
  - 2. Noise and air pollution levels are not noticeably increased along selected haul route.
- D. Haul routes through residential areas shall be avoided.
- E. Submit haul route, procedures for transport, and schedule of operation times to Owner for acceptance.

1.07 PROJECT CONDITIONS:

- A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 degrees F (10 degrees C), and when temperature has not been below 35 degrees F (1 degrees C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
- B. Place asphalt concrete surface course when atmospheric temperature is above 40 degrees F (4 degrees C), and when base is dry. Place binder course when air temperature is above 30 degrees F (-1 degrees C), and rising.

PART 2 - PRODUCTS

2.01 AGGREGATE MATERIALS:

- A. According to AASHTO M147, unless noted otherwise.
- B. Aggregate, including blended filler, shall have:
  - 1. Liquid limit (LL) of not more than 25 as determined by AASHTO T89.
  - 2. Plasticity index (PI) of not more than 6 as determined by AASHTO T90.
- C. At least 45 percent, by count, of number of particles of aggregate retained on No. 4 (4.75 mm) sieve shall have at least one fractured face.

- D. Remove oversized material by screening or crushing to required sizes.
- E. Soundness: AASHTO T104, 5 cycles: No greater than 18 percent weight loss.
- F. Filler for Blending:
  - 1. Use filler for meeting gradation requirements or for satisfactory binding of material. Uniformly blend with base course material at screening plant [or on road].
  - 2. Obtain material from sources accepted by Engineer.
  - 3. Material shall be free of agglomerations or lumps, and contain no more than 15 percent of material retained on No. 4 (4.75 mm) sieve.

2.02 AGGREGATE BASE COURSE:

- A. Gradation: Within limits of DelDOT Specifications, Section 1005 Type B.
- B. Graded Aggregate Base Course (GABC): in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 30 and the Construction Details, or latest revision.

2.03 PAVEMENT MATERIALS

- A. Asphaltic Materials:
  - 1. Asphalt Cement:
    - a. Performance Grade: AASHTO M320, ASTM D6373
      - (1) PG 64-22
  - 2. Prime Coat: Cut-back asphalt type; ASTM D2027 MC-30, MC-70 or MC-250.
  - 3. Tack Coat: DelDOT Standard Specification Section 1011.
- B. Provide Bituminous Concrete as identified herein:
  - 1. Provide base course material in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 401, or latest revision.

2. Provide surface course material in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 401, or latest revision.
3. Provide temporary road material in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 403, or latest revision.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

- A. Check subgrade as to soundness, outline, and contour.

#### 3.02 CONSTRUCTION METHODS

- A. Place Graded Aggregate Base Course (GABC) in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 301, or latest revision.
- B. Place base course material in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 401, or latest revision.
- C. Place surface course material in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 401, or latest revision.
- D. Place temporary road material in accordance with the Delaware Department of Transportation Standard Specifications for Road and Bridge Construction (2016) Section 403, or latest revision.
- E. The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to a condition at least equal to that which existed immediately prior to the beginning of operations unless specified otherwise in these plans and specifications. To this end the Contractor shall perform all necessary highway or driveway and sidewalk work as required. Suitable materials, equipment, and methods shall be used for such restoration. The restoration of existing property or structures shall be done as promptly as practicable as work progresses and shall not be left until the end of the contract period.

#### 3.03 SUBGRADE PREPARATION:

- A. Scrape down subgrade bumps and irregularities to obtain smooth, even surface.
- B. Proof roll as specified in Section 31 23 00.

- C. Remove and replace soft or spongy areas as specified in Section 31 23 00.

3.04 PAVEMENT PREPARATION:

- A. Remove loose material from compacted base course immediately before applying herbicide treatment or prime coat.
- B. If base course becomes rutted, loose or uneven due delays in placing subsequent courses then proof roll prepared surface to check for unstable areas. Provide additional compaction or remove unstable areas, backfill and compact. Do not begin paving work until deficient areas have been re-graded and corrected and are ready to receive paving.
- C. Prime Coat:
  - 1. Apply at rate of 0.20 to 0.50 gallons per square yard (905 to 2264 milliliters per square meter), over compacted subgrade.
  - 2. Apply material to penetrate and seal, but not flood, surface.
  - 3. Cure and dry as long as necessary to attain penetration and evaporation of volatile.
- D. Tack Coat: Apply tack coat in accordance with DeIDOT Standard Specifications, Section 401.

3.05 BASE COURSE INSTALLATION:

- A. Place materials when surface is dry and atmospheric temperature is above 40 degrees F (4.4 degrees C).
- B. Construct in two or more layers of approximate equal lifts; maximum compacted lift is 6 inches (15 cm).
- C. Layers placed upon loose sand subgrade, prone to displacement while compacting, shall be placed in a single compacted lift of 8 inches (20 cm).
- D. Deposit material on foundation or previously placed layer to minimize segregation and facilitate spreading to uniform layer.
- E. If blending of materials is done on roadway, inter-mix aggregate and blending material by blade graders, discs, harrows or other equipment to produce uniform distribution or gradation throughout finished mixture. Avoid excessive manipulation or mixing which will cause segregation between coarse and fine materials.
- F. Place and spread each layer to thickness, width, and contour.
- G. Compact each layer before proceeding to subsequent layers. Refer to Section 31 23 00 for required compaction and testing requirements.

- H. Prior to and during compaction shape material and maintain to dimensions and contour. Keep surface of each layer true and smooth.
- 3.06 PLACING MIX:
- A. Place asphalt pavement in accordance with DelDOT Standard Specifications, Section 401.
- 3.07 ROLLING:
- A. General: Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
  - B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.
  - C. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
  - D. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
  - E. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.
- 3.08 FIELD QUALITY CONTROL:
- A. Base Course Testing:
    - 1. Optimum Moisture Content and Maximum Density: Comply with AASHTO T99, Method C, with replacement of fraction of aggregate retained on 3/4 inch (19 mm) sieve. Replace with No. 4 (4.75 mm) to 3/4 inch (19 mm) material.
  - B. Pavement Testing:
    - 1. General: Test in-place asphalt concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving.
    - 2. Thickness Tolerances: In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness:
      - a. Base Course Thickness: Less than 1/4-inches (6 mm), plus or minus.
      - b. Surface Course Thickness: Less than 1/4-inches (6 mm), plus or minus.

3. Surface Smoothness Tolerances: Test finished surface of each asphalt concrete course for smoothness, using 10-foot (3-meter) straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding following tolerances for smoothness.
  - a. Binder Course: 1/4-inches (6 mm).
  - b. Surface Course: 1/8-inches (3 mm).
  - c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template, 1/4 inches (6 mm).
  - d. Profile and Section: Variation from true shall not exceed +/- 3/8-inches (9.5 mm).

3.09 PROTECTION:

- A. After final rolling:
  1. Do not permit vehicular traffic on pavement until it has cooled and hardened.
  2. Protect paving from traffic until mixture has cooled enough not to become marked.

3.10 CLOSEOUT ACTIVITIES:

- A. Provide in accordance with Section 017400.

END OF SECTION

## **DIVISION 33 – UTILITIES**



## SECTION 33 30 00

### SANITARY SEWERAGE UTILITIES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide gravity sanitary sewers and sanitary force mains from building connections as indicated to work performed by others as indicated and in compliance with Contract Documents.
- B. Section includes: Precast concrete manholes, and cast-iron frames and covers.
- C. Excluded from this section are:
  - 1. Water utilities. Refer to Division 22 for plumbing piping.

##### 1.02 REFERENCES:

- A. ASTM International (ASTM):
  - 1. A746: Standard Specification for Ductile Iron Gravity Sewer Pipe.
  - 2. C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
  - 3. C478: Precast Reinforced Concrete Manhole Sections.
  - 4. C923: Resilient Connectors Between Reinforced Concrete Manhole Structures.
  - 5. D638: Standard Test Method for Tensile Properties of Plastics.
  - 6. D648: Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
  - 7. D2241: Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
  - 8. D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
  - 9. D2729: Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  - 10. D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

11. D3139: Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
12. D3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
12. F477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

B. American Water Works Association (AWWA):

1. C110/A21.10: Ductile Iron and gray Iron Fittings, 3 Inch Through 48 Inch for Water and Other Liquids.
2. C111/A21.11: American National Standard for Rubber Gasket Joints For Cast Iron and Ductile Iron Pressure Pipe and Fittings.
3. C151/A21.51: Ductile-Iron Pipe, Centrifugally Cast, for Water.
4. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.

C. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

D. UNI-BELL (UNI):

1. B3: Recommended Practice for Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch (100-900 mm)).
2. B6: Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe; UNI-Bell PVC Pipe Association.

1.03 DEFINITIONS:

- A. Appurtenances: Additional piping items to provide a complete piping system suitable to convey wastewater as specified and intended. These items may or may not be specified, but are necessary to complete the piping system.
- B. Standard Specifications: New Castle County Department of Public Works Policy No. SS-7, Sewer Design, Capacity and Review Standards for Land Development Applications.

1.04 SUBMITTALS:

- A. Submit the following in accordance with Section 013400.
  1. Pipe materials.

2. Precast manholes.
  3. Manhole frame and covers.
  4. Pipe fittings.
  5. Pipe couplings.
  6. Pipe thrust restraint.
  7. Accessories.
  8. Appurtenances.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
  - C. Instructions: Provide manufacturer's installation instructions for pipe.
  - D. Field Test Reports: Provide results for all testing performed as indicated in Subparagraph – Field Testing.
  - E. Project Record Documents: Provide marked-up set of drawings showing actual locations of piping, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- 1.05 QUALITY ASSURANCE:
- A. Comply with the requirements specified in Section 011006.
  - B. Perform Work in accordance with Contract Documents and New Castle County standards.
  - C. Valves: Manufacturer's name UL/FM, and pressure rating marked on valve body.
- 1.06 DELIVERY STORAGE AND HANDLING:
- A. Comply with the requirements specified in Section 011006.
  - B. Deliver and store valves in shipping containers with labeling in place.
- 1.07 WARRANTY:
- A. Provide standard product warranties for all sanitary sewerage utility materials.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS:

#### A. Force Main (Pressure) Sanitary Sewer Pipe:

1. J-M Eagle

#### B. Precast Concrete Manhole Structures:

1. Atlantic Concrete
2. Gillespie Precast
3. AC Miller Concrete Products

#### C. Manhole Frames and Covers:

1. East Jordan Ironworks
2. Neenah Foundry
3. Bingham & Taylor

#### D. Gravity Sanitary Sewer Pipe:

1. J-M Eagle
2. Charlotte Pipe

#### E. Mechanical Joint Restraint:

1. EBAA Iron Megalug
2. Ford Meter Box Company, Inc.
3. Romac Industries

### 2.02 FORCE MAIN (PRESSURE) SANITARY SEWER PIPE MATERIALS:

#### A. Force Main (Pressure) Sewer Pipe 4 Inches in Diameter and Larger:

1. Ductile Iron Pipe: AWWA C151/A21.51, Class 52 for mechanical and push-on joints and Class 53 for flanged joints; mechanical or push-on joints conforming to AWWA C111/A21.11. Ductile Iron Push-On or Mechanical Joint Fittings: AWWA C110/A21.10 or AWWA C153/A21.53. Ductile Iron Fittings: AWWA C110/A21.10. Pipe and fittings shall have shop applied Protecto 401 interior lining (thickness as recommended by manufacturer) and exterior asphaltic coating.

2. PVC Pipe Up To 36 Inches In Diameter: AWWA C900 DR 18. Bell and spigot ends shall conform to ASTM D3139 with flexible elastomeric seals seated in internal groove. Pipe shall be made of PVC compound meeting ASTM D1784, cell class 12454. Joint design shall meet requirements of ASTM D3212 and gaskets shall conform to ASTM F477. Fittings to conform to requirements specified for ductile iron pipe fittings.

#### 2.03 GRAVITY SANITARY SEWER PIPE MATERIALS:

- A. Ductile Iron Pipe: ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, Pressure Class 350, inside nominal diameter as indicated on the drawings. Pipe and fittings shall have shop applied Protecto 401 interior lining or approved equal (thickness as recommended by manufacturer) and exterior asphaltic coating. Joints: AWWA C111/A21.11, rubber ring compression type joint.
- B. Polyvinyl Chloride (PVC) Pipe: ASTM D3034, SDR 26, Polyvinyl chloride (PVC) material; inside nominal diameter as indicated on the contract drawings, with integral bell elastomeric gasketed joint.

#### 2.04 PRECAST CONCRETE MANHOLES:

- A. Provide precast base sections that extend above pipe top and form portion of barrel. Barrel sections constructed of manhole risers topped with tapered sections or flat tops as indicated. Conform manhole sections to Specification Section 034818; ASTM C478; resilient connectors to ASTM C923.
- B. Manhole Steps:
  1. Provide steps 13 inches minimum width projecting 5 inches minimum from the wall surface. Steps to be driven into preformed holes.
  2. Provide steps with copolymer polypropylene coating conforming to ASTM D4101 and 1/2-inch diameter steel reinforcing rod conforming to ASTM A615 Grade 60.
  3. Test steps to resist a pull out load of 1,500 pounds without loosening or being damaged.
- C. Joints: O-Ring rubber-gasket joints conforming to ASTM C443, confined as indicated.
- D. Pipe Connections: Flexible Joints for Sanitary Sewer Pipes 42 Inches and Smaller in Diameter.
  1. Conform to ASTM C923.
  2. Rubber gasket held in place by 304 stainless steel sleeve and clamps.
  3. Flexible sleeve made of flexible synthetic rubber with stainless steel strap cast in manhole.

- E. Precast Inverts: Conform to invert channels specified in Part 3 of this Specification Section.
- F. Bituminous Waterproofing Material (Exterior)
  - 1. Tnemec Company, Inc.; Series 46-465 H.B. Tnemecol.
  - 2. PPG Industries; Amercoat 78HB.
  - 3. Carboline; Bitumastic 300M.

2.05 MANHOLE FRAME AND COVERS:

- A. Provide cast-iron frames and covers conforming to ASTM A48, Class 35B.
- B. Provide frames and covers suitable for AASHTO HS 20-44 live load. Combined weight of 355 pounds minimum, 225-pound minimum frame, and 130-pound minimum cover weight.
- C. Provide factory-coated with asphalt varnish.
- D. Provide frames with 24-inch nominal diameter clear openings.
- E. Provide removable, interchangeable covers to seat in frames without rocking.
- F. Identify covers with cast marking as directed by Owner or “SANITARY SEWER” and include the name and location of manufacturer on frame and cover castings.
- G. Provide castings free of blowholes, splits, cracks, blisters, mold-pull, and other imperfections affecting strength or serviceability.
- H. Provide External or Internal Seals as required by Owner.

2.06 BEDDING AND COVER MATERIALS:

- A. As specified in Section 31 10 04.

2.07 THRUST RESTRAINT:

- A. Mechanical Joint Restraint: Wedge action restrained joint retainer gland devices. Mechanical joint restraint incorporated into the design of the follower gland.
- B. Thrust Blocks: Dimensions as indicated on the Drawings. Concrete type for thrust restraints as specified in Section 03 30 00.
- C. Pipe Clamps and Tie Rods: ANSI/NFPA 24.

- D. Push-On Restrained Joint Pipe: Provide joint restraint and conforming joint to AWWA C111/21.11, fabricated to be easily disassembled. Provide assembly and disassembly kits.
- 2.08 APPURTENANCES:
- A. Provide all necessary appurtenances for a full and complete piping system suitable for operation, and in conformance with Project Documents.
- 2.09 SHOP PAINTING/COATINGS:
- A. Unless otherwise specified or indicated, provide standard manufacturer paint and coatings for all piping and valves to prevent corrosion for the life of the component.
- 2.10 SHOP TESTING:
- A. Test all pipes and valves per manufacturer requirements, and as required by pertinent Standards.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION:

- A. Verify that trench cut or excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated for sanitary sewer pipe. Verify excavation for manholes to proper depth and proper placement of bedding material.

#### 3.02 PREPARATION:

- A. Sanitary sewer pipe: Hand trim excavations to required elevations. Correct over excavation with bedding material. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.
- B. Manholes: Coordinate placement of inlet and outlet pipe sleeves. Seal exterior surface of sanitary sewer manholes with minimum 16-mil-thick coal tar epoxy coating.

#### 3.03 SANITARY SEWER PIPE INSTALLATION:

- A. Maintain separation of sanitary sewers pipe and water mains as follows:
  - 1. Parallel Installation:
    - a. At least 10 feet horizontally from a sewer or sewer manhole. The distance shall be measured edge-to-edge.
    - b. Under unusual conditions when local conditions prevent a horizontal separation of 10 feet (3 m) the sewer or sewer manhole may be laid closer, provided that:

- (1) The top (crown) of the sewer shall be at least 18 inches (45 cm) above the bottom (invert) of the water main;
- (2) Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe, pressure tested in place without leakage prior to backfilling; and
- (3) The sewer manhole shall be of watertight construction and tested in place.

2. Crossing:

- a. At least 18 inches between the bottom of the water line and the top of the sewer whenever possible. The distance shall be measured edge-to-edge.
  - b. Under unusual conditions when local conditions prevent a vertical separation described, the following construction shall be used:
  - c. Sewers passing over or under water mains shall be constructed of AWWA approved water pipe, pressure tested in place without leakage prior to backfilling;
  - d. Water lines passing under sewers shall, in addition, be protected by providing:
  - e. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line;
  - f. Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the waterline; and
  - g. That the length of the sewer line be centered at the point of the crossing so that joints shall equidistant and as far as possible from the water line.
  - h. No water pipes shall pass through or come in contact with any part of a sewer manhole.
- B. Install pipe, fittings, and accessories in accordance with ASTM D2321, AWWA C605, and manufacturer's instructions. Seal joints watertight.
- C. Lay pipe to slope indicated; with maximum variation from true slope of 1/8-inch in 10 feet. Lay pipe upgrade, with spigot ends pointing in direction of flow. Lay pipe to form a close concentric joint with adjoining section and to prevent sudden offsets in flow line.
- D. Install bedding to depths and dimensions as indicated on plans.



- E. Backfill each section of pipe as it is laid, as specified in Section 31 10 04 and as indicated at least up to centerline, before next joint is made. Do not completely conceal or bury pipe prior to being tested for water tightness and prior to being accepted by the Engineer. Do not displace or damage pipe when compacting.
- F. Clear the interior of the pipe of dirt and superfluous materials as the work progresses. Keep a suitable swab or drag in the pipe and pull it forward past each joint immediately after the jointing has been completed.
- G. Keep trenches and other excavations free of water until final inspection. Do not lay pipe or construct masonry work in water. Do not allow water to rise over the work until concrete or mortar has had ample time to set.
- H. Close open ends of pipe and fittings in a manner acceptable to the Engineer when the work is not in progress so that trench water, earth and other substances will not enter the pipe or fittings.
- I. Handle pipe and fittings to avoid damage. Carefully inspect pipe and fittings for defects before lowering into the trench.
- J. Where necessary deflect pipelines to avoid obstructions or where long-radius curves are indicated. Do not exceed the maximum deflection recommended by pipe manufacturer. Provide short sections of pipe as necessary to maintain required line.
- K. Provide compatible pipe connections to each valve and to equipment. Provide unions on pipelines with welded soldered or threaded joints to allow removal of each valve and equipment without disturbing connecting pipelines. Connect different types of pipe and accessories with flexible couplings or pipe and accessories with flexible couplings or accepted transition fittings. Provide insulation fittings where ferrous pipe connects to nonferrous metallic pipe.
- L. Verify invert of each existing manhole prior to commencing work. Connect to each existing manhole where indicated or directed. Prevent debris from entering the pipelines. The work includes all necessary concrete work, cutting and shaping of invert.
- M. Repair linings, coatings and coverings damaged during construction with accepted materials equal to and compatible with original lining, coating or covering. Repair damaged galvanizing with zinc-rich paint.
- N. Connect to building connections and work by others as indicated.

#### 3.04 PRECAST CONCRETE MANHOLE INSTALLATION:

- A. Maintain separation of sanitary sewer precast concrete manholes and water mains as specified in Paragraph 3.03A of this Section.
- B. Place precast manhole sections plumb and level, adjust to correct elevation. Provide bedding material as specified in Section 31 10 04.

- C. After manhole assembly, plug lift holes with non-shrink grout.
- D. Cut and fit for pipe connections.
- E. Set manhole frames and covers level to correct elevations.

3.05 REPAIR/RESTORATION:

- A. Repair any existing utilities/structures, or features damaged during installation of sanitary sewerage utilities to Owner's satisfaction, and at no cost to Owner.

3.06 FIELD TESTING:

A. General:

- 1. Perform field-testing under provisions of Section 01 10 06.
- 2. All field testing shall be conducted in the presence of the Engineer.

B. Cleaning and Testing Pressure Force Mains

- 1. Cleaning: Flush out and clean sanitary force mains of foreign matter before placing systems into operation. Use flushing velocity of 10 feet per second, minimum. Take care to prevent scale and other objectionable matter from entering piping. Properly dispose of water used for flushing.
- 2. Force Main Pressure Test: To prevent movement of pipe, backfill between joints to provide 2-foot minimum cover. Expose only area immediately at pipe joints. Test force main hydrostatically for 2 hours at a minimum of 1.5 times the design working pressure, or higher as specified elsewhere. Measure leakage in accordance with, and not exceeding, the allowable leakage specified in AWWA C600 or UNI B3.
- 3. Test Force Mains at 100 psi.

C. Cleaning and Testing Gravity Sewer Mains

- 1. Test for Displacement of Buried Sanitary Sewers: After trench has been backfilled and compacted, after cover over pipeline has been brought to finished grade, and after debris and silt has been removed, pipelines will be tested by the Engineer as follows: Light will be flashed between manholes, or, if manholes have not yet been constructed, between locations of manholes, by means of flashlight or by reflecting sunlight with mirror. Correct poor alignment, displaced pipe, and other defects indicated by the Engineer or Closed Circuit Television Inspection.
- 2. Test for Deflection of Gravity PVC Sanitary Sewers

3. Measure pipelines for vertical ring deflection within 15 days after completion of backfill. Limit maximum ring deflection of pipeline under load to 5 percent of vertical internal pipe diameter. Relay or replace pipe exceeding this deflection and retest.
  4. Pull mandrel, sphere, or pin-type go/no-go device through the pipeline. Make diameter of the go/no-go device 95 percent of undeflected inside diameter of pipe.
  5. Cleaning: Flush out and clean sanitary force mains of foreign matter before placing systems into operation. Use flushing velocity of 10 feet per second, minimum. Take care to prevent scale and other objectionable matter from entering piping. Properly dispose of water used for flushing.
  6. Testing of Sanitary Sewers: Conduct tests under supervision of the Engineer. Furnish materials, labor, and equipment required for tests and repair system until test results are satisfactory.
  7. Exfiltration: Subject pipe to hydrostatic head of at least 4 feet (1.2 m) above pipe crown. Fill line until appropriate water level is obtained at selected upstream manhole. Observe rate of drop at this manhole for 1 hour. Leakage rate: Not greater than 100 gallons per inch of pipe diameter, per mile of sewer pipe, per hour per day in any section of system including manholes.
  8. Air Test: When approved by the Engineer, the Contractor shall prepare a modified low-pressure air test may be used instead of exfiltration test for PVC pipelines 12 inches and larger. Perform tests in accordance with UNI B6 for PVC pipelines, and ASTM C924/924M ductile iron pipelines.
- 3.07 FIELD PAINTING/COATINGS:
- A. Repair any shop painting/coatings damaged during storage or installation to Owner's satisfaction.
- 3.08 ADJUSTING:
- A. Coordinate with Engineer for any field adjustments. The Engineer reserves the right to reject any field adjustments.
- 3.09 PROTECTION:
- A. Protect sanitary sewerage utilities from damage throughout storage, installation, testing, and final acceptance.
- 3.10 CLOSEOUT ACTIVITIES:
- A. Provide in accordance with Section 017400.

END OF SECTION

## **DIVISION 40 – PROCESS INTEGRATION**

## SECTION 40 23 13.01

### PROCESS VALVES AND APPURTENANCES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide and process valves and appurtenances as indicated and in compliance with Contract Documents.
  - 1. Provide sizes and capacities as indicated or specified.

##### 1.02 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
  - 1. B1.20.7: Hose Coupling Screw Threads.
  - 2. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.
  - 3. B16.4: Cast-Iron Threaded Fittings, Class 125 and 250.
  - 4. B16.10: Face-to-Face and End-to-End Dimensions of Ferrous Valves.
- B. ASTM International (ASTM):
  - 1. A48: Standard Specification for Gray Iron Castings.
  - 2. A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
  - 3. A536: Standard Specification for Ductile Iron Castings.
- C. American Water Works Association (AWWA):
  - 1. C500: Metal-Seated Gate Valves for Water Supply Service.
  - 2. C504: Rubber-Seated Butterfly Valves.

##### 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. Data, regarding valve characteristics and performance including Cv.
  - 2. Shop drawing data for accessory items.
  - 3. Manufacturer's literature as needed to supplement certified data.

4. Operating and maintenance instructions and parts lists.
5. Listing of reference installations as specified with contact names and telephone numbers.
6. Valve shop test results.
7. Qualifications of field service technician.
8. Shop and Field inspections reports.
9. List of recommended spare parts other than those specified.
10. Recommendations for short and long term storage.
11. Special tools.
12. Shop and field testing procedures and equipment to be used.
13. Number of service technician days provided and per diem field service rate.
14. Manufacturer's product data and specifications for shop painting.
15. Provide a layout drawing, plan and section showing orientation of plug, gate, check, ball valves and actuators and nearest obstructions for each valve.
16. Manufacturer's product data and specifications for shop painting.
17. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
18. The latest ISO 9001 series certification or quality system plan.
19. Material Certification:
  - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
  - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

- B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
  - 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
  - 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.
  
- 1.04 SPARE PARTS:
  - A. Comply with requirements specified in Section 011006.
  
- 1.05 QUALITY ASSURANCE:
  - A. Comply with the requirements specified in Section 01 43 00.
  - B. Provide enclosures for the area classifications specified and indicated.
  - C. Contractor responsible for verifying outside diameter of pipe to be tapped.
  - D. Services of Manufacturer's Representative as stated in Section 01 43 00 and specified herein.
  - E. Manufacturer of valve shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.
  - F. If equipment proposed is heavier, taller, different laying length or requires more operating space than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.
    - 1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.
  
- 1.06 DELIVERY, STORAGE AND HANDLING:
  - A. Comply with the requirements specified in Section 011006 and as specified.



PART 2 - MATERIALS

2.01 RESILIENT SEAT GATE VALVES 12-INCH (300 MM) AND SMALLER:

A. Resilient Seat Gate Valves:

1. Manufacturers-OS&Y and NRS Type Valves:

- a. J&S
- b. Kennedy.
- c. American.

B. General:

- 1. Provide valves that conform to NSF Standard 61.
- 2. Non-potable water service: Provide resilient seat gate valves for all sizes indicated. If resilient seat valves are not available provide solid wedge gate valves.
- 3. Potable water service: Provide resilient seat gate valves for all sizes indicated. If resilient seat valves are not available provide double revolving disc gate valves.
- 4. Provide metallic seated valves conforming to AWWA C500 except as herein modified.
- 5. Provide resilient seated valves conforming to AWWA C509 except as modified herein.

C. Materials:

- 1. Body and Bonnet: ASTM A536 ductile iron.
- 2. Wedge: ASTM A536 ductile iron encapsulated with EPDM.
- 3. Provide all other materials as specified in AWWA C500 and C509. Working water pressure:

Valve Size		Pressure Rating	
inch	mm	psi	kPa
3 to 16	75 to 400	250	1750
18 & Larger	450 & Larger	150	1050

- 4. Exposed Valves: Flanged OS&Y valves. Face-to-face dimensions to comply with ANSI B16.10, flanges to comply with ANSI B16.1.

5. Buried Valves: Mechanical joint or push-on joint ends, non-rising stem valves with operating nut in lieu of hand wheel. Provide gate boxes, steel extension stems or universal-joint operating rods with 2-in (50 mm) square operating nuts at upper end with coupling connected to valve stem to bring to operating nut to within 6 inches (150 mm) of ground surface.
  6. Provide counterclockwise rotation to open valves.
  7. Provide handwheels with arrow and word "open" to indicate open direction.
  8. Provide geared operators where indicated. Gearing shall be steel with enclosed cases.
    - a. Provide bevel gears where required by position of valve.
  9. Chainwheels: Provide where required as specified herein. Provide beveled gear operator to mount chainwheel in vertical position. Provide valve mounted so that the arrow indicator will be visible from the floor level.
  10. Provide conventional packing in OS&Y valves.
  11. Provide conventional packing or double O rings in non-rising stem valves.
  12. Valves capable of being repacked or O ring replaceable while under pressure.
  13. Provide Type 316 stainless steel bolts and bronze nuts for stuffing box follower.
- D. Provide all gate valves with all internal and external wetted parts coated with a fusion bonded epoxy in accordance with ANSI/AWWA C550.

## 2.02 BALL VALVES – GENERAL SERVICE:

### A. Manufacturers:

1. Jamesbury
2. KF
3. Inline
4. Kitz

### B. Valves 1/2-inch (13 mm) through 4-inch (100 mm)

#### 1. Materials:

- a. Body and End Cap: Three piece, ASTM A351 Grade CF8M.
- b. Body Seal: PTFE.

- c. Seat: RTFE.
- d. Ball: Type 316 stainless steel.
- e. Stem: Type 316 stainless steel.

2. Pressure Rating:

- a. 1/2-inch (13 mm) through 2-inch (50 mm): 1000 psi at 100 degrees F (7000 kPa at 38 degrees C)

3. Ends:

- a. 2-inch (50 mm) and Smaller: Screwed or flanged.

C. Actuators:

1. Manual:

- a. 4-inch (100 mm) and Smaller: Lever.

2.03 SWING CHECK VALVES – 3-INCH (75 MM) AND LARGER:

A. Valves 3-inch (75 mm) and larger:

1. Manufacturers:

- a. Golden Anderson
- b. Mueller
- c. Val-Matic

2. Working pressure:

Size	Pressure
3 to 12-inch (75 to 300 mm)	175 psi (1225 kPa)

3. Valve Body:

- a. ASTM A126 Class B cast iron with integral flanges, faced and drilled per ANSI B16.1 Class 125.
- b. Provide full waterway type body with a net flow area not less than the nominal inlet pipe size when swung open a maximum of 25 degrees. When closed, the valve shall seat drop tight.
- c. Provide a replaceable Type 316 stainless steel body seat.

4. Valve Disc:
  - a. ASTM A126 Class B cast iron. Provide disc faced with a renewable resilient seat ring of a material suitable for the service specified and indicated. Provide Type 316 stainless follower ring and hardware.
5. Disc Arm:
  - a. Ductile iron or steel, suspended from and keyed to an austenitic stainless steel shaft located entirely above the waterway and supported at each end by bronze bushings.
  - b. Provide shaft to rotate freely without the need for external lubrication.
  - c. Provide the shaft sealed where it passes through the body by a stuffing box and adjustable packing. O-ring type shaft seals are not acceptable.
  - d. Provide valves with an outside lever and adjustable counterweight to initiate valve closure. Provide final closure dampened by means of a single, side-mounted bronze air-cushion assembly directly mounted to the valve body on machined pads.
  - e. Provide an adjustable amount of cushioning without the need for pre-charged air chambers. Commercial air cylinders which pivot and/or are attached with fabricated brackets are not acceptable.
6. Provide an adjustable dashpot or snubber, to control speed of valve closure.

#### 2.04 AUTOMATIC AIR RELEASE VALVE – WASTEWATER SERVICE:

- A. Manufacturers:
  1. Gorman-Rupp.
- B. Valves: Automatic Air Release Valves are designed to release air from a self-priming pump during the priming cycle. After the pump primes and begins to deliver liquid, the valve closes to restrict by-pass flow. When the pump stops, the valve automatically opens and is ready for the next priming cycle.
- C. For wastewater services provide valves with the following:
  1. Minimum 1-inch (25 mm) dedicated bleed line for each valve. Do not manifold bleed lines in multiple pump installations.
  2. 1-inch (25 mm) inlet.
  3. 1-inch (25 mm) outlet.
- D. Materials:

1. Valve Body and Inspection Cover: ASTM A48 Class 30 Cast Iron
2. Plunger Rod and Internal Hardware: Type 304 stainless steel.
3. Seats: Buna-N.
4. External Hardware: Plated Steel.

2.05 CHAINWHEEL OPERATORS – STAINLESS STEEL (DUCTILE IRON):

- A. Provide chainwheels with chain and chain guides. For all valves with handwheels or gear operators higher than 6.5 feet (2 meters) above operating floor level.
- B. Provide chain that reaches to within 3 feet (1 meter) of the operating floor level.
- C. For valves with gear operator mount with chainwheel in the vertical position.
- D. Provide secondary safety restraint system.
- E. Manufacturer:
  1. Trumbull.
- F. Materials:
  1. Chainwheels: Pocket type wheel, Type 316 stainless steel.
  2. Chain: Type 316 stainless steel straight link machine chain.
  3. Hardware and Attachments: Type 316 stainless steel.
  4. Safety Restraint Cables and Hardware: Type 316 stainless steel.
- G. Materials:
  1. Chainwheels: Sprocket type wheel, ductile iron.
  2. Chain: Galvanized steel connecting link chain.
  3. Hardware and Attachments: Galvanized steel.
  4. Safety Restraint Cables and Hardware: Type 316 stainless steel.

2.06 EXTENSION STEMS:

- A. Provide where indicated and required for operation of all valves
- B. Material:
  1. Stems: Type 316L solid stainless steel bar or Schedule 40 Type 316L pipe

- a. Minimum Size: 1.25 inch (32 mm) diameter, Slenderness ration  $<200$
2. Connectors, thrust relief assemblies, torque tube assemblies, universal joints and operating nuts: Type 316 or Type 316L stainless steel
3. Miter gears: Cast iron with 2 part epoxy coating

## 2.07 FLOOR BOXES-STAINLESS STEEL WITH PACKING

- A. Manufacturer:
  1. Trumbull Industries.
- B. Provide floor boxes where indicated to provide support for extension stems for non-rising stem valves and a cover for the operating nut.
- C. Floor Box Depth: 6 inches (150 mm) and capable of use in thicker floors with a 4 inch (100 mm) schedule 80 Type 316L stainless steel pipe nipple.
- D. Provide system capable of a maximum 2 inch (50 mm) shaft extension.
- E. Provide a water stop welded to the body
- F. Provide cover with O-ring seal and six (6) stainless steel socket screws
- G. Materials:
  1. Body: 6 inch (150 mm) schedule 40 Type 316L stainless steel
  2. Cover: Type 316L stainless steel
  3. Packing Gland: Bronze, NSF 61
  4. Packing: Viton A
  5. Hardware: Type 316 stainless steel
- H. Where indicated provide floor boxes with stuffing box with bronze, NSF61, glands, Type 316 stainless steel hardware and non-asbestos fiber packing

## 2.08 STEM GUIDES:

- A. Manufacturer:
  1. Trumbull Industries.
  2. Troy Valve.
- B. Provide valve stem guides where indicated and as required by the valves manufacturer.

C. Stem Guide Spacing: 6 to 8 feet (1.8 to 2.5 metres), maximum slenderness ratio of 200.

D. Stem Guides for Stems 2-inch (50 mm) and Smaller:

1. Materials:

a. Stem Guide: Cast Type 316 stainless steel with 2 to 36 inch (50 to 900 mm) adjustment.

b. Bushing: Bronze, NSF 61

c. Hardware: Type 316 stainless steel.

E. Stem Guides for Stems 2-1/8-inch (54 mm) to 4 inch (100 mm):

1. Materials:

a. Stem Guide: Ductile Iron 65-45-12 with 2-3/4 to 17-1/4 inch (70 to 438 mm) adjustment.

b. Bushing: Split type, Bronze, NSF 61

c. Hardware: Type 316 stainless steel.

## 2.09 POSITION INDICATORS:

A. Manufacturer:

1. Trumbull Industries.

B. Provide position indicators installed on all multi-turn valves and quarter turn valves with gear boxes 3 inch (75 mm) and larger.

1. Type: Planetary gear design.

C. Materials:

1. Provide the sun gear, planet gear, ring gears and scale plate constructed of Delrin.

2. Housings of carbon steel or aluminum are not acceptable.

3. Hardware and Fasteners: Type 316 stainless steel.

D. Position Indicator Design Features:

1. Provide the position indication to show the position of the valve, from fully open to fully closed, identified at ground level.

2. Movement of the indicating arrow must be visible through a window covering a minimum of 300 degrees of the circumference of the indicator.
3. Size of the characters and numerals: minimum 3/16-inch (5 mm).
4. Provide the top scale plate with markings representing the number of turns, contain the word "CLOSED", and a directional arrow.
5. Provide permanently recessed, embossed or engraved markings in the scale plate. The use of adhesive labels is not acceptable.
6. Provide the "OPEN" line marked on a transparent polycarbonate window, field adjusted for the number of turns of each valve size.
7. Provide the position of the adjustable "OPEN" window secured to the top surface of the scale plate by the outside diameter of three Type 316 stainless button head cap screws.
8. Provide all adapters to secure the position indicator, for installation in either a valve box, floor box or wall bracket as indicated and required.
9. Provide the position indicator and adapter with matching flat sides to prevent rotation of the indicator during operation.

E. Buried Valves:

1. Provide the position indicator installed in a valve box within 6 inches (150 mm) of grade.

2.10 SHOP PAINTING:

- A. Coat internal and external ferrous surfaces of valve with NSF Certified Epoxy in accordance with ANSI/NSF Std. 61, and in conformance to AWWA D102 Inside System No. 1 for all valves not specified to have a fusion bonded epoxy coating.
- B. Process Valve Color: Red.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.
- B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.
- C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in



workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which do not operate easily or are otherwise defective at no additional cost to the Owner.

- D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.
- E. Provide bolted split sleeve coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.
- F. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as shown and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

### 3.02 GATE VALVES:

- A. Install gate valve stem as shown or with stems between vertical and 45 degrees above the horizontal. Valves installed with stems horizontal or below horizontal are not acceptable.

### 3.03 CHECK VALVES:

- A. Install check valves horizontally in pipelines unless otherwise indicated.

### 3.04 FLOORSTAND OPERATORS AND STEM GUIDES:

- A. Set floorstand operators and stem guides so stems run smoothly in true alignment. Anchor guides to walls. Check distances from centerlines of gates to operating level or base of floorstand and adjust if to suit actual conditions of installation.

### 3.05 VALVE BOXES:

- A. Provide valve box for each buried valve and where indicated.
- B. Set box so top is flush with finished surface and so box does not bear on valve, or pipe.

### 3.06 FIELD TESTING:

- A. Pressure test valves with pipeline pressure testing.
- B. Test functions of each valve.
- C. Make all adjustments necessary to place valves in specified working order at time of above tests.
- D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to

demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.07 FIELD TOUCH-UP PAINTING:

- A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 40 23 19.01

### PIPE SUPPORTS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and in compliance with Contract Documents. The term pipe support includes hangers, guides, restraints, anchors and saddles.
- B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.
- C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.
- D. Pipe support locations and types for piping 1/2-inch (13 mm) and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2-inch (13 mm) and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.
  - 1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.
- E. Design and provide all temporary pipe supports required during installation and testing.

##### 1.02 REFERENCES:

- A. The American Society of Mechanical Engineers (AMSE):
  - 1. B31.1: Power Piping.
- B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel
2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
3. A312: Seamless and Welded Austenitic Stainless Steel Pipe
4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.
5. A572: Specification for Steel Plate.
6. E165: Practice for Liquid Penetrant Inspection Method.
7. E709: Practice for Magnetic Particle Examination.

C. American Welding Society (AWS):

1. D1.1: Structural Welding

D. Fluid Sealing Association: Technical Handbook.

E. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design.
2. SP-69: Pipe Hangers and Supports - Selection and Application.
3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.
  - a. Detailed drawing of the device with dimensions.
  - b. A table of applied forces and moments.
  - c. A complete bill of materials.
  - d. A unique identification and revision level.

- e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.
  - f. Detailed connections to existing structure.
  - g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.
2. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.
  3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.
  4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
  5. Pipe support manufacturers' qualifications as specified herein.
    - a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.
    - b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.
  6. Coordination drawings for pipe supports shall include as a minimum the following information.
    - a. Coordination drawings shall include all pipe supports covered by specifications.
    - b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.
    - c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.
    - d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and

appurtenances at not less than 1/4-inch (5 mm) scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches (50 mm) or less in diameter that will be field routed need not be shown on coordination drawings.

- e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.
  - f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.
  - g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.
  - h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.
- 7. Written notification of any deviations from the requirements of this specification.
  - 8. Support documentation and justification as specified.
  - 9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.
  - 10. Manufacturer's product data and specifications for shop painting.

**B. Material Certification:**

- 1. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of

five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
- C. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.
1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
  2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
    - a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
    - b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.
- 1.04 QUALITY ASSURANCE:
- A. Provide in accordance with Section 01 43 00 and as specified.
  - B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.
  - C. Welder Qualifications:
    1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.
  - D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

- E. Structural Concrete: Conform to the requirements of Section 03 30 00. Concrete strength: 4,000 PSI (28 MPa) unless noted otherwise.
- F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.
- G. Pipe Support Manufacturer Qualifications:
  - 1. Must possess a written quality assurance program.
  - 2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.
  - 3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.
  - 4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.
  - 5. Manufacturers' Standardization Society (MSS) Member.
  - 6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.
- H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless steel piping. Copper plated pipe supports are not acceptable.
- B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.



- C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.
- D. Provide only new material. Previously used and/or scrap material is not acceptable.
- E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.
- F. Provide sliding Teflon plates. The sliding surfaces shall be a nominal 3/8-inches (10 mm) glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product.
  - 1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:
  - 2. Tensile strength -2,000 psi (14 MPa).
  - 3. Elongation -225 percent
  - 4. Specific Gravity -2.17 to 2.22
  - 5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi (14 MPa).
  - 6. The compressive creep shall be a minimum of 2 percent at 2,000 psi (14 MPa) and 70 degrees F (21 degrees C).
  - 7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.
- G. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.02 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

- A. Design and provide pipe supports for piping 1/2-inch (13 mm) and larger to include the following loads:
  - 1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.

2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.
  3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.
  4. Wind Loadings: Wind loadings.
- B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.
- C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.
- D. Where possible, provide pipe supports, which are the manufacturers' standard products.
1. Provide pipe supports with individual means of adjustment for alignment.
  2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.
  3. Hanger rods shall be subjected to tension only.
  4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.
  5. Provide concrete inserts capable of supporting the design loads.
  6. Metal framing systems will be acceptable to support piping 2 inch (50 mm) and smaller.
  7. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.
  8. Provide supplementary steel as needed.
  9. Do not support pipes from other pipe, conduits or metal stairs.
  10. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.
  11. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.
  12. All pipe supports located in fluid flow shall be supplied with double nutting.

- E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.
- F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.
- G. For piping 2-inch (50 mm) and smaller provide manufacturer's standard supports and standard spacing guidelines
- H. All outside above ground supports shall be Type 316L stainless steel as specified herein.
- I. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.
- J. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

#### 2.03 FABRICATION:

- A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.
- B. Providing welding in accordance with Structural Welding Code
- C. Provide dimensional tolerances as specified in MSS-SP-89.
- D. Provide threading and tapping in accordance with MSS-SP-89.

#### 2.04 SHOP PAINTING:

- A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.
- B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
- C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

- A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

- B. Perform welding in accordance with Structural Welding Code
1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of groove welds for throat opening and for snug positioning for back-up bars.
  2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.
  3. Magnetic Particle Inspection: Perform in accordance with ASTM E709.
  4. Liquid Penetrant Inspection: Perform in accordance with ASTM E165.
  5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.
  6. Test Locations: As selected by the Owner.
  7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.
- C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03 30 00.
- D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.
- E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.
- F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.
- G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing

length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet (10 mm/10 m), for each 100 degrees F (50 degrees C) change in temperature exceed 1/2-inch (13 mm), provide sliding supports.

- I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch (3 mm) thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.
- J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.
- K. Apply an anti-seize compound to nuts and bolts on all pipe supports.
- L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

### 3.02 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Support piping from structural framing, unless otherwise indicated.
- B. Concrete Inserts:
  - 1. Use existing embedded concrete items whenever possible.
  - 2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

### 3.03 THRUST ANCHORS AND GUIDES:

- A. Thrust Anchors:
  - 1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.
  - 2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.
- B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

### 3.04 PIPE SUPPORTS:

- A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.
- B. Provide minimum of two pipe supports for each pipe piece.

- C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.
- D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.
- E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 inch (40 mm) out from face of wall and at least 3 inches (75 mm) below ceiling.
- F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.
- G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.
- H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.
- I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.
- J. Do not support piping from other piping.
- K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.
- L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.
- M. All rigid rod hangers shall provide a means of vertical adjustment after erection.
- N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.
- O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.
- P. Hanger spacing shall not exceed the spacing listed below:
  - 1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
  - 2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span.

When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

- Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.
  - R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.
  - S. All threads shall be UNC unless otherwise specified.
  - T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8-inch (3 mm) fillet weld, 1/2-inch (13 mm) long every 3 inches (75 mm) on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.
- 3.05 INSULATED PIPING:
- A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.
  - B. Where vapor barriers are indicated on water piping, install coated protective shields.
- 3.06 CONTRACT CLOSEOUT:
- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 40 23 19.04

### DUCTILE IRON PIPE AND FITTINGS

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide and test ductile iron pipe, fittings and appurtenances as indicated and in compliance with Contract Documents.
- B. Options:
  - 1. For buried exterior pipelines provide push-on joint pipe.
    - a. Provide restrained push-on pipe as specified
    - b. Provide either restrained push-on joint fittings as specified and indicated or provide mechanical joint fittings with restraint system as specified herein
  - 2. For piping exposed as in buildings and galleries, provide flanged or rigid-joint, grooved-coupled pipe and fittings.
  - 3. Cast iron pipe and fittings are not acceptable.

##### 1.02 REFERENCES”

- A. American Society of Mechanical Engineers (AMSE):
  - 1. B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
  - 2. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges.
  - 3. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings.
  - 4. B31.1: Power Piping.
- B. ASTM International (ASTM):
  - 1. A240: Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
  - 2. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile.
  - 3. A380: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems.



4. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
5. A774: Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
6. A778: Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

C. American Water Works Association (AWWA):

1. A21.4: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. A21.10: Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
3. A21.11: Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings.
4. A21.15: Flanged Ductile-Iron Pipe with Threaded Flanges.
5. A21.50: Thickness Design of Ductile-Iron Pipe.
6. A21.51: Ductile-Iron Pipe, Centrifugally Cast in Metal Molds, or Sand-Lined Molds, for Water or Other Liquids.
7. A21.53: Ductile-Iron Compact Fittings, 3-in through 16-in. for Water and Other Liquids.
8. C105/A21.5: Polyethylene Encasement for Ductile Iron Pipe Systems.

D. ISO:

1. 8179-1: Ductile Iron Pipes – External Zinc-Based Coating – Part 1: Metallic zinc with finishing layer. Second edition 2004-06-01.

E. Fluid Sealing Association: Technical Handbook.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Pipe manufacturer's technical specification and product data.
2. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.
  - a. Pipe layouts in full detail.

- b. Location of hangers and supports.
  - c. Location and type of anchors.
  - d. Location of couplings and expansion joints.
  - e. 1/2-inch = 1 foot-0 inch (1 mm = 25 mm) scale details of all wall penetrations and special fittings.
  - f. Schedules of pipe, fittings, special castings, couplings, expansion joints and other appurtenances.
3. Certificates: Sworn certificates in duplicate showing compliance with material used and shop tests performed.
  4. Catalog cuts and technical data for expansion joints, couplings, gaskets, pipe supports and other accessories.
  5. Brochures and technical data on coatings and linings and proposed method of application.
  6. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.
- B. Material Certification:
1. Provide certification from the pipe and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
  2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.
- C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.
1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
  - a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
  - b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

#### 1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.
- C. Inspect and test at foundry according to applicable standard specifications.
- D. Owner reserves right to inspect and test by independent service at manufacturer's plant or elsewhere at his own expense.
- E. Visually inspect before installation.
- F. Job Conditions:
  1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps and equipment to be installed in the piping systems.

#### 1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.
- B. During loading, transportation and unloading, prevent damage to pipes and fittings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation.

### PART 2 - PRODUCTS

#### 2.01 PIPE:

- A. Ductile Iron:

1. Design conforming to AWWA A21.50.
2. Manufacture conforming to AWWA A21.15 or AWWA A21.51.
3. Thickness class, unless otherwise indicated or specified:
  - a. Minimum Thickness Class 52.
  - b. Minimum thickness Class 53 for use with flanged pipe.
4. Pressure Class, unless otherwise indicated or specified:
  - a. Minimum Pressure Class, 4-inches (100 mm) through 12-inches (300 mm): 350
  - b. 14 inches (350 mm) through 64 inches (500 mm): 250

2.02 PIPE FOR USE WITH COUPLINGS:

- A. As specified above except ends shall be plain.
- B. With bolted split sleeve couplings, ends cast or machined at right angles to axis.

2.03 FLEXIBLE JOINT PIPE:

- A. Provide joints with maximum deflection 15 degrees in any direction from pipe axis. Joint design to prevent pulling apart, and to remain watertight at any deflection angle within specified range.
- B. Provide boltless type with rubber gaskets.
- C. Pipe barrel thickness: According to manufacturer's standard but not less than AN Standard for pipe of corresponding class.
- D. Machine joint contact surfaces spherical, without depressions or chatter marks, or rough tool cuts.
  1. Smooth by grinding, and buffing.
  2. Machining accuracy: Finished pipes interchangeable without loss of watertightness or flexibility.
  3. Protect spherical spigot and plain ends of cut lengths by fastened wood lagging.

2.04 FITTINGS:

- A. Provide fittings conforming to AWWA A21.10 or AWWA A21.53, at least Class 150 and match piping class.

- B. Provide all bell push-on or mechanical-joint fittings unless otherwise indicated or specified.
- C. Face and drill flanged fittings conforming to AWWA A21.10 except special drilling or tapping for correct alignment and bolting.
- D. If flanged fittings are not available under AWWA A21.10 provide fittings conforming to ASME B16.1 in 125 lb. pressure class.
- E. Provide standard base fittings where indicated.

2.05 WALL CASTINGS:

- A. Provide size and type indicated and specified.
  - 1. Piping 24-inches (600 mm) and Smaller: Mechanical Joint with specified restraint or Restrained Push-On.
- B. Wall Castings: Conform to requirements of AWWA A21.10 or fabricate of Class 53 ductile iron pipe with screwed on flanges and welded on waterstop. Screwed on mechanical or push-on joints are not acceptable.
- C. Provide water stop centered in wall. Weld water stops on in factory under controlled conditions to ensure adequate strength to permit waterstop to absorb thrust up to the pressure rating of the pipe.

<b>Wall Castings with annealed ductile iron water stops</b>	
<b>Pipe Size</b>	<b>Waterstop thickness, inches</b>
4 inch-12 inch (100-300 mm)	0.50 (13 mm)
14 inch-24 inch (350 -600 mm)	0.75 (19 mm)

<b>Wall Castings with fabricated steel water stops</b>	
<b>Pipe Size</b>	<b>Waterstop thickness, in</b>
4 inch-16 inch (100-400 mm)	0.25 (6 mm)
18 inch-24 inch (450 -600 mm)	0.38 (10 mm)

- D. On flanged wall castings, provide space between the wall and flange to permit mounting the nuts on the flange bolts.
- E. Flanged wall castings located with the flange flush with the wall are not acceptable.
- F. Locate push-on joint wall castings with space between the bell and the wall to insert the follower bolts.
- G. As an option, fabricated wall pipe of Schedule 40 Type 316L stainless steel may be substituted for wall castings specified above. Provide with waterstops of above dimensions and welded continuously on both sides of stop. Flanges of Type 316

stainless steel. Bolts for connection to buried pipe Type 316 stainless steel. Provide flange insulation gaskets, sleeves and washers for all flanges.

- H. Testing: Factory pressure test all wall castings to pipe and joint pressure rating for a minimum of 5 minutes. No visible leakage is acceptable.

## 2.06 ADAPTERS:

- A. Furnish and install for joining pipe of different types, unless solid sleeves indicated.
  - 1. Provide ends conforming to above specifications for the correct type of joint, to receive adjoining pipe.
  - 2. Joining two classes of pipe may be of lighter class provided annular space in bell-and-spigot type joints sufficient for jointing.

## 2.07 JOINTS:

- A. Provide push-on joint and mechanical joint pipe with necessary accessories, conforming to AWWA A21.11.
  - 1. Provide gasket composition designed for exposure to liquid within pipe.
  - 2. Provide mechanical joint gaskets with copper tips to provide electrical continuity.
- B. Provide pipe flanges and accessories conforming to AWWA A21.15.
  - 1. Provide flat faced flanges.
  - 2. Provide 1/8-inch (3 mm) thick, full faced gaskets designed for exposure to liquid within pipe.
- C. Provide restrained joint on pipe and fittings where indicated. Provide restrained joint which is:
  - 1. Boltless
  - 2. Capable of being deflected after assembly
  - 3. Designs using set screws or requiring field welding are not acceptable.
  - 4. Manufacturers:
    - a. American Cast Iron Pipe Co. Flex-Ring.
    - b. U.S. Pipe TR FLEX.
    - c. Clow Super-Lock.

2.08 MECHANICAL JOINT FITTINGS – RESTRAINT SYSTEM:

- A. Provide restraint devices for pipe consisting of multiple gripping wedges incorporated into a follower gland meeting requirements of AWWA A21.10.
1. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, retaining full mechanical joint deflection during assembly and allowing joint deflection after assembly.
  2. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.
  3. Provide restraint devices Listed by Underwriters Laboratories (3 inch (75 mm) through 24 inch (600 mm) size) and Designed by Factory Mutual (3 inch (75 mm) through 12 inch (300 mm) size).
  4. Gland body, wedges and wedge actuating components must be domestic manufactured in the USA.
- B. Working Pressure Rating:
1. 16-inch (400 mm) and Smaller: 350 psi (2413 kPa).
  2. 18-inch (450 mm) thru 48-inch (1200 mm): 250 psi (1724 kPa).
- C. Materials:
1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.
  2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.
  3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.
  4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
  5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.
  6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.
  7. Provide coating for restraint devices consisting of the following:

- a. Process all wedge assemblies and related parts through a phosphate wash, rinse and drying operation prior to coating application.
  - b. Coating: A minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.
  - c. Surface pretreat all casting bodies with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. Coating: Polyester based powder to provide corrosion, impact and UV resistance.
  - d. Coating system: MEGA-BOND by EBAA Iron, Inc.
- D. Manufacturer:
- 1. EBAA Iron MEGALUG Series 1100
- 2.09 FLANGE ADAPTORS:
- A. Provide restrained flange adaptors for pipe consisting of multiple individual gripping wedges incorporated into a follower gland meeting requirements of AWWA A21.10.
- 1. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.
  - 2. Provide restraint devices Listed by Underwriters Laboratories (3-inch (75 mm) through 12 inch (300 mm) size) and Designed by Factory Mutual (4-inch (100 mm) through 12-inch (300 mm) size).
  - 3. Gland body, wedges and wedge actuating components must be domestic manufactured in the USA.
- B. Joint Deflection capability:
- 1. 3-inch through 8-inch (30 mm through 200 mm): 5 degrees
  - 2. 10-inch and 12-inch (250 mm and 300 mm): 3 degrees
  - 3. 14-inch and 16-inch (350 mm and 400 mm): 2 degrees
  - 4. 18-inch and 20-inch (450 mm and 500 mm): 1.5 degrees
- C. Provide flange adaptor to maintain seal with and 0.6 inch (15 mm) gap between end of pipe and mating flange
- D. Working Pressure Rating:
- 1. 16-inch (400 mm) and Smaller: 350 psi (2413 kPa)



2. 18-inch (450 mm): 300 psi (2068 kPa)
3. Minimum safety factor: 2 to 1.

E. Materials:

1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.
2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.
3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.
4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.
6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.
7. Provide coating for restraint devices consisting of the following:
  - a. Process all wedge assemblies and related parts through a phosphate wash, rinse and drying operation prior to coating application.
  - b. Coating: A minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.
  - c. Surface pretreat all casting bodies with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. Coating: Polyester based powder to provide corrosion, impact and UV resistance.
  - d. Coating system: MEGA-BOND by EBAA Iron, Inc.

F. Manufacturer:

1. EBAA Iron MEGAFLANGE Series 2100

2.10 FLEXIBLE CONNECTIONS:

A. Use as specified or indicated:

1. Bolted split sleeve couplings

- 2. Grooved couplings
  - 3. Expansion joints
- 2.11 BOLTED SPLIT SLEEVE COUPLINGS:
- A. Provide in accordance with Section 40 23 19.04.
  - B. Pressure rating at least equal to that of related pipeline.
  - C. Provide with gaskets of composition designed for exposure to liquid within pipe.
- 2.12 GROOVED COUPLINGS:
- A. Conform to AWWA C606.
  - B. Minimum pipe wall thickness specified under "Pipe For Use With Couplings."
  - C. Where grooved couplings are indicated to provide for expansion or flexibility, cut pipe grooves to provide necessary expansion or flexibility.
  - D. Where grooved couplings are used instead of flanged joints, joint to be of rigid type with pipe grooves cut to bring pipe ends together. Beam strength of joint shall be equal to or greater than that of flanged joint.
- 2.13 EXPANSION JOINTS:
- A. Provide in accordance with Section 40 23 19.04.
  - B. Pressure rating at least equal to that of related pipeline.
- 2.14 FILLING RINGS:
- A. Provide where necessary.
  - B. Materials, workmanship, facing, and drilling, conforming to 125-lb. ANSI (Class 125).
  - C. Suitable length with nonparallel faces and corresponding drilling, if necessary, for correct assembly of adjoining piping or equipment.
- 2.15 CONNECTIONS – TAPPED:
- A. Provide service saddles for all taps for lines 24-inch (600 mm) and smaller.
    - 1. Body: Ductile iron ASTM A395 or Bronze.
    - 2. Straps and Hardware: Type 316 stainless steel.

## 2.16 PIPE COATING:

- A. Outside of pipe and fittings within structures: Clean and apply one shop coat with a 3 to 5 mil (75 to 125  $\mu\text{m}$ ) DFT of moisture cured urethane.
- B. Outside surfaces of castings to be encased in concrete: No coating.
- C. Machined surfaces cleaned and coated with rust-preventative compound at shop.
- D. Outside of buried pipe and fittings:
  - 1. Provide the exterior of all buried ductile iron pipe coated with a layer of arc-sprayed zinc in accordance with ISO 8179.
  - 2. Mass of zinc applied: 200  $\text{g}/\text{m}^2$  of pipe surface area.
  - 3. Provide a finishing topcoat applied to the zinc.
  - 4. Provide the coating system conforming ISO 8179-1 "Ductile iron pipes - External zinc-based coating - Part 1: Metallic zinc with finishing layer. Second edition 2004- 06-01".

## 2.17 CERAMIC EPOXY LINING:

- A. Material:
  - 1. Amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment, Protecto 401 or approved equal.
  - 2. Permeability rating: 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
  - 3. Provide the following testing performed on coupons from factory lined ductile iron pipe:
  - 4. ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.
  - 5. ASTM G-95 Cathodic Disbondment 1.5 volts at 77 degree F (25 degrees C). Results to equal no more than 0.5mm undercutting after 30 days.
  - 6. Immersion Testing rated using ASTM D-714-87.
  - 7. 20 percent Sulfuric Acid - No effect after two years.
  - 8. 140 degrees F (60 degrees C) 25 percent Sodium Hydroxide - No effect after two years.
  - 9. 160 degrees F (71 degrees C) Distilled Water - No effect after two years.

10. 120 degrees F (49 degrees C) Tap Water (scribed panel) - 0.0 undercutting after two years with no effect.
  11. An abrasion resistance of no more than 3 mils (75  $\mu\text{m}$ ) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.
- B. Lining Thickness:
1. 40 mils (1015  $\mu\text{m}$ ) nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40 degrees F (5 degrees C). The surface also must be dry and dust free.
  2. Provide the number of coats of lining material as recommended by the lining manufacturer.
- C. Preparation and Application: As recommended by the lining manufacturer
- D. Lining Inspection:
1. Check all ductile iron pipe and fitting for thickness using a magnetic film thickness gauge using the method outlined in SSPC-PA-2 Film Thickness Rating.
  2. Test the interior lining of all pipe barrels and fittings for pinholes with a nondestructive 2,500 volt test. Any pinholes found shall be repaired prior to shipment at no additional cost to the Owner.
  3. Mark each pipe joint and fitting with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.
  4. Certification: The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, lining manufacturers recommendations for preparation and application and that the material used is as specified.

#### 2.18 GASKETS, BOLTS, AND NUTS:

- A. Provide ring or full face synthetic rubber gaskets for flanged joints and neoprene faced phenolic for insulating gaskets in accordance with AWWA A21.11 and ASME B16.21.
1. 1/8 inch (3 mm) thick.
- B. Make flanged joints with:
1. Bolts.
  2. Bolt studs with nut on each end.
  3. Studs with nuts where flange is tapped.

- 4. Plastic bolt sleeves and washers for insulating joints.
- C. Number and size of bolts conform to same ANS as flanges.
- D. Provide Type 316 stainless steel bolts, washers and nuts for all services.

### PART 3 - EXECUTION

#### 3.01 HANDLING AND CUTTING:

- A. Mark pipe and fittings "Rejected" and remove from site when cracked or has received a severe blow.
- B. If permitted, cut on sound barrel at a point at least 12 inch (300 mm) from visible limit of crack, at Contractor's expense.
- C. Machine cut with milling type cutters, knives, or saws. Snap cutters, torch, or hammer and chisel NOT ALLOWED. Examine for possible cracks.
- D. Chamfer cut ends if used for push-on joints.
- E. Do not cut glass lined pipes.

#### 3.02 INSTALLATION:

- A. Visually inspect before installation.
- B. Ensure pipelines parallel to building walls wherever possible. Install piping to accurate lines and grades. Where temporary supports are used, ensure rigidity to prevent shifting or distortion of pipe. Provide for expansion where necessary.
- C. Pitch piping toward low points. Provide for draining low points.
- D. Before assembly, remove dirt and chips from inside pipe and fittings.
- E. Piping Support: Provide in accordance with Section 40 23 19.01.
- F. Pipe and Fittings:
  - 1. Remove and replace defective pieces.
  - 2. Clear of all debris and dirt before installing and keep clean until accepted.
  - 3. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically.
  - 4. Provide firm bearing along entire length of buried pipelines.

5. Do not allow deflection of alignment at joints to exceed permissible deflection as specified below:

**PIPE DEFLECTION ALLOWANCES**

<b>Maximum permissible deflection, inches* (mm)</b>		
<b>Size of pipe, inches (mm)</b>	<b>Push-on joint</b>	<b>Mechanical joint</b>
4 (100)	19 (482)	31 (787)
6 (150)	19 (482)	27 (685)
8 (200)	19 (482)	20 (508)
10 (250)	19 (482)	20 (508)
12 (300)	19 (482)	20 (508)
14 (350)	11 (279)	13-1/2 (343)
16 (400)	11 (279)	13-1/2 (343)
18 (450)	11 (279)	11 (279)
20 (500)	11 (279)	11 (279)
24 (600)	11 (279)	9 (228)
30 (750)	11 (279)	9 (228)
36 (900)	11 (279)	8 (203)
42 (1050)	7-1/2 (190)	7-1/2 (190)
48 (1200)	7-1/2 (190)	7-1/2 (190)
54 (1350)	7-1/2 (190)	0 (0)

\* Maximum permissible deflection for 20-foot (6.1 metres) lengths; for other lengths in proportion of such lengths to 20-foot (6.1 metres).

- a. For push-on joint or similar pipe, clean bell of excess tar or other obstruction and wipe out before inserting next pipe spigot. Shove new pipe into place until properly seated and hold securely until joint completed.
  - b. Set castings to be encased in concrete accurately with bolt holes, if any, carefully aligned. Clean off rust and scale before setting.
- G. Temporary Plugs: When pipe laying not in progress, close open ends of pipe with temporary watertight plugs. If water in trench, do not remove plug until danger of water entering pipe passed.
- H. Appurtenances: Set valves, fittings and appurtenances as indicated.

3.03 JOINTS AND COUPLINGS:

A. Push-on Joints:

1. Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end.
2. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom.

B. Bolted Joints:

1. Remove rust-preventive coatings from machined surfaces.
2. Clean pipe ends, sockets, sleeves, housings, and gaskets and smooth all burrs and other defects.
3. Use torque wrench to tighten to correct range of torque not to exceed values specified below:

TORQUE RANGE VALUES		
Nominal pipe size, in	Bolt diameter, in	Range of torque, ft-lb
3	5/8	40-60
4-24, incl.	3/4	75-90
30, 36	1	100-120
42, 48	1-1/4	120-150

TORQUE RANGE VALUES		
Nominal pipe size, mm	Bolt diameter, mm	Range of torque, Nm
75	16	55-80
100-600, incl.	19	100-120
750, 900	25	135-160
1050, 1700	32	160-200

C. Flanged Joint:

1. Make up tight.
2. Do not put strain on nozzles, valves, and other equipment.
3. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch (13 mm) excess thread protruding from the nut.

D. Mechanical Joints:

1. Wire brush surfaces in contact with gasket and clean gasket.
2. Lubricate gasket, bell, and spigot with soapy water.
3. Slip gland and gasket over spigot, and insert spigot into bell until seated.
4. Seat gasket and press gland firmly against gasket.
5. After bolts inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.

E. Flexible Joints:

1. Clean and dry before assembly.
2. Place gaskets, rings, glands and followers in position in back of spigot ball.
3. Coat ball and socket with thin film of lubricant conforming to joint manufacturer's standards.
4. Insert ball and seat in socket. Seat gasket against ball.
5. Boltless joints:
  - a. Assemble retainer rings and glands conforming to manufacturer's standard.
  - b. Lock in place with lead strips.

F. Tapped Connection:

1. Drill and tap normal to longitudinal axis.
2. Drilled by skilled mechanics using proper tools.
3. Use only tapered threads.

G. Electrical Conductors:

1. Install pipes so terminal strips are aligned.
2. Install jumper strips and tighten bolts.

3.04 FIELD TESTING:

A. Provide in accordance with Section 09 91 13.

B. Clean of all dirt, dust, oil, grease and other foreign material, before conducting pressure and leakage tests.

C. Pressure and Leakage Tests:

1. Maintain pressure and make leakage test by metering water flow into pipe. Acceptable results:
  - a. Average leakage during test: less than 10 gallons (1 liter) per inch (mm) of diameter per 24 hours per mile (km).
  - b. No visible leakage in joints.



2. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section fails test.
3. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.
4. Modify test procedure only if permitted by Engineer.

3.05 FIELD PAINTING:

- A. Provide in accordance with Section 09 91 13.

3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

## SECTION 40 23 19.05

### PROCESS PIPING AND APPURTENANCES

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION:

- A. Provide and test process piping and appurtenances as indicated and in compliance with Contract Documents.

##### 1.02 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
  1. B16.1: AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
  2. B16.3: Malleable Iron Threaded Fittings Classes 150 and 300
  3. B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
  4. B16.9: Factory-Made Wrought Buttwelding Fittings
  5. B16.15: Standard for Cast Bronze Threaded Fittings, 125 and 250 lb
  6. B16.18: Standard for Cast Copper Alloy Solder-Joint Pressure Fittings
  7. B16.22: Standard for Wrought Copper and Bronze Solder-Joint Pressure Fittings
  8. B16.26: Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
  9. B31.1: Power Piping
- B. ASTM International (ASTM):
  1. A36: Standard Specification for Carbon Structural Steel
  2. A47: Standard Specification for Ferritic Malleable Iron Castings
  3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  4. A105: Standard Specification for Carbon Steel Forgings for Piping Applications
  5. A139: Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

6. A181: Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
7. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
8. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
9. A197: Standard Specification for Cupola Malleable Iron
10. A216: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
11. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
12. A256: Standard Method of Compression Testing of Cast Iron
13. A269: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
14. A278: Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C)
15. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
16. A312: Seamless and Welded Austenitic Stainless Steel Pipe
17. A351: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
18. A449: Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
19. A536: Ductile Iron Castings
20. B62: Standard Specification for Composition Bronze or Ounce Metal Castings
21. B75: Specification for Seamless Copper Tube
22. B88: Specification for Seamless Copper Water Tube
23. C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
24. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

25. D256: Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
26. D570: Standard Test Method for Water Absorption of Plastics
27. D638: Standard Test Method for Tensile Properties of Plastics
28. D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degree C and 30 Degree C with a Vitreous Silica Dilatometer
29. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
30. D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
31. D1330: Standard Specification for Rubber-Sheet Gaskets
32. D1457: Standard Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials
33. D1599: Standard Test for Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings
34. D1784: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
35. D1785: Standard Specification for Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) Plastic Pipe, Schedules 40, 80 and 120
36. D2000: Rubber Products in Automotive Applications
37. D2105: Standard Test for Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube
38. D2412: Standard Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading
39. D2467: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
40. D2564: Standard Specification for Solvent Cements for Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) Plastic Pipe and Fittings
41. D2855: Standard Practice for Making Solvent Cemented Joints with Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) Pipe and Fittings

42. D2996: Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
  43. D3035: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
  44. D3222: Standard Specification for Unmodified Polyvinylidene Fluoride (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings
  45. D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
  46. D5685: Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
  47. E84: Standard Test Method for Surface Burning Characteristics of Building Materials
  48. F441: Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
  49. F491: Standard Specification for Polyvinylidene Fluoride (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings
  50. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
  51. F1476: Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.
- C. American Welding Society (AWS):
1. B3.0: Welding Procedure and Performance Qualification
- D. American Water Works Association (AWWA):
1. C213: Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
  2. C219: Bolted, Sleeve-Type Couplings for Plain-End Pipe
  3. C606: Grooved and Shouldered Joints
- E. Expansion Joint Manufacturers Association Standards.
- F. Fluid Sealing Association - Technical Handbook.
- G. Manufacturer's Standardization Society (MSS):

1. SP-67: Butterfly Valves
2. SP-69: Pipe Hangers and Supports - Selection and Application

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  1. Submit manufacturer's certificates of conformance.
  2. Submit certified copies of test reports.
  3. Piping layouts in full detail.
  4. Location of pipe hangers and supports.
  5. Large scale details of wall penetrations and fabricated fittings.
  6. Schedules of all pipe, fittings, special castings, flexible connectors, adapters, couplings, expansion joints, and other appurtenances.
  7. Reports as required for welding certifications per ASME B31.1 Paragraph 127.6.
  8. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.
- B. A copy of the contract mechanical process, civil, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".
  1. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
  1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
  2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

#### 1.04 QUALITY ASSURANCE:

##### A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ANSI B31.1, for shop and project site welding of piping work.
2. Qualification for welders: Welding shall be performed by welders holding current certification for the welding procedures in use.
3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

##### B. Provide all grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools used must be of the same manufacturer as the grooved components.

1. Provide all castings used for coupling housings, fittings, and valve bodies date stamped for quality assurance and traceability.

##### C. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

#### 1.05 DELIVERY, STORAGE AND HANDLING:

##### A. Provide in accordance with Section 011006.

##### B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

### PART 2 - PRODUCTS

#### 2.01 DUCTILE IRON PIPE AND FITTINGS:

##### A. Provide in accordance with Section 40 23 19.04.

#### 2.02 STAINLESS STEEL PIPE AND FITTINGS 1/2-INCH (13 MM) TO 2-INCH (50 MM):

##### A. Provide either Pressfit, grooved or a socket welded system.

1. Provide a sufficient number of unions for Vic-Press and socket welded systems to allow removal of all valves and inline devices.
2. Provide threaded connections only where required.

B. Vic-Press Schedule 10S System:

1. Vic-Press system, 1/2-inch (13 mm) through 2-inch (50 mm) Schedule 10S comprised of stainless steel Vic-Press fittings, couplings and pipe.
2. Type 316 stainless steel Pressfit couplings and fittings and Type 316 stainless steel Pressfit pipe UL classified to ANSI/NSF 61 for cold +86 degrees F (+30 degrees C) and hot +180 degrees F (+82 degrees C) potable water service.
  - a. Maximum working pressure of 500 psi (3490 kPa) for water, oil, gas, chemical, air and vacuum services.
3. Couplings, Fittings: Pressfit products formed of Type 316/316L stainless steel tubing including a self-contained o-ring seals molded of synthetic HNBR rubber suitable for water operating temperatures to +210 degrees F (+98 degrees C).
4. Valves 1/2-inch (13 mm) through 2-inch (50 mm) ball valves with Type 316 stainless steel plain ends for Pressfit assembly. Victaulic Series 569.
  - a. Pressure Rating: 300 PSI (2195 kPa).
  - b. CF8M stainless steel body and ball
  - c. Type 316 stainless steel stem
  - d. PTFE seats.
5. Pipe: Type 316/316L ASTM A312 stainless steel
  - a. Schedule 10S.

2.03 PRESSURE GAUGES:

A. Gauges:

1. Non-liquid filled type.
2. Helical wound bourdon tube, Inconel X-750.
3. Welded parts: Type 316 stainless steel.
4. Bearings: Precision Sapphire Type.
5. 1/2-inch (13 mm) NPT bottom male thread connection.



6. Accuracy: 1/2 percent of scale range.
  7. 4-1/2-inch (114 mm) diameter with ABS plastic case.
  8. Provide external adjustment.
  9. Pipe and Fittings: Schedule 5 Pressfit or Schedule 40 threaded or socket welded, Type 316L stainless steel.
  10. Pump Suction Gauges: Provide gauges with range to cover both the normal operating range and the range of pressures that will result from flushing.
  11. Pump Discharge Gauges: Provide gauges with range to cover the normal operating range, above the pump shutoff head and the range of pressures that will result from flushing.
- B. Pipe and fittings: Type 316L stainless steel, provide as specified herein.
- C. Ball valves: General service stainless steel ball valves in accordance with Section 40 23 13.01.
- D. Pressure Sensor Rings:
1. 1-inch (25 mm) and Larger: Provide sensor/isolators that fit inside the bolt circle of 150-lb (Class 150) or 300-lb (Class 300) ANSI flanges as required.
  2. 3/4-inch (19 mm) and Smaller: Provide sensor/isolators full flange or threaded as specified and indicated.
  3. Face to face length of the sensor: Conform to Specification MSS-SP67.
  4. Type: Flow through design with flexible sleeve around full circumference. The center section shall have a cavity behind the sleeve filled with silicone fluid to transfer pressure to the gauge.
  5. Rigidly support all pressure instruments by a post at least 7/8 inch (22 mm) diameter welded to the isolator. On sensor rings with more than one instrument, provide all connections 1/2-inch (13 mm) NPT as a minimum, 1/4-inch (6 mm) NPT fittings are not acceptable.
  6. Provide sensor/isolator rings that do not have any fill plugs or valves that can be inadvertently removed with the resultant loss of fill fluid. Pressure sensor/isolators using valves are not acceptable.
  7. Provide liquid filled sensor/isolators permanently vacuum sealed at the factory with a modular seal consisting of a membrane and needle fitting to allow removal and replacement of pressure instruments without compromising the vacuum fill. Sensor/isolators using valves are not acceptable.

8. Provide the needle fitting with both 1/4-inch (6 mm) NPT(F) threads and 1/2-inch (13 mm) NPT(M) threads.
9. Provide the pressure sensor/isolator capable of operating under pressure with all pressure instruments removed with no loss of fill fluid. Provide an intergral block valve, separate isolation valves are not acceptable.
10. Attach pressure instruments to the isolator with a hand tightened lock ring.
11. It shall be possible to remove or attach pressure instruments to the isolator without requiring the use of any tools.
12. Permanently fill the pressure sensor with high viscosity silicone instrument oil to damp out surges or pressure spikes without the requirement for a separate snubber.
13. Pressure rating: 200 psi (1400 kPa) minimum for all lines tested at 150 psi (1050 kPa) or less and 600 psi (4200 kPa) minimum per lines tested above 150 psi (1050 kPa).
14. Provide gauges as specified herein. Provide all other types of instruments indicated and specified in accordance with Section 40 90 00.
15. Materials:
  - a. Pressure sensor/isolator rings: Provide materials suitable for the service conditions specified and indicated, as a minimum provide the following

<b>Service</b>	<b>Body &amp; Plates</b>	<b>Sleeve</b>
Wastewater	Type 316L Stainless Steel	Natural Rubber

2.04 PRESSURE AND FLOW INSTRUMENTATION:

- A. Provide in accordance with Section 40 90 00.

2.05 COUPLINGS-SLEEVE TYPE:

- A. Manufacturers:
  1. Romac
  2. Smith Blair
  3. Viking Johnson
  4. Dresser
- B. Provide couplings meeting AWWA C219
- C. Couplings 12-inch (300 mm) and smaller:

1. End rings and center rings: ASTM A536 ductile iron, fusion bonded epoxy coated
  2. Gaskets: Buna-N, NSF 61 approved
  3. Hardware: Type 316 stainless steel
- D. Couplings 14-inch (350 mm) and larger:
1. End rings and center rings: ASTM A36 steel, fusion bonded epoxy coated
  2. Gaskets: Buna-N, NSF 61 approved
  3. Hardware: Type 316 stainless steel
- E. Bridles and tierods: Minimum 3/4-inch (19 mm) diameter, except where tierods replace flange bolts of smaller size, in which case fit with nut on each side of pair of flanges.
1. Provide as indicated
- 2.06 COUPLINGS-BOLTED SPLIT SLEEVE TYPE:
- A. Manufacturers:
1. Victaulic Depend-O-Lok
- B. Type: Bolted, split-sleeve type coupling consisting of four basic components; one piece housing, gaskets assembly, bolts and nuts, and restraint rings as required for restraint.
1. Provide split-sleeve with a double arch cross section closing around pipe ends that are smooth for expansion or contraction requirements or pipe ends with end rings affixed for pipe end restraint requirements. As the coupling housing closes, it confines the elastomeric gasket beneath the arches of the sleeve to create the radial seal. The axial seal is affected by the sealing plate at the closure plates as the bolts pull the coupling housing snug around the pipe.
  2. Provide sealing members comprised of two “O” ring gaskets and an elastomer sealing pad bonded to the integral sealing plate.
- C. Provide couplings designed for the type, size, and working pressure of the piping system as indicated in the Process Piping Schedule and specified.
- D. Materials:
1. Split-sleeve:
    - a. Carbon Steel and Ductile Iron pipelines: ASTM A36 Carbon Steel.
    - b. Stainless steel pipelines, ASTM A240 Type 316L stainless steel.

- c. Provide stainless steel couplings where there is a transition for ductile iron to stainless steel piping.
2. Gaskets:
- a. Material: Elastomers in accordance with ASTM D2000.
    - (1) Air Service: Silicone conforming to ASTM D2000 for air service up to 240 degrees F (115 degrees C) with intermittent exposure to 280 degrees F (138 degrees C).
    - (2) Liquid Service: Isoprene or Buna-N conforming to ASTM D2000 for service within the temperature range of -20 degrees F (-29 degrees C) to 180 degrees F (38 degrees C).
3. Bolts and Nuts:
- a. Bolts: Stainless steel conforming to ASTM F593 Type 316, minimum tensile strength 85,000 psi (593 MPa), (or threaded studs to ASTM A193, Class 2 Grade B8M Type 316)
  - b. Nuts: ASTM F593 Type 316.
4. End Restraint Rings:
- a. Provide restraint rings of the same material as the coupling housing.
  - b. Non-restrained (ExE) type couplings allows for up to 4 degree deflection. Provides for coupling joint where restraint is not required. If restraint is required, it must be provided independent of the coupling.
  - c. Fixed x Expansion (FxE) type couplings: Allows for thermal expansion and contraction at the pipe joint. Provide one or two restraint rings fixed to one end of the pipe to keep coupling in the proper location. Where split sleeve coupling FxE for expansion is used provide the expansion side of the coupling with a combination of fixed and sliding supports for thermal movement.
  - d. Fixed x Fixed (FxF) type couplings: Provides a fully restrained pipe joint. Provide one restraint ring welded to each of the pipe ends fitting beneath the coupling to prevent the pipe joint from pulling apart.
  - e. Provide type as indicated and specified.
  - f. Follow manufacturer's written recommendations and instructions for location dimensions and welding detail required to attach the restraint rings.

- E. Provide a Type 316 stainless steel nameplate welded to each coupling with the following data:
  - 1. Manufacturer and date fabricated.
  - 2. Type of Coupling (ExE, FxE, FxF).
  - 3. Working Pressure in psi (kPa).
  - 4. Test Pressure in psi (kPa).
  - 5. Materials for coupling, hardware and gaskets.
- F. Protective Coating: Prior to installation, couplings shall be coated on the I.D. and O.D. in accordance with section 09 91 10 and 09 91 13.
- G. Couplings installed underground: Provide bitumastic coating or joint tape wrap.
- H. Installation of couplings shall be in accordance with manufacturer's recommendation.
  - 1. The coupling housing shall be assembled pulling the closure plates together with the bolts tightened to assure snug coupling housing contact with the pipe OD. Follow the manufacturer's recommendation regarding the installation and tightening of the bolts.

#### 2.07 EXPANSION JOINTS-ELASTOMERIC FLEXIBLE CONNECTION:

- A. General: Provide flexible connectors as indicated, specified and as required for ductile iron, steel and stainless steel piping
  - 1. At equipment connection: To eliminate vibration and stress on equipment.
  - 2. Elsewhere: Designed for expansion/contraction.
    - a. Hot Water Systems: 1.25 inch per 100 feet (1 mm per metre).
    - b. All other Piping Systems: 0.5 inch per 100 feet (0.4 mm per metre).
- B. Manufacturers:
  - 1. Mercer Rubber Co.
  - 2. General Rubber Co.
  - 3. Garlock, Inc.
  - 4. Proco.
- C. Products:

1. Straight-through or tapered design as required.
  2. Filled arch type for wastewater, sludge and scum applications
  3. Furnish control rods for test pressures as indicated or required.
  4. Materials: Suitable for service specified and indicated.
  5. At expansion joints, provide guide supports located per manufacturer's recommendations.
  6. Flanges: 125 lb (Class 125) drilling.
  7. Provide Type 316 stainless steel retaining rings.
- D. Install joints in their neutral position.
- 2.08 HOSE, HOSE FITTINGS AND ACCESSORIES:
- A. Hose Manufacturers:
1. Goodrich, HPD Industries
  2. Goodyear
  3. United Rubber Supply
  4. Goodall
- B. Hose: 1-inch (25 mm):
1. Provide 4-ply rubber-lined and rubber-covered water hose for 150 psi (1050 kPa) working pressure.
  2. Nozzle:
    - a. Shatter proof and UV resistant Lexan constant flow nozzle with bumper.
- C. Hose Reels:
1. Type 316 (304) stainless steel, mill finish.
  2. Heavy duty square tubing frame.
  3. Spring rewind with declutching arbor.
  4. Stainless steel ball bearing swivel joint.
  5. 1-inch (25 mm) female NPT.

6. 50 feet (15 m) of hose.
7. Provide a flexible connector between the inlet pipe and inlet swivel joint.
8. Manufacturer: Hannay Model SS800 or acceptable equivalent product.

2.09 WALL AND FLOOR SLEEVES:

A. Materials:

1. Schedule 40 Type 316L stainless steel with 2-inch water stop welded both sides to prevent thrust movement and provide positive water sealing.
2. Schedule 40 carbon steel with 2-inch water stop welded both sides to prevent thrust movement and provide positive water sealing. Model GPWSW manufactured by Advance Products & Systems, Inc., or Equal
3. HDPE, 2-inch thru 24-inch and only where indicated and specified.

B. Water Stops: Provide water stops welded on both sides. Provide water stops 1/4-inch (6 mm) thick and 2-inch (50 mm) high and centered on the wall thickness.

C. Provide modular, mechanical type seals, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

1. Manufacturer:
  - a. Innerlynx
  - b. Or equal.

D. Provide the elastomeric elements sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link shall have a permanent identification of the size and manufacturer's name molded into it.

E. Temperature Range: -40 to +250 degrees F (-40 to 121 degrees C).

1. Material: EPDM, ATSM D2000 M3 BA510
2. Color: Black

F. Modular seal pressure plates: Molded of glass reinforced Nylon Polymer with the following properties:

1. Izod Impact – Notched: 2.05ft-lb/in. (1.09 Nm/cm) per ASTM D256
2. Flexural Strength @ Yield: 30,750 psi (215 MPa) per ASTM D790

3. Flexural Modulus: 1,124,000 psi (7846 MPa) per ASTM D790
  4. Elongation Break: 11.07 percent per ASTM D638
  5. Specific Gravity: 1.38 per ASTM D792
- G. Hardware: Type 316 stainless steel.
- 2.10 TRANSITION COUPLINGS:
- A. Provide coupling in accordance with AWWA C219 as specified herein
  - B. Sizes: 2-inch (50 mm) through 24-inch (600 mm).
  - C. Materials:
    1. End rings and center rings: Ductile iron ASTM A536.
    2. Gaskets: Virgin Styrene Butadiene Rubber(SBR) suitable for potable water and wastewater service, ASTM D2000 MBA 710.
    3. Provide 5/8-inch (16 mm), Type 316 Stainless steel bolts and nuts
  - D. Working Pressure: 250 psi (1745 kPa).
  - E. Lining and Coating: Fusion bonded epoxy in accordance with AWWA C213.
- 2.11 DISMANTLING JOINTS:
- A. Materials:
    1. Flanged Spool: AWWA Class D steel ring flange compatible with ANSI class 125 and 150 bolt circles. Provide pipe of ASTM A36 plate 1 percent cold expanded to size.
    2. End Ring and Body: ASTM A36 steel
    3. Gaskets: ASTM 2000 Virgin NBR suitable for wastewater service
    4. Bolts and Nuts: Type 316 stainless steel
    5. Tie Rods: Type 316 stainless steel
  - B. Assembly Tolerance: 3 inches (76 mm)
  - C. Coating: Fusion bonded epoxy, NSF 61 certified
  - D. Pressure Rating: 150 psi (1050 kPa) working pressure



E. Manufacturers

1. Romac
2. Viking Johnson

2.12 STAINLESS STEEL HOSE AND FITTINGS:

A. Manufacturers:

1. Anamet, Inc Series 616

B. Provide corrugated stainless steel hose

C. Pressure Rating:

1. Maximum working pressure: Unbraided type
  - a. 3/8-inch (10 mm) and smaller: 250 psi (1745 kPa)
  - b. 1/2-inch (13 mm): 60 psi (420 kPa)
  - c. 3/4-inch (19 mm) to 1-inch (25 mm): 40 psi (280 kPa)
  - d. 1-1/4-inch (32 mm): 20 psi (140 kPa)
  - e. 1-1/2-inch (38 mm): 15 psi (730 kPa)
  - f. 2-inch (50 mm) to 3-inch (80 mm): 10 psi (70 kPa)
2. Maximum working pressure: Single braided type
  - a. 1/2-inch (13 mm) and smaller: 1000 psi (700 kPa)
  - b. 3/4-inch (19 mm) to 2-inch (50 mm): 450 psi (3140 kPa)
  - c. 2-1/2-inch (65 mm) to 4-inch (100 mm): 300 psi (2100 kPa)
3. Safety Factor: 4:1

D. Material:

1. Core: Type 316
2. Braid: Type 316L stainless steel
3. Ends: Type 316L stainless steel

E. Ends: Provide type as indicated

1. 3/4 -inch (19 mm) to 3-inch (75 mm): 150-lb (Class 150) welded female union end
2. 3/4-inch (19 mm) and larger: 150-lb (Class 150) flat faced floating flanged

#### 2.13 SHOP PAINTING:

- A. Provide in accordance with Section 09 91 10.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION OF PIPE:

- A. Install pipelines parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Where temporary supports are used, provide temporary supports as specified in Section 40 23 19.01 to prevent shifting or distortion of pipe. Provide for expansion.
- B. Slope piping toward low points and provide for draining at low points.
- C. Before assembly, remove debris from inside pipes and fittings.
- D. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.
  1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch (15 mm) excess thread protruding from the nut.
- E. Install grooved joints in accordance with the manufacturer's written recommendations.
  1. Grooved ends: Clean and free from indentations, projections, or roll marks.
  2. Gaskets: Molded and produced by the coupling manufacturer of an elastomer suitable for the service specified and indicated.
  3. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed.
- F. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.
- G. Examine pieces for damage. Do not install pieces that are damaged according to Engineer. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.

- H. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.
  - I. Support piping laid in trenches in trench on bed of selected backfill material which maintains desired line and grade.
  - J. Use dielectric bushings or unions when ferrous pipes join nonferrous pipes carrying liquid either underground or elsewhere.
  - K. Welding in accordance with AN Standard B31 and AWS B3.0.
- 3.02 WALL SLEEVE SEALS:
- A. Expand rubber against pipe and sleeve by tightening bolts when assembled around pipe and inserted in wall.
- 3.03 TEMPORARY PLUGS:
- A. Close open ends of pipe with temporary plugs or caps when pipe installation is not in progress. Use watertight plugs for exterior, buried piping and if water or debris is in trench when work is resumed, do not remove until adequate provision has been made to prevent any water or debris entering pipe even if it necessitates dewatering trench.
- 3.04 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:
- A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.
  - B. Water for testing provided by the Contractor.
  - C. Pressure and Leakage Tests:
    - 1. Provide temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.
    - 2. Test pipelines in sections of acceptable length.
    - 3. Fill section of pipe with water and expel air.
    - 4. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.
    - 5. No visible leakage in joint is acceptable.
    - 6. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.

- 7. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.
  - D. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.
  - E. Do not cover joints in underground piping with backfill material until piping has successfully passed pressure test.
  - F. Test pressures as indicated in Process Pipe Schedule.
  - G. Repair faulty joints even to extent of disassembling and remaking joint, remove defective pipe and fittings and replace in manner satisfactory to the Owner.
- 3.05 FIELD PAINTING:
- A. Provide in accordance with Section 09 91 13.
- 3.06 CONTRACT CLOSEOUT:
- A. Provide in accordance with Section 017400.

END OF SECTION

SECTION 40 70 00

INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. The Contractor will retain the services of SCADATEK Inc. to service the System Integrator (SI) as defined in the specification section.
  - a. Scadatek Inc.  
7562 Northfield Lane  
Manlius, NY 13104  
315-247-6072  
support@scadatek.com
- B. Provide, calibrate and test the instrumentation and control systems specified. Provide equipment, installation services and appurtenances required to achieve a complete, integrated and fully operational system.
- C. Provide instruments as specified herein and as indicated on the Contract Drawings.
- D. Provide control panels and components as specified herein and as indicated on the Contract Drawings.
- E. Provide programming and system operation in accordance with loop descriptions indicated within Appendix B.
- F. All equipment shall comply with the electrical area classification indicated on the electrical drawings.
- G. Provide materials and equipment which are listed, labeled or certified by Underwriters Laboratories (UL) Inc. or equivalent, where such standards have been established.
- H. Provide a RTU or PLC equivalent as described in this specification. The System Integrator shall be responsible for configuration and programming.
- I. Provide a RTU or PLC equivalent components for installation and certification by the manufacturer's authorized technician.
- J. Perform signal strength testing to finalize radio tower height. The transmit site for testing is existing (Odessa, DE). All communication test results shall be submitted for review with shop drawings.

## 1.02 REFERENCES:

- A. National Fire Protection Association (NFPA)
- B. Underwriters Laboratories (UL)
- C. National Electrical Manufacturers' Association (NEMA)
- D. International Society of Automation (ISA)
- E. The Institute of Electrical and Electronics Engineers (IEEE)
- F. The American Society for Testing and Materials (ASTM)
- G. National Institute of Standards and Technology (NIST)

## 1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01 33 00:
  - 1. System Integrator (SI) qualifications:
    - a. Summary of five previously performed successful projects of a similar nature to the work of this contract. The summary shall include a brief description of each project, client contact information and date of project.
  - 2. Wiring diagrams, control panel elevations, catalog cut sheets, radio equipment, and descriptive literature. Annotate information to clearly identify the proposed items and options.
  - 3. Submit documentation that all control panels are constructed in conformance with UL 508A and bear the UL seal confirming the construction.
  - 4. Control Panel Submittal:
    - a. Submit control panel loop diagrams on 11 inch by 17 inch sheets. Show all loops in their entirety including control wiring within and between all field devices including those devices furnished under other Divisions. Clearly identify the selector switch contact states in each selector switch position. Identify normally open or normally closed status for all relay and switch contacts. Assign each wire a unique wire number. Show all power sources, grounding, isolation and lightning protection. Show both analog and discrete signals on a single loop diagram.

- b. Submit equipment outline drawings showing exterior and interior elevations, front panel arrangement, internal panel wiring and internal panel layout.
  - c. Provide complete Bill of Materials indicating manufacturer's part numbers.
  - d. Certified shop test, field test and inspection reports.
  - e. Identify where exceptions are being taken or an "or equal" piece of hardware is being proposed.
5. Instrument Submittal:
- a. Instrument manufacturing data sheets indicating pertinent data. Identify each instrument submitted with applicable loop numbers and nomenclature as indicated on the Contract Drawings and specifications.
  - b. Instrument drawings indicating dimensions, mounting and external connection details.
  - c. Wiring schematics for connections between radio and RTU or PLC hardware.
  - d. Provide a hard and soft copy of RTU or PLC program documentation including ladder logic, cross reference, memory usage, symbols, and descriptions. Written description of the programming developed for the installation, including procedures for modifications, downloading, and programmer operation, if applicable.
  - e. RF signal strength test results including dB fade margin, etc.

#### 1.04 QUALITY ASSURANCE:

- A. Calibrate all instrumentation. Provide calibration tag to all calibrated instruments. The calibration tag shall have the name and phone number of the SI who performed the calibration with the date of calibration. Provide calibration records to the Construction Manager for Architect/Engineer review prior to substantial completion.
- B. The SI shall coordinate with the mechanical and electrical system suppliers to identify any signal isolation or auxiliary relays that may be required to complete the system.
- C. Protect materials and equipment against damage during shipping, storage and construction.

## 1.05 CONTRACTORS (SYSTEM INTEGRATOR) RESPONSIBILITY

- A. The System Integrator's responsibility shall be to furnish a complete and functional, fully integrated RTU or PLU system as described in this specification. This includes furnishing all special cables, such as communication cables, co-axial cable, or sensor/transmitter specialty interconnection wiring.
- B. The System Integrator shall review all appropriate drawings and specification sections for this entire project.
- C. The System Integrator shall be responsible for the installation of the RTU or PLC system. This includes conducting all tests, calibrations, and operational demonstrations, and providing technical supervision for the installation and connections to equipment.
- D. The System Integrator shall, for the duration of this contract and the guarantee period, provide next day, on site services for all RTU or PLU problems. In addition, the System Integrator will provide operation and maintenance manuals and operation training.

## PART 2 – PRODUCTS

### 2.01 GENERAL:

- A. Equipment, cabinets, instruments and other devices furnished under this section shall be suitable for continuous use in the intended application.
- B. The system shall consist of current production products.
- C. I/O points required are identified by type on the Contract Drawings.

### 2.02 INSTRUMENTS:

- A. Provide instruments in accordance with the data sheets attached to this specification as 40 70 00-A.
- B. Data sheets specify minimum requirements.
- C. Provide all brackets, hangers, and miscellaneous metals for mounting of equipment. Mounting hardware shall be installed in accordance with the manufacturers printed recommendations and not interfere with any other equipment.
- D. All equipment shall be tested at the factory prior to shipment.

### 2.03 CONTROL PANELS:

- A. Control Panel Enclosure



1. Panels furnished under this section shall be of the design, arrangement and size as shown on the Contract Drawings and specified herein.
2. Provide control panels with NEMA rating in accordance with the electrical area classification indicated on the electrical drawings.
3. Provide panels doors extending the full width for full access to panel-rear mounted components. Doors shall open 180° and be provided with drawing pocket to hold as-built and service documentation.

B. Surge Protection

1. Provide Surge Protection Devices (SPDs) for panel as follows:
  - a. For each power feed into the control panel.
  - b. Rated a minimum of 10 kilo amps (kA)
  - c. With light indicating fault
  - d. Mount SPD inside control panel
  - e. Minimize lead length of SPD
  - f. SPD manufactured by Joslyn, Dehn, MTL, Harger or equal.
2. Provide surge protection for analog signals as follows:
  - a. For signals originating in a structure outside the one housing the control panel or greater than 200 feet from the control panel.
  - b. Surge protection shall be: two-stage common-mode protection by means of arrestor reactor and varistor in combination and differential mode protection by means of gas arrestor, reactor and zener diode in combination.
  - c. Rated a minimum of 10 kilo amps (kA)
  - d. Manufactured by Dehn, Harger, MTL or equal.

C. Power Supplies

1. Provide one 120V circuit for the UPS, PLC, I/O cards, and courtesy equipment, etc. Provide a local disconnecting circuit breaker for the circuit.

D. Courtesy Equipment

1. Provide a 120VAC duplex service receptacle and switchable light fixture within each control panel.

E. Power to Remote Instruments

1. Provide provisions for power to field instruments from the same panel that receives the signal. Feed each instrument from an individual fused disconnect or circuit breaker.

#### F. Mounting

1. Mount all panel components to allow easy access for servicing, calibration, adjustments, testing and removal, without the removal of other equipment.
2. Provide internal panel components mounted directly on removable plates made of the same material and finish as the panel, of a thickness to provide rigid support for mounted components.
3. Mount all equipment on wall of panel enclosure. Loose equipment on the floor of enclosure is not acceptable.

#### G. Labeling

1. Attach identification labels to all internal components.
2. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers. Number wiring in accordance with the numbering system used on the instrument submittal drawings.
3. Terminal strip labeling shall be identical to the wire numbers.

#### H. Switching

1. Pushbuttons shall be of oil-tight, heavy-duty momentary contact pushbuttons, rated for 10A at 120VAC unless specified otherwise.
2. Rotary selector switches shall be oil-tight, heavy-duty, maintained contact type rated for 10A at 120VAC.

#### I. Indicating Lights

1. Provide oil-tight, heavy-duty, LED cluster type pilot lights, with average life of 40,000 hours, minimum, unless otherwise specified.

#### J. Control Relays

1. Provide sealed relays DIN rail mounted with indicating light to indicate its' operation. Contacts shall be rated for 10A at 120VAC.
2. Provide electronic timer delay of the plug-in, digital type with output contacts rated for 10A at 120VAC.

3. Provide all relays from a single manufacturer.

#### K. Termination Points

1. Terminate all wiring at a central terminal array consisting of rigid terminal strips with numbering identical to the wire numbers.
2. Arrange the terminal blocks into functional groups indicated below:
  - a. 120VAC power wiring
  - b. DC power wiring
  - c. Discrete signals
  - d. Analog signals
3. Provide 25% spare terminal blocks for each functional group.
4. Use only one side of each terminal block row for internal wiring. Use the other side for field wiring. Do not locate terminal blocks within 6 inches of any right angle panel surface.
5. Provide terminal blocks of corrosion proof material such as nickel plated copper. Provide AC and DC control terminals suitable for 12 AWG or larger wire. Provide terminals for DC analog signals suitable for 16 AWG wire.

#### L. Wires

1. Power and control wire shall be 600 Volt class, Type THHN/THWN insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than 14 AWG.
2. Provide 16 AWG shielded cable pairs for all analog signals internal to the panels.

#### M. Wiring Methods

1. Grounding
  - a. Provide a grounding terminal strip bonded to the panel enclosure with 20 percent spare terminals.
  - b. Individually connect ground wires between control panel components to grounding terminal strip.
2. Wire Troughs

- a. Provide internal wiring troughs of the plastic, open-side type with snap-on covers.
- b. Wiring troughs shall not be filled to greater than 60% capacity. Provide snap-on covers marked to identify their locations.

3. Wire Path

- a. Group wiring within the panel according to function. Harness groups together or place within ducts which are secured to the panel structure.
- b. Remote instrument power shall not be commingled with panel power for other panel devices.
- c. Crossings of the two system's wires shall be at right angles. Parallel runs of the two system's wires shall be separated by a minimum of 12 inches.
- d. Partition intrinsically safe wiring separately from all other wiring. Provide a protective cover with labeling to cover the intrinsically safe wires.

4. Wire colors shall be assigned as follows:

AC Power	Black
AC Neutral or Common	White
AC Control	Red
DC Control	Blue
Equipment or Panel Ground	Green
Externally Powered Circuits	Yellow

- 5. Wire connectors shall be the hook-fork type, with non-insulated barrel to allow easy inspection of crimp integrity.

N. Signal Management

- 1. Design all instrumentation equipment to operate on 120VAC, +/-10%, at 60Hz, except as specifically noted. Provide power supplies, regulators and constant-voltage transformers to allow compliance with the above.
- 2. Provide electronic type solid-state instrumentation utilizing linear transmission signals of 4-20mADC, (milliamperere direct current), except as specifically noted.
- 3. Provide 4-20mADC outputs capable of driving a 750 ohm load from all transmitters, controllers, and signal processing devices. Inputs to controllers, recorders, indicators, signal processing devices shall be 4-20mADC.

4. Convert nonstandard signals into compatible standard signals at their source. Zero based signals are not acceptable.
  5. Direct interlock of equipment without auxiliary relaying shall not be allowed.
  6. For all signals to be transferred to/from another panel, provide current isolators (analog) or dry relay contacts (discrete) wired out to terminal blocks.
- O. Operator Interface Terminal (OIT)
1. Provide OIT as specified in the Contract Drawings.
- P. Uninterruptable Power Supply (UPS)
1. Provide UPS as specified in the Contract Drawings.
- Q. Programmable Logic Controller (PLC)
1. Provide PLC as specified in the Contract Drawings.
- R. Radio Antenna
1. Provide a radio antenna tower made of galvanized steel or aluminum, designed to withstand loadings per applicable code requirements.
  2. Tower heights up to forty-five feet shall be supplied, as determined from the RF survey.
  3. Tower foundation shall be designed per manufacturer's specifications and include lightning protection per National Electrical Code (NEC) requirements.

## 2.04 SHOP TESTING

- A. Provide a shop, factory and field test plan outlining the SI's procedures for testing all field primary devices, final control elements, local control panels, the control system and termination cabinets at the factory prior to shipment. This plan shall demonstrate the system performs as specified and as indicated. Submit the shop test plan with the shop drawings as specified. Submit results of test to Construction Manager for Architect/Engineer review.

## PART 3 – EXECUTION

### 3.01 GENERAL INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's printed instructions and approved shop drawings.

- B. The locations of equipment, transmitters, alarms and similar devices are diagrammatic only. Exact locations shall be determined by the SI during development and fabrication of systems.
- C. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the instrument manufacturer, but in no case shall more than one ground point be employed for each shield.
- D. All work shall be executed in full accordance with codes and these contract documents. Should any work be performed contrary to said rulings, ordinances and regulations, the SI shall bear full responsibility for such violations and at no additional cost to the DEP Owner.
- E. All equipment used in areas designated as hazardous shall be designed for the Class, Group and Division as indicated in the area classification schedule on the electrical drawings.
- F. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing and blowdown service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.
- G. All piping and tubing to and from field instrumentation shall be provided with unions, calibrations and test tees, couplings, adaptors, and shut off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.

### 3.02 FACTORY TESTS:

- A. The SI shall test all equipment provided by the SI at the factory prior to shipment unless otherwise specified.
- B. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied. The SI shall provide a detailed step by step test procedure for review and approval by the Architect/Engineer.
- C. All tests shall be conducted in accordance with prior Architect/Engineer approved procedures, forms and checklist. Each specific test to be performed shall be described

and a space provided after it for sign off by the appropriate party after its satisfactory completion.

- D. No equipment shall be shipped until the DEP Owner has received all test results and approved the system is ready for shipment.

### 3.03 INSTRUMENT INSPECTION AND CALIBRATION:

- A. Calibrate instrument with calibration tools that conform to NIST traceability chain. Calibration instruments shall be twice as accurate as the instrument being calibrated but as a minimum the calibration instrument shall have a measurement uncertainty of 0.02 percent.
- B. Provide calibration of instruments at 10%, 50%, 80% and 100% of measured span. Provide calibration tag for all calibrated instruments. Provide calibration tag with name, phone number, date and signature of the person and company performing the calibration. Provide calibration documentation and records to the Construction Manager for Architect/Engineer review prior to substantial completion.

### 3.04 FIELD TESTS:

- A. Perform field testing in accordance with equipment manufacturer recommended instructions.
- B. The test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied. The SI shall provide a detailed step by step test procedure for review and approval by the Architect/Engineer prior to testing. Each specific test to be performed shall be signed off by the appropriate party after its satisfactory completion.
- C. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulation techniques in the test procedures.
- D. Signed copies of the test procedures prepared by the SI, forms and checklists will constitute the required test documentation.
- E. The SI shall furnish the services of field service engineers, all special calibration and test equipment and labor to perform the field tests.
- F. A witnessed Functional Acceptance Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these specifications. Each specified function shall be demonstrated on a paragraph by paragraph, loop by loop, and site by site basis.

### 3.05 START-UP TESTING:

- A. After completion of the Field Tests indicated above, the acceptance testing period shall begin. All furnished hardware and software shall operate for a period of 30 consecutive days, under conditions of full plant process operation, without a single non field repairable malfunction.
- B. During this test, operations personnel and SI personnel shall be present as required. The SI shall have staff available, within 4 hours of notification, who have an intimate knowledge of the hardware and SI furnished systems.
- C. While the start-up testing is proceeding, the Owner shall have full use of the system.
- D. Any malfunction to the SI' system during the tests shall be analyzed and corrected by the System Integrator. The Owner shall determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.
- E. Any malfunction attributed to the SI during the Start-up Testing which cannot be corrected within 24 hours of occurrence by the SI's personnel, or more than two similar failures of any duration, will be considered as a non-field repairable malfunction.
- F. Upon completion of repairs by the SI, the associated test shall be repeated as specified herein.
- G. In the event of rejection of any part or function, the SI shall perform repairs at no additional cost to the DEP Owner.
- H. Upon successful completion of the 30 day startup operation test and subsequent review and approval of complete system final documentation, the system shall be considered Substantially Complete, after approval by the DEP, Construction Manager, and Architect/Engineer.

### 3.06 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION



ATTACHMENT A

INSTRUMENT DATA SHEETS

DATA SHEET 853.1  
DATA SHEET 1454.1

LEVEL SWITCH (FLOAT TYPE) SPECIFICATION  
PRESSURE GAUGE SPECIFICATION

## LEVEL SWITCH (FLOAT TYPE) SPECIFICATION

-----  
DATA SHEET NO. 853 . 1  
-----

### GENERAL

1. Tag Number : SEE TABLE BELOW
2. Service : SEE TABLE BELOW
3. P & I D No. : SEE TABLE BELOW
4. Location : SEE ELECTRICAL DRAWINGS

### FLOAT

5. Dimensions : APPROX. 6 INCH DIAMETER
6. Material : POLYPROPYLENE

### SWITCH

7. Type : MICRO SWITCH STEEL BALL ACTIVATED
8. Contact : SPDT
9. Rating : 5 AMPS AT 120 VAC
10. Enclosure : ENCAPSULATED
11. Open/Close : CLOSE ON INCREASING, OPEN ON DECREASING
12. Mounting : ADJUSTABLE CLAMP ON 1 INCH STAINLESS PIPE
13. Elec. Class'tion : SEE ELECTRICAL DRAWINGS

### PROCESS CONDITIONS

14. Operating Temp. : 40 TO 75 DEG. F.
15. Operating Pressure : ATMOSPHERIC

### MISCELLANEOUS

16. Intercomm. Cable : REQUIRED APPROX. 50 FEET
17. Manufacturer(s) : COX OR KARI NO OR EQUAL
18. Model No.(s) : OPTI-FLOAT OR KA SERIES NO OR EQUAL

## NOTES

- a. Provide 1-inch diameter SCH 40 316L SS pipe to mount the float switch(s).
- b. Provide COX or KARI level switches as specified. Other manufacturers shall not be accepted based on performance.
- c. Provide detailed instructions for proper installation of switches, enclosures and mounting hardware.
- d. Provide 316 SS brackets and hardware to attach pipe to side of well or tank.
- e. Provide a minimum of 3 brackets spaced a maximum of 10'-0" OC.
- f. Provide all 316 SS mounting hardware to mount float switch(s) to 1-inch pipe. Mounting hardware shall allow for float level adjustment with hand tools.
- g. Provide single sealed well/tank penetration for float switch(s) cables.
- h. Provide 316 SS NEMA 4X or cast aluminum termination enclosure (based on area electrical classification). The enclosure shall provide termination for the float(s) and include isolation relays and intrinsic safety barriers.
- i. Provide termination enclosure mounted on 316 SS UNISTRUT® supports for wall or floor mounting.

<u>TAG NO.</u>	<u>SERVICE</u>	<u>P&amp;ID</u>
LSH 101	Grinder Wet Well High Level	10-DI-601
LSL 001	Wet Well Low Level	10-DI-601
LSHH 001	Wet Well High-High Level	10- DI-601

## APPENDIX B

### NEW CASTLE COUNTY WEST WING PUMP STATION I&C CONTROL STRATEGIES

#### PART 1 – GENERAL

The New Castle County West Wing Pump Station will be controlled automatically via a new pump control panel. This section discusses controls for new equipment provided under this contract.

The pump station will be primarily controlled via a vendor-supplied pump control panel. A PLC-based control panel will provide limited control of ancillary equipment at the station. The PLC will also collect monitoring signals from the pump control panel and other station equipment and transmit signals offsite via radio communication for monitoring. There is no remote control associated with the station. Human Machine Interface (HMI) screens will be generated, and the operator will be able to monitor the equipment according to this specification section at the PLC located at the pump station as well as at off-site SCADA workstations.

Normally, the pump station will be run automatically with minimal need for operator intervention, as described in this document. All automatic functions are provided with manual controls for trouble shooting, maintenance, and operation during loss of the PLC or pump control panel. When the equipment is in Hand mode, control will take place at the local control panel/station. When the equipment is in Auto, the control will take place at the PLC.

All programmable monitoring and alarm setpoints described herein shall be operator adjustable and alarm and switch setpoints shall have an operator-adjustable time delay. For each process monitoring instrument (pressure transmitter, level transmitter), the PLC shall generate an “Instrument Failure” signal upon loss of signal from the instrument. All signals from process monitoring equipment shall be input into the PLC for indication, trending, totalization, accumulation, reporting, etc.

All connected equipment will be programmed to provide a runtime history in PLC, calculated from the Run signal from the motor. For all motor operated equipment, the PLC shall generate a Fail to Run alarm if the motor does not provide a Run status to the PLC after an operator-adjustable time delay after being called to run.

HMI displays for process pumps shall indicate pumps on/off status, elapsed running time, pumps failure alarms, pump ready indicator, pump low flow alarms and lead/lag pump status information. In addition, the pumps sequencing controls and indicators shall be displayed. This information shall be connected to the PLC for monitoring and control.

## New Castle County West Wing Pump Station Control Strategies

### CONTROL STRATEGY NO. 01

I&C Loop Name: Raw Wastewater Grinder  
P&ID: 10-DI-601  
I&C Loop Numbers: 101  
PLC/RIO: PLC-1  
Equipment Location: Grinder Wet Well  
Equipment Tag Nos. RWW.GR-1  
Objective: Grind raw wastewater to facilitate pumping.  
Programmable Setpoints: N/A

Operation: When the raw wastewater pump is called to start, the grinder will start first. Once the grinder is confirmed running from the PLC, the raw water pump may start. The grinder will operate continuously while the raw wastewater pump is running. When the raw wastewater pump stops, the grinder will stop after an operator-adjustable time delay.

The grinder is provided with a local control panel. If the grinder experiences a jam, the local control panel will jog the grinder forward and backward in an attempt to alleviate the jam.

Local Indication: Local control and monitoring of the grinder is provided via a vendor-supplied local control panel.

Alarms: Provide the following alarm conditions to the ERD PLC:

- Not in Remote
- Grinder Fault

## CONTROL STRATEGY NO. 02

I&C Loop Name:	Grinder Wet Well Sump Monitoring
P&ID:	10 DI-601
I&C Loop Numbers:	101
PLC/RIO:	PLC-1
Equipment Location:	Grinder Wet Well
Equipment Tag Nos.	LSH 101
Objective:	Provide high level alarm to indicate water intrusion or pipe leak in the grinder wet well.
Programmable Setpoints:	N/A
Operation:	A level switch will alarm on high water level in the grinder wet well, indicating water intrusion or a pipe leak. Alarm is transmitted back to the PLC and transmitted offsite via radio.
Local Indication:	N/A
Alarms:	Provide the following alarm conditions to the PLC: <ul style="list-style-type: none"><li>• High Grinder Wet Well Level</li></ul>
Interlocks:	N/A

## CONTROL STRATEGY NO. 03

I&C Loop Name:	Wet Well Level Monitoring
P&ID:	01 DI-601
I&C Loop Numbers:	1011
PLC/RIO:	RWW.P-1/2-CP
Equipment Location:	Wet Well
Equipment Tag Nos.	LSHH 001, LSL 001, PIT 001
Objective:	Provide level monitoring of the wet well and pump control.

Programmable Setpoints: Wet well level:

- High high level set point
- High level setpoint
- Pump Run Level Setpoint
- Low level set point
- Low low level set point

Operation: A bubbler-type level measurement will be provided. The air pump associated with the level monitoring system will be located inside the pump control panel. A 4-20mA signal shall be provided to the PLC proportional to the wet well level. The 4-20mA signal shall provide input to the pump control loop as described in Control Strategy 04. Backup float switches shall provide backup level monitoring and control for the pump control loop.

Local Indication: Level indication will be provided locally at the pump control panel.

Alarms: Provide the following alarm conditions to PLC-1:

- Level Instrument Fail
- Air Pump Fail
- High-High Dewatering Well Level
- High Dewatering Well level
- Low Dewatering Well Level
- Low-Low Dewatering Well Level

Interlocks: Provide pump control interlocks during normal pump operation as described in Control Strategy 04.

#### CONTROL STRATEGY NO. 04

I&C Loop Name: Raw Wastewater Pumps

P&ID: 01 DI-601

I&C Loop Number: 101, 201

PLC: RWW.P-1/2-CP

Equipment Location: Pumping Station

Equipment Tag Nos. RWW.P-1, RWW.P-2

Objective: Provide pumping system to transport raw wastewater from the wet well to the wastewater treatment plant.

Operation: The raw wastewater pumps are constant speed, and are controlled by the vendor-supplied local control panel. The raw wastewater pumps will operate in a duty/standby configuration. When the level in the wet well reaches an operator-adjustable high level setpoint as measured by the level transducer (as described in Control Strategy 04), the duty pump will start. The pump will run until it reaches the low level setpoint. The low-low level switch provides hard-wired backup control to the pump control loop. In the event that the level transducer in the dewatering wet well fails, the float switches will provide backup control to the transducer.

For each of the raw wastewater pumps a high temperature switch will be provided to monitor pump overtemp. The pump shall shut down on pump overtemp.

Pump alternation will be controlled at the pump control panel. The OIT at the pump control panel will also display analog and digital indicators and alarms. The pump control panel will transmit signals to the facility PLC for monitoring of the pumping system.

Local Controls/ Status: A Hand/Off/Auto (HOA) switch is provided at each pump. See pump specification for details regarding local controls at the vendor-supplied pump control panel.

Alarms: The following alarms are provided for each pump:

- Motor Starter fault
- High Pump Temperature
- Pump Not in Auto
- Emergency Stop

Process Interlocks: The RWW pumps shall have the following automatic process interlocks:

- Automatic “start/stop” and as described above.

Protective Interlocks: RWW pumps shall have the following automatic protective interlocks via the motor starters.

- Stop pump if motor overloads.
- Stop pump on moisture detection.
- Stop pump on motor high temp.



- Stop pump if motor starter faults.
- Stop pump on low low level.

CONTROL STRATEGY NO. 05

I&C Loop Name: Main Circuit Breaker Monitoring

P&ID 99 DI-601

I&C Loop Numbers: 9006

PLC/RIO: PLC-1

Equipment Location: West Wing Pumping Station Electrical Room

Objective: Provides monitoring of the main circuit breaker positions.

Programmable Setpoints: N/A.

Operation: Monitor the main circuit breaker positions

Local Indication: See Division 16 specifications for local indication.

Alarms: The following conditions shall be transmitted to the PLC:

- Main Circuit Breaker Open
- Main Circuit Breaker Closed
- Main Circuit Breaker Tripped
- Main Circuit Breaker in Maintenance Mode

Interlocks: None

CONTROL STRATEGY NO. 06

I&C Loop Name: Automatic Transfer Switch Monitoring

P&ID 99 DI-601

I&C Loop Numbers: 102

PLC/RIO: PLC-1

Equipment Location: West Wing Pumping Station Electrical Room

Objective: Provides monitoring of the Automatic Transfer Switch.

Programmable Setpoints: N/A.

Operation: Monitor the Automatic Transfer Switch

Local Indication: See Division 16 specifications for local indication.

Alarms/Monitoring: The following conditions shall be transmitted to the PLC:

- ATS in Normal Position
- ATS in Emergency Position
- Utility Power Available
- Generator Power Available

Interlocks: None

CONTROL STRATEGY NO. 07

I&C Loop Name: West Wing Pumping Station Generator Monitoring

P&ID 99 DI-601

I&C Loop Numbers: 104

PLC/RIO: PLC-1

Equipment Location: West Wing Pumping Station Generator Enclosure

Equipment Tag Nos. GEN-1

Objective: Provides monitoring of the generator.

Programmable Setpoints: N/A.

Operation: Monitor the status of the generator

Local Indication: Local indication will be provided at the generator control panel

Alarms: The following conditions shall be transmitted to the PLC:

- Not in Auto
- Generator Status
- Common Fault
- Low Battery Voltage
- E-Stop
- Oil Pressure Low

Interlocks: None

CONTROL STRATEGY NO. 08

I&C Loop Name: West Wing Pumping Station Automatic Temperature Controller  
(ATC) Monitoring

P&ID 99 DI-601

I&C Loop Numbers: 120

PLC/RIO: PLC-1

Equipment Location: West Wing Pumping Station Electrical Room

Equipment Tag Nos. ATC-1

Objective: Provides monitoring of the ATC system as well as hard wired relays to activate horns and strobes to indicate ATC systems status.

Programmable Setpoints: N/A.

Operation: Monitor the status of the ATC system. The PLC will monitor a general HVAC trouble alarm. The ATC will also send an alarm to the PLC panel on no flow from exhaust fan EH-1. This contact will connect to relays located within the PLC panel which will drive horns and strobes (see Electrical plans for locations) indicating that the space may not be safe for occupancy. The No Flow alarm is also transmitted to the PLC for monitoring. The operator may silence the horns via the SCADA HMI as well.

Local Indication: See Division 15 specifications for local indication at the ATC Panel.

Alarms:

The following conditions shall be transmitted to the PLC:

- HVAC System Trouble
- No Flow from EH-1

Interlocks:

None

**DIVISION 41 – MATERIAL PROCESSING AND HANDLING  
EQUIPMENT**

SECTION 41 22 23.19  
HOISTING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test hoisting equipment, motors, gear reducers, controls and appurtenances as indicated and in compliance with Contract Documents.
  - 1. Rail and supporting beams included in building structure, refer to structural drawings.
  - 2. Hoist capacities and operating data are indicated in the Hoisting Schedule.

1.02 REFERENCES:

- A. American Bearing Manufacturers Association (ABMA):
  - 1. 9: Load Ratings and Fatigue Life for Ball Bearings.
  - 2. 11: Load Ratings and Fatigue Life for Roller Bearings.
- B. American Society of mechanical Engineers (ASME):
  - 1. B30.16: Overhead Hoists (Underhung) Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings
- C. American Welding Society (AWS):
  - 1. D1.1: Structural Welding Code Aluminum.
- D. National Electric Code (NEC).
- E. National Electrical Manufacturers Association (NEMA):
  - 1. MG1: Motors and Generators.
- F. Occupational Safety and Hazard Association (OSHA):
  - 1. 29 CFR 1910.179: Overhead and Gantry Cranes.

1.03 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00:
  - 1. Data regarding hoisting equipment characteristics and performance:

2. Certified setting plans, with tolerances, for anchor bolts.
3. Manufacturer's literature as needed to supplement certified data.
4. Operating and maintenance instructions and parts lists.
5. Listing of reference installations as specified with contact names and telephone numbers.
6. List of recommended spare parts other than those specified.
7. Shop and field inspection reports.
8. Motor shop test results.
9. Qualifications of field service engineer.
10. Recommendations for short and long-term storage.
11. Shop and field testing procedures, equipment to be used.
12. Special tools.
13. Number of service person-days provided and per diem field service rate.
14. Manufacturer's product data, specifications and color charts for shop painting.
15. The latest ISO 9001 series certification.
16. Provide Certificate of Responsibility. See Section 01 33 00 for Certificate form.
17. Provide scaled drawing height and weight of equipment serviced by the hoisting equipment including hook height and travel dimensions.
18. Material Certification:
  - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
  - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

- B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.
  - 1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
  - 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
  - 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

- A. Comply with the requirements specified in Section 011006.
- B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Permanently mark the capacity of the hoist and trolley on each hoist, in easy to read letters and in a prominent position.
- C. Provide only safety type hooks.
- D. Provide hoists so that hook can reach the floor at the lowest level of the lift.
- E. Do not use hoists for construction purposes of any nature.
- F. Hoists shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.
- G. Welding: In accordance with American Welding Society Code D1.1.



- H. Provide shop tests as specified.
- I. Hoisting equipment manufacturer shall provide hoists, motors, gear reducers, switches, and controls regardless of manufacturer as a complete integrated package to ensure coordination, compatibility and operation of the systems.
- J. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.
- K. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
  - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
  - 2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping and electrical:
    - a. [ ] person-days.
  - 3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.
    - a. [ ] person-days.
  - 4. Performance Testing: Field performance test equipment specified.
    - a. [ ] person-days.
  - 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
    - a. [ ] person-days.
  - 6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
  - 7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- L. Manufacturer of hoisting equipment shall have a minimum of five (5) operating installations with hoists of the size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

- A. Hoisting equipment capacities and operating data are indicated in the Hoist Schedule.

2.02 HOIST AND TROLLEY MANUFACTURERS:

- A. Dresser Industries.
- B. ACCO-Wright.
- C. Yale Hoisting Equipment Division.

2.03 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.
- B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.
- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 ELECTRIC HOISTS:

- A. Electric Hoists: Spur-gear driven antifriction bearings throughout, a mechanical load brake, and a separate electrically operated motor brake. Design mechanical load brake with capability of supporting the full load at any point when the motor is stopped. Motor brake shall be externally adjustable, electrically operated friction disk brake that shall apply automatically when the power is off. The brake shall hold 150 percent of the rated load and 125 percent of the rated load at any operating speed. Design shafts of motor, drum, and drum pinion to run in grease-lubricated ball or roller bearings. Design the mechanical-load brake and gear train and bearings to be oil-bath lubricated.
- B. Arrange hoist for parallel lug mounting from a 4-wheel geared trolley.

- C. Provide hoist with right angle mounting with H-wheel trolley, motorized as specified and indicated.
- D. Hoist: Standard type.
- E. Hoist: Low headroom type meeting the requirements of ASME B30.16.
- F. Design drum with machine-cut grooves and guarded flanges and with capacity to take entire run of cable in one layer with no overlapping.
- G. Provide hoist with an upper and lower geared limit switch with automatic reset control circuit to prevent overtravel. Settings to be field adjustable in accordance with OSHA 29 CFR 1910.179.
- H. Supply sufficient hoisting cable with hoists for two-part single reeving and to accommodate not only the maximum lift but two additional wraps on drum. Make cable flexible high-strength plowsteel cable with a load safety factor of at least 5 to 1.
- I. Make load block of rugged construction containing a ball-bearing sheave and a high-grade forged-steel swivel hook with antifriction bearings.
- J. Provide control equipment in an enclosed compartment which forms an integral part of hoist and include a transformer for a 120-volt control circuit.

#### 2.05 TROLLEYS:

- A. Motor-Driven Trolleys: Four-wheel type consisting of a fully enclosed electric motor equipped with a magnetic brake, a geared transmission completely enclosed in an oiltight housing and suspended on flanged driving wheels with power to two wheels. Use ball or roller bearings throughout.
- B. Make trolleys designed for operation on beam or rail indicated on drawings. Trolleys to be provided by the hoist manufacturer.

#### 2.06 SWITCHES AND SWING-OUT SECTIONS:

- A. Manufacturers:
  - 1. American Monorail Co.
  - 2. Richards-Wilcox Mfg.
  - 3. ACCO-Louden.
- B. Switches: Glide or sliding type, manually operated. Design transfer mechanisms and locking devices capable of positioning switch to maintain true vertical and horizontal alignment of track and conductors and prevent switch operation when any part of trolley is in switch.

- C. Furnish swing-out sections at roll-up doors as indicated on drawings.
- 2.07 SAFETY STOPS:
- A. Provide safety stops on all open ends of track (or where indicated) to prevent trolley from running off ends or damaging building. Provide stops with capability of withstanding impact imposed by motion of fully loaded hoist and trolley.
- 2.08 TRACK:
- A. Monorail Track: Standard beam of sizes indicated on drawings.
  - B. Shop fabricate all curves for either track or switches to radius indicated.
  - C. Erect track level throughout, with section ends machined fitted and spliced with web-type or other designed couplings to provide flush level connections. Maximum gap between adjacent ends not exceeding 1/16 inch (1.6 mm).
- 2.09 CABLE REELS:
- A. Manufacturers:
    - 1. Gleason Reel Div.
    - 2. Aero-Motive Mfg. Co.
    - 3. Liftech.
  - B. Feed cable reel for electric current supply for all electric hoists with trolleys, except as otherwise indicated, through a single flexible, multi-conductor powercable from a self-winding spring-operated reel located near mid-point of trolley travel or where indicated on drawings.
    - 1. The cable shall have at least [\_\_\_\_] conductors.
    - 2. The reel shall have a fixed base.
    - 3. The reel shall have a swivel base.
    - 4. The reel shall have a roller outlet.
    - 5. The reel shall have a explosionproof Class [\_\_\_\_], Division [\_\_\_\_], Group [\_\_\_\_] enclosure.
    - 6. The reel shall have a weatherproof enclosure.
  - C. Furnish junction box to connect cable reel to power supply circuit with hoist.

## 2.10 ELECTRICAL CONTROLS:

- A. Supply complete integral electrical control system with the electric hoisting equipment (by hoist manufacturer) consisting of starters, circuit breakers, overload relays, limit switches, control transformer for a 120-volt control circuit, control relays, and controlling devices.
- B. Furnish magnetic controls for motors. Design controls to permit "inching" in both forward and reverse directions under full load, automatically regulated acceleration, and rapid brake response.
- C. Provide each hoist with limit switches of automatic-reset control circuit type to prevent overtravel in both raising and lowering directions.
- D. Compliance: Make all electrical equipment including motors, controls, resistors, brakes plus all conduit, wiring, panels, and enclosures with applicable requirements for materials, workmanship, construction, and installation of latest NEMA and National Electrical Code Standards.

## 2.11 MOTORS:

- A. Provide in accordance with Section 26 20 00 and as specified herein.
- B. Motors for Hoists and Trolley: Totally enclosed, reversible, induction motors especially adapted to hoist service.
  - 1. Enclosure: As indicated in the Hoist Schedule.
  - 2. Insulation: Minimum Class "F" with Class "B" temperature rise, 40 degrees C ambient unless otherwise indicated or specified.
  - 3. Service Factor: 1.15.
  - 4. Provide capacity to start and operate hoists at maximum speed rated capacity indicated without exceeding nameplate ratings for current and power and without operating in the service factor.
  - 5. Provide ball or roller bearings, in accordance with ABMA Standard 9 and Standard 11; minimum L-10 life of 100,000 hours.
  - 6. Premium efficient motors, nominal and minimum motor efficiencies per NEMA MG1.
  - 7. Rating: 460V, 3-phase, 60 Hertz.

## 2.12 PUSHBUTTON CONTROL:

- A. Provide pendent pushbutton control station with sufficient pushbuttons to control all operations of hoists and trolley. Clearly mark each pushbutton to indicate its function.

Make cable long enough to reach within 4 feet (1.2 metre) of operating floor or platform level with a supporting chain. If necessary, attach an arm to hoist so that pendent cable and pushbutton controls will hang vertically and be readily accessible from operating positions.

- B. For control of pump building hoist, use a five-step pushbutton station operating magnetic controls to provide automatically regulated acceleration and rapid brake response.
- C. Provide hoist with an upper limit switch of automatic reset control circuit type to prevent overtravel.

#### 2.13 CONDUCTORS AND COLLECTORS:

##### A. Manufacturers:

1. Insul-8-Bar Protected Conductors made by Insul-8-Corp.
2. Safety-T-Bar Conductor Systems made by Howell Corp.
3. Duct-O-Bar Conductor System made by Duct-O-Wire Co.

##### B. Use equipment and accessories approved by Underwriter's Laboratories (UL).

##### C. For conductor for electric current supply use safety type in which conductor is shielded by a molded-plastic cover that surrounds conductor except for a slotted opening shaped to contour of collector head. Provide separate conductor for each phase. (Dual conductors in a single insulating shield are not acceptable.) Make conductor of plated steel or copper designed for carrying maximum anticipated current. Make molded-plastic shield of high dielectric strength, rigid yet sufficiently flexible to permit bending to radius of curves or switches, and resistant to corrosion and deterioration from sunlight or weather. Space insulated supports not over 5 feet (1.5 metre) on straight track and 3 feet (0.9 metre) on curves.

##### D. Provide weather shield for exterior conductors.

##### E. Use collectors of sliding shoe type with an adjustable spring-load arm capable of horizontal or vertical movement to automatically adapt to irregularities of conductor. Set shoe in a molded-plastic head that will prevent external contact with shoe when it is running on conductor. There shall be no exposed bare current-carrying surfaces or wires in collector or arm where shoe is in contact with conductor.

#### 2.14 SHOP PAINTING:

##### A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.

##### B. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer's printed instructions and as specified.

- C. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
- D. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

- A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.
- B. Check horizontal and vertical alignment of track and rails.
- C. Erect rack level throughout, with section ends machined fitted and spliced with web-type couplings to provide flush level connections. Maximum gap between adjacent ends not exceeding 1/16-inch.
- D. Do not use cast fittings.

#### 3.02 FIELD TESTING:

- A. Provide as specified herein. Perform all tests with instrumentation controls and motor controls. Perform testing in accordance with OSHA 29 CFR 1910.179 and as specified herein.
- B. After installation of hoist equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service technician, conduct test for each hoist in presence of the Engineer to determine its ability to operate at rated speeds and capacity under conditions specified and indicated. During tests, observe and record, capacity and motor inputs. Promptly correct or replace all equipment not conforming to the requirements of this section revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results are obtained. Contractor to provide all labor, weights and materials for conducting tests.
  - 1. Provide a 60 minute test for each hoist.
  - 2. Running test shall consist of moving hoist and trolley through two complete cycles. The first cycle will be with no load. For the second cycle, the unit will be loaded with 100 percent of the specified load rating.
  - 3. Test and simulate all limit switches, locking and safety devices.
- C. Make all adjustments to place equipment in specified working order at time of above tests.

- D. After three (3) unsuccessful testing attempts, remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated.

3.03 FIELD TOUCH-UP PAINTING:

- A. After installation and testing, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION



**DIVISION 43 – PROCESS GAS AND LIQUID HANDLING,  
PURIFICATIONS, AND STORAGE EQUIPMENT**

SECTION 43 21 00.20

SELF-PRIMING PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test self-priming pumps, motors, V-belt drives, main control panel, automatic liquid level control system, and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

- 1. B16.1: Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250)
- 2. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

B. ASTM International (ASTM):

- 1. A36/A36M: Standard Specification for Carbon Structural Steel.
- 2. A48/A48M: Standard Specification for Gray Iron Castings.
- 3. A322: Standard Specification for Steel Bars, Alloy, Standard Grades.
- 4. A743/A743M: Standard Specification for Castings, Iron-Chromium, Iron-Chromium Nickel, Corrosion Resistant, for General Application.
- 5. A897/A897M: Standard Specification for Austempered Ductile Iron Castings

C. Hydraulic Institute (HI):

- 1. Current Standards.
- 2. 14.6: Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

D. National Electrical Manufacturers Association (NEMA):

- 1. MG1: Motors and Generators.

E. Underwriter's Laboratory Inc. (UL):

- 1. UL-508A Electrical Industrial Control Panels

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding pump and motor characteristics and performance:
  - a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, lift, priming time, efficiency and NPSH<sub>r</sub>.
    - (1) For units of same size and type, provide curves for a single unit only.
  - b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR) and preferred operating range (POR).
  - c. Results of shop performance tests as specified.
  - d. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch (A4) sheets, one curve per sheet.
2. Characteristic curves for constant speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide NPSH<sub>r</sub> curve for each speed.
3. Shop drawing data for accessory items.
4. Certified setting plans, with tolerances, for anchor bolts.
5. Manufacturer's literature as needed to supplement certified data.
6. Operating and maintenance instructions and parts lists.
7. Listing of reference installations as specified with contact names and telephone numbers.
8. Certified results of hydrostatic testing.
9. Certified results of dynamic balancing.
10. Bearing temperature operating range for the service conditions specified.
11. List of recommended spare parts other than those specified.
12. Shop and field inspection reports.

13. Bearing Life: Certified by the pump manufacturer. Include design data.
14. Pump shop test results.
15. Motor shop test results.
16. Qualifications of field service engineer.
17. Recommendations for short and long-term storage.
18. Resonant frequency analysis.
19. Shop and field testing procedures, pump and piping set up, equipment to be used and ANSI/HI testing tolerances to be followed.
20. Special tools.
21. Number of service person-days provided and per diem field service rate.
22. Results of field vibration test data including a vibration signature for each pump and drive assembly. Provide vibration testing procedure for review.
23. Recommended location of suction and discharge pressure gauges.
24. Manufacturer's product data, specifications and color charts for shop painting.
25. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
26. The latest ISO 9001 series certification.
27. Provide a scaled drawing for each pump service showing the pumps, motors, hoists and bridge cranes including equipment weights, lifting attachments, slings and clearances for equipment removal and maintenance.
28. Material Certification:
  - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

- b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
29. Main control panel
- a. Elevation of main control panel and operator control station showing panel mounted devices. Provide details of power distribution and full load current draw of panel. Provide list of all terminations required to receive inputs or a transmit input from the main control panel.
  - b. Catalog sheets for devices in the main control panel.
  - c. Manufacturer's standardized elementary diagrams will not be accepted unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.
  - d. Complete wiring diagrams, written process instrumentation and control sequence descriptions, control panel layout drawings, and control schematics, including required coordination with other electrical control devices operating in conjunction with the system and suitable outline drawings to facilitate interconnections with other equipment, shall be furnished for approval before proceeding with manufacture.
  - e. O&M manual shall be provided with complete ladder logic program documentation including rung comments, and coil/contact cross-references.
- B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.
- 1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
- 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
  - 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in

submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

- A. Comply with the requirements specified in Section 011006.
- B. Provide spare parts that are identical to and interchangeable with similar parts installed.
  - 1. For each pump:
    - a. One complete set of gaskets and O-rings.
    - b. One mechanical seal repair kit or complete mechanical seal.
    - c. One shaft sleeve.
  - 2. For each set of pumps of the same size and performance.
    - a. One set of all special tools required.
    - b. One wear plate.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00.
- B. Pumps shall be the product of one manufacturer.
- C. Equipment components and devices shall be UL labeled.
- D. Provide UL 508 certified control panels.
- E. Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.
- F. Welding: In accordance with latest applicable American Welding Society Code or equivalent.
- G. Shop tests as specified.
- H. The Contractor shall obtain the pumps, motors, V-belt drives and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

- I. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.
- J. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
  - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
  - 2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
    - a. [ ] person-days.
  - 3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
    - a. [ ] person-days.
  - 4. Performance Testing: Field performance test equipment specified.
    - a. [ ] person-days.
  - 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
    - a. [ ] person-days.
  - 6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
  - 7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- K. Manufacturer of pumps shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.
- L. If equipment proposed is heavier or taller, different rotation, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 011006.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

- A. Pump capacities and operating data are indicated in the Process Pump Schedule.
- B. Raw Wastewater Pumps: Pump raw wastewater from wet wells.
- C. Equipment Limitations:
  1. Pumps: 2
    - a. Maximum Total Pump Weight with motor: 1968 lbs. (893 kg)
    - b. Maximum Rotating Assembly Weight: 1370 lbs. (622 kg)
    - c. Maximum Pumping Assembly Length x Width, with motor: 70 in. (1778 mm)
- D. Coordinate pump dimensions and weights with hoists and bridge cranes as specified in Sections 41 22 23.19 and 41 22 13.13 respectively and as indicated.
- E. Pumps normally operate with a suction lift as indicated in the Process Pump Schedule.
- F. Design pumps so that future conditions specified can be achieved by:
  1. Installation of future pumps, motors and V- belt drives.
  2. Provide bases capable of mounting future motors and pumps without changes to bases.

2.02 MANUFACTURERS:

- A. Self-Priming Pumps
  1. Gorman Rupp



2.03 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.
- B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.
- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 PUMP CONSTRUCTION:

- A. Pumps: Self-Priming, single-stage, centrifugal pumps. Driven as indicated in the Process Pump Schedule.
- B. Design and proportion all parts of pump specially adapted for the service specified and indicated and capable of pumping unscreened raw wastewater, grit, plastics, grease and hair balls, without plugging.
- C. Pump Baseplates:
  - 1. Mount each pump and drive on a common base.
    - a. Material: ASTM A36 fabricated structural steel.
    - b. Provide structural steel shape bases, bent form bases are not acceptable.
    - c. Provide bases with provisions for grouting and for anchor bolts.
    - d. Design baseplates to support pump and driver.
    - e. Provide planed surfaces of bearing pads for pumps and drives.
    - f. Provide a minimum one 4-inch grout hole or equal in top and provisions for anchor bolts.
- D. Check Valves: Suction, internal to pumps.
  - 1. Molded neoprene with steel and nylon reinforcing.
- E. Pump Casing:
  - 1. Casing:

- a. ASTM A48 Class 30 cast iron.
  - (1) Provide ceramic lining of all wetted surfaces except impeller and wear plate.
    - (a) Cured Properties
    - (b) Hardners (Shore D): 85
    - (c) Tensile Strength: 6500 psi (45 MPa)
- b. Centerline discharge.
- c. Back pull-out design.

2. Suction and Discharge Connections:

- a. Flanges faced and drilled in accordance with 125-lb. ANSI B16.1 (PN16).
- 3. Provide casings for removal of rotating parts without disconnecting suction and/or discharge piping.
  - 4. Provide lifting devices on casings as required for ease of handling.
  - 5. Provide ribs or reinforcing if required to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust and to support the motor.
  - 6. Provide components with machined registered concentric shoulder fits to ensure precision alignment.
  - 7. Fit high point of casing with an air vent and low point with a drain.

F. Main Frame:

- 1. ASTM A48 Class 30 Cast iron.
- 2. Fit to casing with machine-faced joints.
- 3. Design main frame heavy and rigid so as to resist safely and without distortion, all stresses due to impeller thrust and bearing loads.
- 4. Design pump main frame to support shaft and impeller and to contain stuffing box and bearings.

G. Bearings:

- 1. Outboard bearing to be combination thrust and radial type; inboard bearing radial type.

2. Provide bearings in a dust and moisture proof enclosures.
3. Provide bearings with minimum L-10 life rating of 100,000 hours at specified operating conditions and 40,000 hours minimum at 25 percent of the BEP at highest speed, based on latest ABMA and ANSI Standards.
4. Oil lubricated with dedicated reservoir.
  - a. Provide the bearing cavity with an oil level sight gauge and fill plug check valve.
  - b. Provide the clear sight gauge monitoring the bearing cavity oil level and condition of oil without removal of the fill plug check valve.
  - c. Provide the check valve to vent the cavity but prevent introduction of moist air to the bearings.

#### H. Pump Shaft:

1. AISI4140 alloy steel, accurately machined.
2. Protect shaft from wear at stuffing box and from contact with pumped liquid by removable and replaceable sleeve.
3. Sleeves:
  - a. Extend sleeves through stuffing box.
  - b. AISI 4130 alloy steel

#### I. Mechanical Seal:

1. Cartridge oil lubricated mechanical type.
2. Stationary and Rotating Seal Faces: Tungsten titanium carbide alloy.
3. Provide each mating surface lapped to within three light bands flatness (35 millionths of an inch (889 Nm)), as measured by an optical flat under monochromatic light.
4. Stationary Seal Seat: Double floating by a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock.
5. Elastomers: Viton
6. Cage and spring: Type 316 stainless steel.
7. Lubrication: Oil lubricated from a dedicated reservoir.

- a. Provide the seal cavity with an oil level sight gauge and fill/vent plug.
- b. Provide a clear sight gauge monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

J. Impeller:

1. Impeller Type: Semi-open solids handling.
2. Material:
  - a. ASTM A536 Ductile Iron and AISI 1015 HRS wear plate
3. Statically and dynamically balance each impeller.
4. Provide external adjustment of impeller face clearance

K. Handhole Cleanout Access Cover:

1. Provide a removable casing front cover for access to the impeller and mechanical seal.
2. Provide a handhole cover for access to the internal check valve.
3. Provide covers removable without the use of tools and removable without disturbing the suction and discharge piping.
4. Shape interior surface of covers to maintain contour of interior of casing so as to maintain efficiency and to prevent lodging of solids.
5. Gaskets: Neoprene or Buna-N

2.05 V-BELT DRIVE:

- A. Drive Safety Factor: 1.50 based on motor nameplate rating.
- B. Provide Type 316 stainless steel OSHA safety guard with Type 316 stainless steel hardware and lifting attachments for handling.
- C. Minimum drive efficiency: 95 percent.
- D. Provide in-line type arrangement with motor mounted in-line with the pump but above the centerline pump on a fabricated steel drive stand. Provide a mounting plate with a minimum of four (4) Type 316 stainless steel bolts for tensioning and adjustment of the drive position.
- E. Provide pump and V-belt drive side by side on a common baseplate arrangement. Provide separate, adjustable motor base so that the motor can be easily moved for V-belt

tensioning and adjustment and provide with Type 316 stainless steel bolts for tensioning and adjustment of the drive position.

F. Provide guards for protection for personnel, conforming to OSHA requirements.

1. Guards and Hardware: Type 316 stainless steel.

## 2.06 MOTORS:

A. Provide in accordance with Section 26 20 10 and as specified and indicated.

B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.

C. Motor enclosure and motor speed: As indicated in the Process Pump Schedule.

D. Provide motors for horizontal pumps with mounts for bolting to baseplate.

E. In addition to the requirements for bearings specified under Electric Motors in Section 26 20 10, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

F. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet (1 meter) from motor.

G. Operate without overheating at the speeds specified and indicated.

H. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

I. Rating: 460V, 3-phase, 60 Hertz.

J. Insulation: Class F with Class B temperature rise, 40 degree C ambient.

K. Site Altitude: Less than 3,300 feet (1,000 metres) above sea level.

L. Provide Inpro/Seal bearing isolators.

## 2.07 DRAIN AND VENT PIPING:

A. Provide drains from stuffing box and casing vent and drain piping and valves to discharge into gutters or sumps as indicated and as directed by the Engineer.

B. Drain and vent piping: Schedule 10 Type 316L stainless steel with Pressfit connections or Schedule 40 Type 316L stainless steel with socket welded connections. Provide a sufficient number of unions to permit removal of each valve and in-line device.

- C. Provide pipe and fittings in accordance with Section 40 23 19.04 and as indicated.
  - D. Valves: Provide size and type as indicated and in accordance with Section 40 23 13.01.
- 2.08 GAUGES:
- A. Provide gauges assemblies for suction and discharge of each pump in accordance with Section 40 23 19.04 and as indicated.
  - B. Suction Gauges: compound type with operating range at approximately point of the gauge range.
    - 1. Scale: inches Hg to psi (mm Hg to kPa)
  - C. Discharge gauges: Provide standard range with top limit above pump shutoff head at maximum pump speed.
    - 1. Scale: psi (kPa)
- 2.09 ELECTRICAL CONTROL COMPONENTS
- A. Provide NEMA 1 enclosure sized to contain equipment specified herein. Doors shall be hinged and sealed with a neoprene gasket and equipped with captive closing hardware.
  - B. Short Circuit Rating: 65kAIC minimum.
  - C. Rating: 480VAC, 3PH
  - D. Circuit Breakers
    - 1. Provide a circuit breaker for each pump motor. The circuit breakers must be sealed by the manufacturer after calibration to prevent tampering.
    - 2. Provide a main disconnecting circuit breaker with through the door handle. Provide the main circuit breaker with an interlock to prevent opening the enclosure doors while the circuit breaker is in the ON position.
  - E. Solid State Soft Starter
    - 1. Provide a reduced voltage, solid state motor starter for each pump motor. Starting modes shall be selectable soft start, current limit, or full voltage.
    - 2. Bypass: When the start ramp time is complete, the starter shall energize an integral bypass contactor. When in the bypass mode, the bypass contactor shall carry the motor load to minimize internal heating in the electrical enclosure.
    - 3. Protection: The starter shall include protective features: Communication fault, control temperature, excess starts/hour, stall, jam, line fault, open gate, overload,

overvoltage, phase reversal, power loss, underload, undervoltage, shorted SCR, open bypass and voltage unbalance.

4. An integral electronic overload relay equipped with thermal memory shall be included and shall utilize three phase current sensing.
5. Display: The starter shall include a keypad and display on the front of the control module. Metering capabilities shall include: Three phase current, three phase voltage, power factor, motor thermal usage, wattmeter, kilowatt hours, and elapsed time meter.
6. Door Mounted Display: Each starter shall be furnished with a display and keypad mounted to the door of the control panel. The door mounted display will duplicate the functions of the starter display and allow the operator to monitor or change parameters without opening the control panel door.

#### F. Phase Monitor

1. The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, low voltage, and voltage unbalance. An integral time delay shall be provided to minimize nuisance trips.

#### G. Surge Protection Device (SPD)

1. The control panel shall be equipped with a modular surge arrester to minimize damage to the pump motors and control from transient voltage surges. The suppressor shall utilize thermally protected, heavy duty zinc oxide varistors encapsulated in a non-conductive housing. Mechanical indicators shall be provided on each phase to indicate protection has been lost. The suppressor shall have a short circuit current rating of 200,000 Amps and a Maximum Discharge current rating (Imax) of 40,000 Amperes. Nominal discharge current (In) is 20,000 Amperes. Surge arrester according to UL 1449 3rd Edition, Type 2 component assembly.

#### H. Control Circuit

1. Provide an integral control power transformer to step down the 480VAC to 120VAC for controls. The primary and secondary side of the transformer to be protected by a thermal magnetic circuit breaker, sized to meet the power requirements of the transformer.
2. A normal duty thermal magnetic circuit breaker shall protect all control circuits by interrupting control power.
3. Pump mode selector switches shall permit manual start or stop of each pump individually, or permit automatic operation under control of the liquid level control

system. Manual operation shall override all shutdown systems, except the motor overload relays.

4. Control logic shall be accomplished using a programmable logic controller (PLC). Programmable controls shall operate on 120VAC power and be equipped with 120VAC inputs and hard contact outputs.
5. Operator interface equipment shall be provided to permit field adjustment of the programmable control timers and counters and shall be mounted on the control panel with other operator controls and displays.
6. The program logic shall be stored in battery backed random access memory, as well as on a programmable, read only memory module. The memory module shall be included to facilitate field repair or replacement of the programmable control hardware.
7. The control shall be pre-programmed or wired to provide the following routines:
  - a. Pump alternation at lead stop
  - b. Excessive pump run time alternation (1-9999 minutes)
  - c. Jump to idle pump/drive on lead failure
  - d. Pump start delays after power restoration
  - e. Flashing alarm/steady acknowledge on all alarm pilot lights
  - f. Station trouble alarm (115vac and normally open dry contact)
  - g. High and low level alarms
  - h. Pump high temperature shutdown
  - i. Motor high temperature
8. The control system shall be equipped with the dry contacts wired to the terminal blocks as shown in the Contract Drawings.
9. Provide a hard wired interlock to shutdown the pumps on high pump temperature as sensed by the integral pump protections.
10. A duplex ground fault receptacle providing 115 VAC, 60 Hz, single phase current, will be mounted on the side of the control enclosure.
11. Equipment Marking
  - a. Provide a UL 508A Listed and Labeled Control Panel.



- b. Control components, switches, indicators, and instruments mounted through the control panel door shall be labeled to indicate function.

## 2.10 LIQUID LEVEL CONTROL

- A. The level control system shall be capable of operating as an air bubbler type level control system and backup high and low level floats.
- B. The level control system shall utilize alternation to select first one pump, then the second pump, to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle, or in the event of excessive run time.
- C. The level control system shall utilize an electronic pressure switch which shall continuously monitor the wet well level, permitting the operator to read wet well level at any time. Upon operator selection of automatic operation, the electronic pressure switch shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the electronic pressure switch shall stop this pump. These actions shall constitute one pumping cycle. These levels shall be adjustable as described below.
  - 1. The electronic pressure switch shall include integral components to perform all pressure sensing, signal conditioning, EMI and RFI suppression, DC power supply and 120 volt outputs. Comparators shall be solid state, and shall be integrated with other components to perform as described below.
  - 2. The electronic pressure switch shall be capable of operating on a supply voltage of 12-24Vdc in an ambient temperature range of 10 degrees C (14 degrees F) through 55 degrees C (131 degrees F). Ingress Protection of IP56 for indoor use with closed cell neoprene blend gasket material. Evaluated by Underwriters Laboratories for Pollution Degree 2 device for U.L. and cU.L. Control range shall be 0 to 33.3 feet of water with an overall repeat accuracy of (plus/minus) 0.1 feet of water. Memory shall be non volatile. A Battery backed real time clock shall be standard.
  - 3. Eleven optically isolated, user defined digital inputs for pump and alarm status. Rated at 10mA at 24Vdc. Eight digital output relays (mechanical contacts), configurable for pump start/stop or alarms. Three relays rated at 12 Amp @ 28Vdc and 120Vac, five relays rated at 3 Amp @ 30Vdc and 120Vac. The electronic pressure switch shall consist of the following integral components: pressure sensor, display, electronic comparators, digital inputs and digital output relays.
    - a. The internal pressure sensor shall be a strain gauge transducer and shall receive an input pressure from the air bubbler system. The transducer shall convert the input to a proportional electrical signal for distribution to the display and electronic comparators. The transducer output shall be filtered to prevent control response to level pulsations or surges. The transducer range shall be 0-14.5 PSI, temperature compensated from -40 degrees C (-40

- degrees F) through 85 degrees C (185 degrees F), with a repeat accuracy of (plus/minus) 2.5% full scale about a fixed temperature. Transducer overpressure rating shall be 3 times full scale.
- b. The electronic pressure switch shall incorporate a digital back lighted LCD panel display which, upon operator selection, shall indicate liquid level in the wet well, and pump status indication for up to 2 pumps. The display shall include a 128 x 64 bit resolution LCD to read out directly in feet of water, accurate to within one tenth foot (0.1 foot), with a full scale indication of not less than 12 feet. The display shall be easily convertible to indicate English or metric units.
  - c. Level adjustments shall be electronic comparator set points to control the levels at which the lead pump starts and stops. Each of the level settings shall be easily adjustable with the use of membrane type switches, and accessible to the operator without opening any cover panel on the electronic pressure switch. Controls shall be provided to permit the operator to read the selected levels on the display. Such adjustments shall not require hard wiring, the use of electronic test equipment, artificial level simulation or introduction of pressure to the electronic pressure switch.
  - d. Each digital input can be programmed as pump run, pump HOA, pump high temp, pump moisture/thermal, starter failure (RVSS), and phase failure. Inputs are used for status and alarm indication.
  - e. Each output relay in the electronic pressure switch shall be hard contact mechanical style. Each relay input shall be optically isolated from its output and shall incorporate zero crossover switching to provide high immunity to electrical noise.
- 4. The electronic pressure switch shall be equipped with alarm banners with time and date history for displaying alarm input notification. Alarm history will retain a 16 of the most recent alarm events.
  - 5. The electronic pressure switch shall be equipped with pump start/stop and alarm input delay(s) that have an adjustable delay set points.
  - 6. An Antiseptic function with a built in timer shall be incorporated in the electronic pressure switch to prevent the well from becoming septic.
  - 7. The electronic pressure switch shall be capable of jumping to next available pump if current pump is out of service due to pump failure or manual selection. Circuit design in which application of power to the lag pump motor starter is contingent upon completion of the lead pump circuit shall not be acceptable.
  - 8. The electronic pressure switch shall be capable of calculating and displaying pump elapse run time. The elapse run time is resettable and adjustable.

9. The electronic pressure switch shall have internal capability of providing automatic simplex and duplex alternation, manual selection of pump sequence operation, and alternation in the event of 1-24 hours of excessive run time.
  10. The electronic pressure switch shall be equipped with a security access code to prevent accidental set up changes and provide liquid level set point lock out. The supervisor access code is adjustable.
  11. The electronic pressure switch shall be equipped with one (1) 0-33 ft. W.C. input, one (1) scalable analog input of either 0-5Vdc, or 4-20mA, and one (1) scalable analog output of either 0-5Vdc, 0-10Vdc or 4-20mA. Output is powered by 10-24Vdc supply. Load resistance for 4-20mA output shall be 100-1000 ohms.
  12. The electronic pressure switch shall include a DC power supply to convert 120Vac control power to 12 or 24Vdc power. The power supply shall be 500 mA (6W) minimum and be UL listed Class II power limited power supply.
  13. The electronic pressure switch shall be equipped with an electronic comparator and mechanical output relay to alert maintenance personnel to a high or low liquid level in the wet well. An alarm banner, visible on the front of the controller, shall indicate that a high or low wet well level exists. The alarm signal shall be maintained until the wet well level has been lowered or raised, and the circuit has been manually reset. High or low water alarm shall be furnished with a dry contact wired to terminal blocks. A low liquid level condition shall disable all pump motors. When the wet well rises above the low level point, all pump motors shall be automatically enabled.
  14. Analog Output circuit will be furnished with transient voltage surge suppression to protect related equipment from induced voltage spike from lightning.
- D. An alarm silence pushbutton and relay shall be provided to permit maintenance personnel to de-energize the audible alarm device while corrective actions are under way. After silencing the alarm device, manual reset of the alarm condition shall clear the alarm silence relay automatically. The pushbutton shall be a membrane style button integral to the level controller.
- E. Air Bubbler System
1. The level control system shall be the air bubbler type, containing air bubbler piping which extends into the wet well. A pressure sensor contained within the electronic pressure switch shall sense the air pressure in this piping to provide wet well level signals for the remainder of the level control system.
  2. Two vibrating reed, industrial rated, air pumps shall be furnished to deliver free air at a rate of approximately 5 cubic feet per hour and a pressure not to exceed 7 psi. Liquid level control systems utilizing air compressors delivering greater quantities of air at higher pressures, requiring pressure reducing valves, air storage reservoirs, and other maintenance nuisance items will not be acceptable. A

selector switch shall be furnished to provide manual alternation of the air pumps. The switch shall be connected in such a manner that either pump may be selected to operate continuously. The selector switch shall be oil tight design with contacts rated NEMA A300 minimum.

3. An air bell constructed of PVC 3 inches in diameter shall be provided for installation at the outlet of the air bubbler line in the wet well. The air bell shall have a 3/8" NPT tapped fitting for connection to the bubbler line.
4. An air flow indicator gauge shall be provided and connected to the air bubbler piping to provide a visual indication of rate of flow in standard cubic feet per hour.

#### 2.11 SHOP PAINTING:

- A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.
- B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
- C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

#### 2.12 SHOP TESTING:

- A. Comply with the requirements specified in Section 011006 and as specified herein.
- B. Provide motor shop testing in accordance with Section 26 20 10.
- C. Pump Tests:
  1. Test pump casings under a hydrostatic head of at least 75 psi (500 kPa) or 150 percent of rated shutoff head, whichever is greater. Test casing with pump assembled.
  2. Provide certified performance tests as specified herein for all pumps and spare rotating assemblies except those specified to be witness tested.
  3. Certified performance.
    - a. Run pump at full speed rating point for 60 minutes prior to start of any testing.
    - b. Full speed tests:
      - (1) Test pumps at the conditions specified and indicated and take not less than seven operating points between shut-off and run out. Test points must be at the conditions specified and indicated.

- (2) Take readings to determine flow, differential pressure, rpm, horsepower, priming time and efficiency.
      - (3) Operate each pump for not less than one hour and take readings to determine that the pump will operate as specified and indicated without cavitation at the specified maximum lift condition with not more than the specified NPSH available. Test with the job submergence as indicated.
    - c. Factory tests on pumps:
      - (1) Use witness tested job motors that are shipped to the pump testing facility for use in these pump tests.
      - (2) Use factory calibrated test drives.
    - d. Provide a reprime test for each size pump and service.
    - e. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.
  4. Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.
  5. Testing Acceptance Grade and Tolerances:
    - a. ANSI/HI 14.6 Acceptance Grade: 1U.
    - b. Efficiency Tolerance: -0 percent.
    - c. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.
  6. In the event that specified tests indicate that pump or motor will not meet specifications, Engineer has the right to require additional complete witnessed tests for all pumps and motors at no additional cost to the Owner.
  7. Repeat tests until specified results are obtained.
  8. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
  9. When pump witness performance testing is specified, provide roundtrip airfare, all transportation and lodging for witness testing for two (2) people. If air travel is more than 6 hours provide business class airfare.

D. Control Panel

1. The pump station control panel will be tested as an integral unit by the pump station manufacturer. The control panel shall also be tested with the pump station as a complete working system at the pump station manufacturer's facility.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION:

- A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.
- B. Install pumping units on a concrete pad and align thereon.
  1. Coupling halves must be disconnected and only reconnected after alignment.
  2. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.
- C. Horizontal pumps: Dowel pump and drive to baseplate after alignment in field to facilitate realignment after disassembly.
- D. Final Coupling Alignment:
  1. Perform only after base is installed and piping is connected and pump nozzle connections tested in accordance with paragraph 3.02.
  2. If realignment is required piping must be disconnected prior to alignment, piping reconnected and alignment checked prior to connecting coupling halves.
- E. After alignment is correct, grout using high grade non-shrink grout.
  1. For horizontal pumps fill entire base and leave no gaps or voids.
  2. Do not imbed leveling nuts in grout.

#### 3.02 FIELD TESTING:

- A. Comply with the requirements specified in Section 011006 and as specified herein.
- B. Test piping connections to prove the pump nozzle are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. This must be performed and the piping acceptable prior to any field performance testing.
- C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 01 for checklist.

- D. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each pump in presence of the Engineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.
1. During tests, observe and record head, capacity, pump bearing housings and motor bearing temperature, noise and vibration and motor inputs.
    - a. Provide vibration signature test data for each pump and drive assembly.
      - (1) Limit: 50 percent of ANSI/HI allowable limits.
    - b. Bearing Temperature: Bearing temperature not to exceed 180 degrees F (82 degrees C).
    - c. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.
  2. Run each pump for minimum four hours prior to taking temperature readings of the pumps, motors, and shafting.
  3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
  4. Repeat tests until specified results are obtained.
  5. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.
    - a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.
    - b. All calibrations must be within 30 days of the field testing.
    - c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.
    - d. Contractor is responsible for delivery and disposal of water used for testing.
- E. Make all adjustments necessary to place equipment in specified working order at time of above tests.
- F. Test pump on product only. If product is not available, test with water. Water for testing furnished by Contractor.

- G. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING:

- A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION



**DIVISION 44 – POLLUTION CONTROL EQUIPMENT**

SECTION 44 42 26.03

CHANNEL GRINDERS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test channel grinders, controls and appurtenances as indicated and specified.

1.02 REFERENCES:

A. ASTM International (ASTM):

- 1. A36: Standard Specification for Carbon Structural Steel.
- 2. A351: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
- 3. A536: Standard Specification for Ductile Iron Castings.

B. American National Standards Institute (ANSI):

- 1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

C. National Electrical Manufacturers Association (NEMA):

- 1. MG1: Motors and Generators.

D. Society of Automotive Engineers (SAE):

- 1. 660: Bearing Bronze.

E. Underwriters' Laboratories (UL):

- 1. 508: Industrial Control Equipment.

1.03 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00.

- 1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.
- 2. Data regarding grinder, screen drum, gear reducer and motor characteristics and performance:

- a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop or field tests of mechanically duplicate grinders, showing they meet indicated and specified requirements for capacity, pressure drop and horsepower.
    - (1) For units of same size and type, provide curves for a single unit only.
  - b. Results of shop performance tests as specified.
  - c. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch (A4) sheets, one curve per sheet.
3. Shop drawing data for accessory items.
  4. Certified setting plans, with tolerances, for anchor bolts.
  5. Manufacturer's literature as needed to supplement certified data.
  6. Operating and maintenance instructions and parts lists.
  7. Listing of reference installations as specified with contact names and telephone numbers.
  8. Bearing temperature operating range for the service conditions specified.
  9. List of recommended spare parts other than those specified.
  10. Shop and field inspection reports.
  11. Bearing Life: Certified by the grinder manufacturer. Include design data.
  12. Grinder shop test results.
  13. Motor shop test results.
  14. Qualifications of field service engineer.
  15. Recommendations for short and long-term storage.
  16. Shop testing procedures and equipment to be used including the details of all equipment and testing set up.
  17. Field testing procedures and equipment to be used including the details and calibration certificated of all equipment and portable flow meter locations.
  18. Special tools.
  19. Number of service person-days provided and per diem field service rate.

20. Schematic control and power wiring diagrams.
  21. Manufacturer's product data and specifications for painting.
  22. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
  23. The latest ISO 9001 series certification or quality system plan.
  24. Material Certification:
    - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
    - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
  25. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.
    - a. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
- B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
  2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in

submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

- A. Provide in accordance with Section 011006 and as specified herein.
- B. Provide spare parts that are identical to and interchangeable with similar parts installed.
  - 1. For each grinder:
    - a. One complete set of gaskets.
    - b. One set of cutters
    - c. One set of spacers
  - 2. For each set of grinders of the same size and performance.
    - a. One set of all special tools required.
  - 3. Provide spare rotating assemblies as indicated.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in Section 01 43 00 and as specified herein.
- B. Channel grinders and control panels shall be the product of one manufacturer.
- C. Channel grinders shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.
- D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.
- E. Shop tests as specified.
- F. The Contractor shall obtain the channel grinders, motors, gear reducers and controls, from a single grinder manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.
- G. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.
- H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
  2. Installation: Inspect location of anchor bolts; pump setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections:
    - a.  person-days.
  3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
    - a.  person-days.
  4. Performance Testing: Field performance test equipment specified.
    - a.  person-days.
  5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
    - a.  person-days.
  6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
  7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- I. Manufacturer of channel grinders shall have a minimum of ten (10) operating installations with channel grinders of the size specified and in the same service as specified operating for not less than five (5) years.
  - J. If equipment proposed is heavier or taller, different rotation, or discharge arrangement than specified and indicated; provide all structural, architectural and mechanical revisions at no additional cost to the Owner.
- 1.06 DELIVERY, STORAGE AND HANDLING:
- A. Comply with the requirements specified in Section 011006 and as specified herein.

## PART 2 - PRODUCTS

### 2.01 SYSTEM DESCRIPTION:

- A. Channel grinder capacities and operating data are indicated in the Channel Grinder Schedule in this specification.
- B. Raw Wastewater: Grinders will be upstream of wet well and pump suctions.
- C. Equipment Limitations:
  - 1. Channel Grinders: [ \_\_\_\_\_ ]
    - a. Maximum Grinder Capacity: 4792 gpm (302L/s)
    - b. Maximum Grinder Headloss: 50 in. (1270mm) of water column
    - c. Maximum Assembly Weight: 2300 lbs. (1043 kg)
    - d. Maximum Assembly Height: 60 in. (1524 mm)
    - e. Number of Screen Drums: 2
  - 2. Coordinate channel grinder dimensions and weights with hoists and bridge cranes as specified in Sections 41 22 23.19 and 41 22 13.13.

### 2.02 MANUFACTURERS:

- A. Franklin Miller.

### 2.03 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.
- B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.
- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

### 2.04 CHANNEL GRINDER CONSTRUCTION:

- A. General:

1. Type:
  2. Vertical with two counter-rotating shafts, where one cutter stack intermeshes with a second one which has a much larger diameter. Grinder is provided with submersible motor, explosion-proof, 3-phase motor. Capable of operating with or without flow and without an external water source.
- B. Housing and Cover:
  1. End Housing and Top Cover Material: ASTM A536 Ductile Iron.
  - 2.
  3. Side Rails:
    - a. Material: ASTM A536 Ductile Iron.
    - b. Provide side rails with UHMW sealing strip to create an adjustable interface between side rails and rotating drum.
- C. Cutters and Spacers:
  1. Materials:
    - a. Cutters: AISI 4140 Heat-treated alloy steel, Hardness Rockwell C 45-49.
    - b. Spacers: AISI 4130 alloy steel, Hardness Rockwell C 45-49.
  2. Provide a cutter cartridge and drive assembly that is removable from the housing as a complete unit.
  3. Provide cutters with 7 cam shaped teeth
- D. Shafts:
  1. Material: AISI 4140 heat treated hexagon steel.
  2. Shaft shall measure a nominal 2 inch (51 mm) across flats of hex.
- E. Nominal tensile strength rating of 180,000 PSI (1241.1 MPa). Bearings and Seals:
  1. Materials:
    - a. Seal Faces: Tungsten Carbide with 6 percent nickel.
    - b. O-Rings: Buna-N (Nitrile).
  2. Seal cartridges which require flushing or lubrications are not acceptable.



3. Radial and axial loads shall be supported by sealed, oversized, deep-groove ball bearings.

F. Frame and Supports:

1. Material: AISI 304 Stainless Steel.

G. Driver:

1. Provide grease lubricated speed reducers.

H. Controllers:

1. Provide a programmable logic controller (PLC) with ladder logic programming.
2. Provide thermal motor overload protection and single phase protection.
3. Furnish all controls for operation of unit, circuit breaker, motor starter, control transformer, pushbuttons and relays.
4. Provide the following control functions:
  - a. Grinder On-Off-Remote switch.
  - b. Screen Drum On-Off-Auto switch.
  - c. Start/Stop pushbutton.
  - d. Reset pushbutton
  - e. Motor heater coils as an integral part of an adjustable overload relay.
5. Jam Condition:
  - a. When a grinder jam condition occurs, design controller to stop the grinder and reverse its rotation. If the jam is cleared the controller will return to normal operation.
  - b. If three (3) grinder reverses occur within a 30 second interval, design controller to stop the grinder motor and activate the grinder fail indicator and relay.
  - c. When a screen drum jam condition occurs, design controller to stop the screen drum and reverse its rotation. If the jam is cleared, the controller will return to normal operation.
  - d. If two (2) screen drum reverses occur within a 30 second interval, design controller to stop the screen drum motor and activate the fail indicator and relay. The grinder and other screen shall continue to operate.

6. Power Failure:
  - a. If while the grinder and screen drum(s) are running, the grinder and screen drum(s) shall resume running when power is restored.
  - b. If the grinder and/or screen drum(s) are stopped due to a fail condition and a power failure occurs, the fail indicator shall reactivate when power is restored.
7. Provide one free digital input and one output each capable of interfacing with the monitored functions and full programmable capabilities of the PLC.
8. Provide the following indicating lights:
  - a. Power on
  - b. Each overload/Fail
  - c. Grinder Run
  - d. Screen Drum Run
  - e. Each maintenance condition.
9. Provide momentary contact stop/Reset and Start pushbuttons.
10. Provide an auxiliary overload relay for remote, overload and/or alarm indication.
11. Enclosure:
  - a. NEMA 4X.
  - b. For panels located within structures provide fiberglass reinforced polyester or Type 316L stainless steel. For panels located outside provide Type 316L stainless steel.
  - c. Hardware: Type 316 stainless steel.
  - d. Comply with U.L. 508 Standards.
12. Provide a reversing motor starter, full voltage reversing type.
13. Provide lamp test button.

2.05 MOTORS:

- A. Provide in accordance with Section 26 00 00 and as specified and indicated.

- B. In addition to the requirements for bearings specified under Electric Motors in Section 26 00 00, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.
- C. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet (1 meter) from motor.
- D. Operate without overheating at the speeds specified and indicated.
- E. Service Factor: 1.15.
- F. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.
- G. Rating: 460V, 3 PH, 60 Hz.
- H. Insulation: Class F with Class B temperature rise, 40 degrees C ambient.
- I. Site Altitude: Less than 3,000 feet above sea level.

2.06 SHOP PAINTING:

- A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.
- B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
- C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.07 SHOP TESTING:

- A. Provide in accordance with Section 011006 and as specified herein.
  - 1. Provide motor shop testing in accordance with Section 26 20 00 .
- B. Grinder and Screen Drum Tests:
  - 1. Test casings under a hydrostatic head of at least 75 psi (5 bar).
  - 2. Test all functions of each controller.
  - 3. Repeat tests until specified results are obtained.
- C. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2.08 CHANNEL GRINDER SCHEDULE:

A. Service: Raw Wastewater

Tag Numbers:	RWW.GR-1
Location:	Grinder Wet Well
Solids Concentration:	0.75 percent to 2 percent
Design Flow, MGD:	5.6
Pressure Drop, max, inches @ design flow:	38
Grinder Motor HP:	5
Motor Enclosure:	Squirrel cage

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install items in accordance with manufacturer's printed instructions, as indicated and specified.
- B. Install grinders on a concrete pad and align thereon.
  - 1. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.
- C. After alignment is correct, grout using high grade non-shrink grout.
  - 1. Do not imbed leveling nuts in grout.

3.02 FIELD TESTING:

- A. Provide in accordance with Section 011006 and as specified herein.
- B. After installation of grinders, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each grinder in presence of the Engineer to determine its ability to:
  - 1. Deliver its rated capacity under specified conditions
  - 2. Operate within the vibration and temperature limits specified
  - 3. During tests, observe and record pressure drop, flow, motor inputs, pump bearing housing temperature, noise and vibration.
  - 4. Immediately correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results and results acceptable to the Engineer are obtained.

5. Contractor to provide all labor, equipment, and materials for conducting tests.
6. Bearing and Motor Temperature:
  - a. Run each grinder for minimum four hours prior to taking temperature readings of the gears and motors.
  - b. Bearing temperature not to exceed 180 degrees F.
7. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.

- C. Make all adjustments necessary to place equipment in specified working order at time of above tests.
- D. Test on product only. If product is not available, test with water. Water for testing furnished by Contractor.
- E. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

### 3.03 FIELD TOUCH-UP PAINTING:

- A. After installation and accepted testing by the Engineer. Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

### 3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 017400.

END OF SECTION

# **PROPOSAL DOCUMENTS**

**PROPOSAL AND SCHEDULE OF PRICES**

Contract No.: 2022-03

PROJECT No. C309603

**West Wing Service Area Force Main**

**BID OPENING DATE:** October 17, 2023

**TIME:** 2:00 P.M.

**LOCATION:** New Castle County Purchasing Division  
2<sup>nd</sup> Floor, New Castle County Government Center  
87 Reads Way, New Castle, Delaware 19720

**LOCATION OF PROPOSED WORK:**

**The project is located within public rights-of-way and on various private properties in Middletown, New Castle County, Delaware.**

**TYPE OF PROPOSED WORK:**

The work under this contract includes all labor, tools, material, and equipment necessary to construct 14-inch and 18-inch diameter wastewater force mains, 16-inch and 20-inch diameter wastewater force mains via horizontal directional drilling, 30-inch and 34-inch steel casing pipes via jacking and boring, air valve manholes, force main junction box, appurtenances, and related site work.

\*Proposal Guarantee: (10.02-9) 10% of Bid Price

\*Contract Time: (10.08-7) **[395] Consecutive calendar days**

\*Liquidated Damages: (10.08-9) **[\$1500].00** per calendar day

**\*NEW CASTLE COUNTY STANDARD SPECIFICATIONS FOR CONSTRUCTION ARE PART OF CONTRACT**

**PROPOSAL**

**West Wing Service Area Force Main**

The undersigned Bidder has carefully examined the location of the proposed work, the form of Agreement, Specifications, Special Provisions, Drawings and Addenda, if any, forming a part of this contract to be known as **West Wing Service Area Force Main, Contract No.: 2022-03, Bid No.: 22-2204** and binds himself under this proposal, upon notice of tentative award to him by New Castle County, to execute in accordance with such award, a contract, accompanied by the required Surety Bond, of which contract, this proposal and said plans and specifications shall be a part of and upon notice to him of formal award, at his own proper cost and expense, to furnish all the materials, supplies, machinery, equipment, tools, superintendence, labor, insurance, and other accessories and services necessary to complete the said work either with his own organization or with licensed subcontractors possessing current pre-qualification by New Castle County Licensing in the class of work to be performed, if required as a bid conditions.

Such work shall be completed to the satisfaction of the General Manager of the Department of Public Works in strict accordance with the plans, specifications, and terms of the contract for the lump sum for the items on the preceding proposal pages.

The contract provisions relating to liquidated damages and Addendum Number(s): \_\_\_\_\_ has/have been considered in compiling this bid.

**TOTAL AMOUNT FOR PROPOSAL:**

Amount written in words: \_\_\_\_\_ \$ \_\_\_\_\_

\_\_\_\_\_  
For Individuals and Partnerships

\_\_\_\_\_ as to  
\_\_\_\_\_ seal  
Witness Contractor

\_\_\_\_\_  
For Corporations

\_\_\_\_\_  
Name of Corporation & Corporate Seal

\_\_\_\_\_ By \_\_\_\_\_  
Witness Signature of Officer

Title \_\_\_\_\_

Address \_\_\_\_\_



**West Wing Service Area Force Main  
Contract No.: 2022-03**

ITEM NO.	APPROX. QUANT.	DESCRIPTION OF ITEMS AND PRICES BID (In Written Words)	UNIT PRICES		BID AMOUNT	
			DOLLAR	CT.	DOLLAR	CT.
		<b>BASE BID ITEMS</b>				
1	Lump Sum	General Prov. 011007 / Special Prov. 015100 Construction of West Wing Pump Station	-	-		
		Per Lump Sum (In Written Words)				
2	Lump Sum	Technical Specification 012250 Project Sign	-	-		
		Per Linear Foot (In Written Words)				
		<b>SUBTOTAL BASED BID ITEMS</b>				
		(In Written Words)	-	-		
3	Lump Sum	Mobilization (not to exceed 5% of subtotal above)	-	-		
		Per Lump Sum (In Written Words)				
		<b>TOTAL BASE BID</b>				
		(In Written Words)	-	-		

**West Wing Service Area Force Main**

**Contract No.: 2022-03**

ITEM NO.	APPROX. QUANT.	DESCRIPTION OF ITEMS AND PRICES BID (In Written Words)	UNIT PRICES		BID AMOUNT	
			DOLLAR	CT.	DOLLAR	CT.
<b>CONTINGENT BID ITEMS</b>						
4	100 CY	Technical Specification 311004 Borrow Type C				
		Per Cubic Yard (In Written Words)				
5	100 CY	Technical Specification 312316 Rock Excavation				
		Per Cubic Yard (In Written Words)				
6	100 CY	Technical Specification 312300 Trench Excavation and Stone Bedding (as ordered by the Engineer including excavation and disposal of materials )				
		Per Cubic Yard (In Written Words)				
7	100 CY	Technical Specification 312300 Crusher Run				
		Per Cubic Yard (In Written Words)				
8	100 SY	Technical Specification Filter Fabric				
		Per Square Yard (In Written Words)				
9	Lump Sum	Contingency Allowance Work Allowance  [ One Million ] dollars and no cents Lump Sum (In Written Words)	-	-	\$1,000,000.00	
		<b>SUBTOTAL CONTINGENT BID ITEMS</b>				
		(In Written Words)	-	-		

**West Wing Service Area Force Main**

**Contract No.: 2022-03**

ITEM NO.	APPROX. QUANT.	DESCRIPTION OF ITEMS AND PRICES BID (In Written Words)	UNIT PRICES		BID AMOUNT	
			DOLLAR	CT.	DOLLAR	CT.
		<b>TOTAL BASE BID AND CONTINGENT ITEMS</b>				
		..... (In Written Words)	-	-		

**LIST OF SUBCONTRACTORS**

For contracts exceeding \$10,000 in amount for the construction, alteration, or repair of any public building of New Castle County, Delaware Law states the contract shall be awarded to those bidders only whose bid contain the names and addresses of the subcontractors whose services such bidder intends to use in performing the work. If bidder intends to complete the category of specialty work listed as Subcontract Trades with his own work force, such bidder shall list himself as the Subcontractor.

New Castle County will not award any contract for any public work unto any bidder, as the general contractor, in the event any such bidder has listed himself as the subcontractor or any specialty work required to complete such public work, unless it has been established to the satisfaction of New Castle County (1) that such bidder has customarily performed such specialty work by artisans regularly employed by him; (2) that such bidder is duly licensed by the State to engage therein; and (3) that such bidder is recognized in the trade as a bona fide subcontractor in such specialty work.

I/WE \_\_\_\_\_ (Name of Firm)  
intend to use the following listed subcontractors in performing work under Contract No. 2022-04. Bids submitted without completion of the following list are subject to rejection.

SUBCONTRACT TRADES	NAME & ADDRESS OF SUBCONTRACTOR
_____	_____
	_____
	_____
_____	_____
	_____
	_____
_____	_____
	_____
	_____
_____	_____
	_____
	_____
_____	_____
	_____
	_____

**BOND TO ACCOMPANY BID**

Know All Men By These Presents, That We, The Principal \_\_\_\_\_ of \_\_\_\_\_ in the County of \_\_\_\_\_ and the State of \_\_\_\_\_ and \_\_\_\_\_ (a duly constituted surety company empowered to do business in the State of Delaware) a corporation of the State \_\_\_\_\_ hereinafter called the "Surety", are held and firmly bound unto New Castle County, a political subdivision of the State of Delaware in the full and just sum of \_\_\_\_\_ dollars, (\$ \_\_\_\_\_) to be paid to New Castle County, or its certain attorney, its successors and assigns, for which payment, well and truly to be made and done, we bind ourselves, and each of us, our, and each of our heirs, executors, administrators, and successors, jointly and several, firmly by these presents.

NOW, THEREFORE, the condition of This Obligation is Such, that if the said above bounden PRINCIPAL shall and do well truly, if awarded a contract for **West Wing Service Area Pump Station**, Contract Number **2022-04** in the County of New Castle and State of Delaware, execute in writing, a proper agreement with said New Castle County and furnish surety, satisfactory to the General Manager of the Department of Public Works within fifteen days after notification by New Castle County of the tentative awarding of the said contract to him, for the faithful performance of said contract according to the plans and specifications, then this obligation shall have no effect; otherwise it shall remain in full force and virtue.

IN WITNESS WHEREOF, The above-bounden parties have executed This Instrument under their several seals on this the \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_ .

The name and corporate seal of each corporate party being hereto affixed and there presents duly signed by its undersigned representative, pursuant to authority of its governing body.

\_\_\_\_\_  
FOR INDIVIDUALS AND PARTNERSHIPS

\_\_\_\_\_  
Witness AS TO \_\_\_\_\_ Contractor (SEAL)

\_\_\_\_\_  
FOR CORPORATIONS  
\_\_\_\_\_  
Name of Corporation and Corporate Seal

\_\_\_\_\_  
Witness By \_\_\_\_\_ Signature of Officer and Title

\_\_\_\_\_  
FOR SURETY  
\_\_\_\_\_  
Surety Company and Corporate Seal

\_\_\_\_\_  
Witness By \_\_\_\_\_ Attorney in Fact

**NON-COLLUSION STATEMENT**

DATE: \_\_\_\_\_

New Castle County  
New Castle County Government Center  
87 Reads Way  
New Castle, Delaware 19720

Gentlemen:

This is to certify that the undersigned bidder, \_\_\_\_\_  
\_\_\_\_\_ has not, either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with this proposal for **West Wing Service Area Pump Station**, Bid Number 2022-04 submitted to New Castle County and shall comply with the Copeland "Anti-Kick Back" Act (18 U.S.C. 874) as supplemented in the U. S. Department of Labor Regulations (29 CFR, Part 8) on the \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_ for Contract Number 2022-04.

**CORPORATE SEAL**

Signature of Bidder: \_\_\_\_\_

By: \_\_\_\_\_

Attest: \_\_\_\_\_  
Secretary

Sworn to and subscribed before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_.

My Commission Expires \_\_\_\_\_.

\_\_\_\_\_  
Notary Public

**NOTARIZED STATEMENT TO ACCOMPANY BID**

\_\_\_\_\_  
Firm (Bidder's) Name

\_\_\_\_\_  
Prequalification Number

2022-04  
\_\_\_\_\_  
Contract No.

\_\_\_\_\_  
Bid Opening Date

List below all uncompleted contracts  
Prime Contractor's Work Load

Contract No.	with whom made	Total amount of contracts	Total amount sublet	Total less sublet	Total uncompleted	Amount to be completed in 30 days	Balance after 30 days

1. Amount of uncompleted work after 30 days that has not been sublet.....\$ \_\_\_\_\_.
2. Amount of work bid on which award is anticipated.....\$ \_\_\_\_\_.
- Total of lines 1 & 2 above .....\$ \_\_\_\_\_.

The bidder represents, and it is a condition of the acceptance of this bid, that the bidder has not been a party with other bidders to any agreement to bid a fixed or uniform price, and that, to the best of his knowledge, the information above regarding uncompleted contracts is correct.

\_\_\_\_\_  
Witness

Firm Name and Seal

\_\_\_\_\_  
Signature of Officer and Title

SUBSCRIBED AND SWORN to before me, a Notary Public of the State of \_\_\_\_\_, County or City of \_\_\_\_\_, this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_.

\_\_\_\_\_  
Signature of Notary Public





G. That it shall be the sole responsibility of the Company and subcontractor to comply with the requirements of the *New Castle County Code* pertaining to the alcohol and drug testing program.

By: \_\_\_\_\_

Company: \_\_\_\_\_

Title: \_\_\_\_\_

SWORN AND SUBSCRIBED before me on \_\_\_\_\_, 20\_\_.

\_\_\_\_\_  
Notary Public

My Commission Expires:



**NEW CASTLE COUNTY  
DEPARTMENT OF PUBLIC WORKS  
187-A OLD CHURCHMANS ROAD  
NEW CASTLE, DE 19720**

**CONTRACTOR/SUBCONTRACTOR  
RESPONSIBILITY CERTIFICATION**

**CONTRACTORS:**

This form must be executed and submitted to the New Castle County Department of Public Works as soon as possible for review, but no later than the advertised date of the bid opening. If a bidder fails to provide the Contractor Responsibility Certification, the bidder shall be disqualified from bidding the special services contract.

**SUBCONTRACTORS:**

Must submit this form to requesting contractor.

**CONTRACTOR/SUBCONTRACTOR RESPONSIBILITY CERTIFICATION  
FOR CONTRACTS EXPECTED TO EXCEED \$500,000.00 AND FOR  
SUBCONTRACTORS OF \$500,000.00 OR MORE**

Name of Company: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contract/Project Name: \_\_\_\_\_

Contract/Project Number: \_\_\_\_\_

As a condition of performing work under Public Works contracts/projects for New Castle County, Delaware, contractors and subcontractors (hereinafter referred to as "Bidders") must meet certain responsible contractor qualifications and criteria specified in *New Castle County Code*, Section 2.05.303. Pursuant to this law, the Company named above certifies the following:

***PLEASE INITIAL EACH ITEM TO INDICATE COMPLIANCE***

\_\_\_\_\_ 1. The Bidder has valid federal, state, county or local licenses, registrations or certificates required by federal, state, county or local law including but not limited to licenses, registrations or certifications required to:

- (a) do business in New Castle County and the State of Delaware and comply with all tax laws thereof; and
- (b) perform the labor and supply the material involved in the performance of the public works contract, including but not limited to, licenses for any type of trade work or specialty work which the bidder proposes to self-perform.

\_\_\_\_\_ 2. The Bidder meets all:

- (a) bonding requirements as required by applicable law or contract specifications; and
- (b) insurance requirements per applicable law or contract specifications including general liability insurance, workers' compensation insurance, and unemployment insurance.

\_\_\_\_\_ 3. The Bidder has not within the past three (3) years:

- (a) been debarred by a federal government agency;
- (b) been debarred by a state government agency;
- (c) been debarred by a local government agency;
- (d) defaulted on a project;
- (e) had any type of business license, registration or certification revoked or suspended;
- (f) had any type of contracting license, registration or certification revoked or suspended; or
- (g) had any type of trade license, registration or certification revoked or suspended.

\_\_\_\_\_ 4. The Bidder is not currently delinquent in any tax obligations

\_\_\_\_\_ 5. The Bidder has not within the past three (3) years been found by a final decision of a court or administrative body of competent jurisdiction in violation of any law applicable to its contracting business, including but not limited to those laws listed below, where the penalty for such violation resulted in the imposition of a fine, back pay damage or any other type of penalty in the amount of \$5,000 or more:

- (a) licensing laws
- (b) tax laws
- (c) prompt payment laws
- (d) wage and hour laws
- (e) prevailing wage laws
- (f) environmental laws
- (g) antitrust laws, or
- (h) labor laws

- \_\_\_\_\_ 6. The Bidder has not within the past three (3) years been found by a final decision of a court or administrative body of competent jurisdiction to have committed a willful violation of federal or state workplace safety laws.
- \_\_\_\_\_ 7. In the event the Bidder employs any of the following craft workers on the public works contract: carpenters, electricians, elevator constructors, boilermakers, insulators, iron workers, laborers, plumbers, sheet metal workers, sprinkler fitters, bricklayers, operating engineers or millwrights, certification that the Bidder:
- (a) participates in a Class A Apprenticeship Program; or
  - (b) participates in an apprenticeship program that has been approved by the U.S. Department of Labor or a state apprenticeship agency within the past three (3) years; or
  - (c) commits that, at the time the Bidder executes the public works contract, it will be participating in an apprenticeship program that has been approved by the U.S. Department of Labor or a state apprenticeship agency.
- \_\_\_\_\_ 8. The Bidder will fully abide by the equal employment opportunity requirements of all applicable laws and that it will maintain equal employment opportunity policies in the recruitment, hiring and retention of all workers, including minority and women workers, employed in its performance of public works contracts. Such policies shall be designed, developed, and administered in a manner to promote diversity in the workplace and to strive toward having the composition of the workforce employed by the bidder on public works contracts be generally representative of the demographics of New Castle County.
- \_\_\_\_\_ 9. Within fourteen (14) calendar days following the date of receipt of notice that they are the apparent low bidder, Bidder will provide a list of subcontractors it will use in the performance of the public works contract, a brief description of their scope of work, and completed Subcontractor Responsibility Certifications for the identified subcontractors containing the information equivalent to that required for the Bidder in the Contractor Responsibility Certification. This subsection shall apply only to subcontractors with subcontracts of five hundred thousand (\$500,000.00) dollars or more.
- \_\_\_\_\_ 10. If at any time during the past three (3) years the Bidder has controlled or has been controlled by another corporation, partnership or other business entity operating in the construction industry, it will disclose such facts by attaching a detailed statement to its Contractor Responsibility Certification explaining the nature of the relationship.
- \_\_\_\_\_ 11. Bidder acknowledges that it shall be required to provide appropriate documentation of the conditions specified in this Contractor/Subcontractor Responsibility Certification. The Bidder also understands that New Castle County may request additional information or documents at any time as New Castle County deems necessary to evaluate the responsibility of Bidder. Bidder agrees to provide such additional information or supporting documentation for this Certification.

\_\_\_\_\_ 12. The Bidder has the necessary experience, technical qualifications and resources, including but not limited to, equipment, tools, financial resources and personnel resources to successfully perform the public works contract or will obtain the same through the use of qualified subcontractors.

\_\_\_\_\_ 13. If Bidder is awarded the public works contract, upon completion of its work under the contract, it will provide the Department of Public Works with a verification that it continued to participate in its apprenticeship program as certified above until the issuance of conditional acceptance of the work by the Department of Public Works.

**If a bidder fails to provide the Contractor Responsibility Certification, the bidder shall be disqualified from bidding the public works contract. If a bidder fails to provide other information or documentation required by the Department of Public Works, it may be disqualified from being awarded the public works contract.**

Under the penalty of perjury, the Bidder's authorized representative hereby certifies that all information included in the Contractor Responsibility Certification or otherwise submitted for purposes of determining the Bidder's status as a responsible contractor is true, complete and accurate and that he/she has knowledge and authority to verify the information in this certification or otherwise submitted on behalf of the Bidder by his or her signature below.

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Date

(PRINT)

Name: \_\_\_\_\_

Title: \_\_\_\_\_

\_\_\_\_\_  
Witness Signature

\_\_\_\_\_  
Date

*PLEASE SUBMIT **SIGNED ORIGINAL** VERSION OF THIS FORM TO:*

**NEW CASTLE COUNTY  
PUBLIC WORKS  
ATTN: CONTRACTS OFFICER  
187-A OLD CHURCHMANS ROAD  
NEW CASTLE, DE 19720**

If you have any *questions* regarding this form contact:  
John Wolos - 302-395-5749 – john.wolos@newcastlede.gov

# **Report of Geotechnical Exploration**

R E P O R T

GEOTECHNICAL  
INVESTIGATION  
WEST WING SANITARY SEWER  
FORCE MAIN PROJECT

MIDDLETOWN, DELAWARE

*Prepared for*  
AECOM  
248 Chapman Road, Suite 101  
Newark, DE, 19702

January 5, 2023

**AECOM**

AECOM  
625 W. Ridge Pike, Suite E100  
Conshohocken, PA 19428  
Tel: 610.832.3500  
Fax: 610.832.3501

60602492



January 5, 2023  
60602492

Mr. Ed Strauss, P.E.  
AECOM  
248 Chapman Road, Suite 101  
Newark, DE, 19702

Subject: Report on Geotechnical Investigation  
West Wing Sanitary Sewer  
Force Main Project  
Middletown, Delaware

Dear Mr. Strauss,

We are pleased to present herein our report of a geotechnical investigation which was performed in connection with the proposed West Wing Sanitary Sewer Force Main Project in Middletown, Delaware.

Soil samples which were obtained during the investigation will be retained in our laboratory for a period of three months, after which they will be returned to you for proper disposal.

We sincerely appreciate the opportunity to be of service to you on this project. If you have any questions on the contents of this report, or if we may be of additional service, please give us a call.

Very truly yours,

Neil Scafonas, P.E.  
Project Engineer

Yongli Min, P.E.  
Associate Vice President  
Geotechnical Engineering  
Department Manager



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Plate 1	Regional Location Plan
Plate 2	Test Boring Location Plan

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Appendix A	Subsurface Exploration
Appendix B	Laboratory Testing

The Geotechnical Investigation reported herein was performed at the request of the New Castle County Department of Special Services, in connection with the proposed West Wing Sanitary Sewer Force Main Project in Middletown, Delaware. The project location is shown on Plate 1, Regional Location Plan.

The purpose of this investigation was to evaluate the geotechnical conditions at the site and to formulate conclusions and recommendations pertaining to the design and construction of the foundations for the proposed structures. Our services consisted of planning the investigation, a subsurface exploration program consisting of test borings, laboratory testing of representative soil samples, engineering analysis of the data obtained, and preparation of this report.

A description of the subsurface exploration program and test boring logs are presented in Appendix A. The geotechnical laboratory testing program is described and the results are summarized in Appendix B. Relevant findings, conclusions, and recommendations derived from this investigation are presented in the following sections.

The new proposed structures consist of the approximately 17,500 linear feet of sanitary sewer force main between Regional Pump Station #1, located on the Carter Farm, and the existing 30” gravity sewer located in Whispering Woods and up to 5,200 linear feet of gravity sewer. The force main and gravity sewer will follow Route 15 and Churchtown Road. The depths of the new lateral will vary from 5 to 20 ft below grade.

Lateral crossings will occur at the following locations:

- Back Creek and Choptank Rd,
- Three locations along Churchtown Rd under wetlands,
- Crossing under active Norfolk Southern rail and Summit Bridge Rd.

The loads and dimensions of the proposed new pump station at Carter Farm have not been finalized at the time of this report. The pump station is expected to extend to approximately 35 ft below the existing ground surface.

The terrain is relatively flat with existing elevations varying from El. 45 feet to El. 48 feet.

Based on a review of available geologic information, the site is underlain by four Upper Cretaceous formations including Merchantville Formation, Wenonah Formation, Redbank Formation and Mt. Laurel-Navesink Formation from west to the east.

The Merchantville Formation mainly consists of dark gray to bluish gray slightly glauconitic, micaceous silt and very fine sand. The Wenonah Formation primarily consists of gray and rust-brown fine to medium micaceous, sparingly glauconitic quartz sand. The Redbank Formation consists of reddish-brown, slightly micaceous and glauconitic fine to medium sand. The Mt. Laurel-Navesink Formation consists of dark greenish brown and dark gray highly glauconitic sandy silt and silty sand.

(References: Spolijaric, Nenad, and Jordan, R.R., 1966, Generalized Geologic Map of Delaware, Delaware Geologic Survey, Special Publication 4, scale 1:297,500.)

The subsurface conditions at the site were explored by means of thirteen test borings (B-01 through B-13), as shown on Plate 2, Test Boring Location Plan. The borings were drilled to a depth of approximately 15 to 71 feet below the existing grades. Logs of the test borings are presented in Appendix A, together with a description of the drilling and sampling methods. Geotechnical laboratory test results are presented in Appendix B. The various strata encountered are described below:

## 4.1 STRATUM 1 – FILL

The fill material was encountered below the topsoil in all borings except Borings B-02, B-03 and B-13, with a thickness of approximately 3 to 7 feet. The soils of this stratum generally consist of brown and gray silty coarse to fine sand with varying amount of clay and gravel. The Standard Penetration Test (SPT) values range from of 1 to 23 blows per foot (bpf). Based on the SPT value and resistance encountered when probing using hand tools, the fill material was judged to be in loose to medium dense condition.

Results of two moisture content tests indicate moisture contents of 3.5 and 5 percent. Grain size distribution curves are shown in Appendix B. The result of one Atterberg limits test indicates a liquid limit of 29 percent, plastic limit of 17 percent, and plasticity index of 12 percent.

Corrosivity testing results on one sample indicate a pH of 8.1, resistivity of 7,560  $\Omega$ -cm, sulfates of 55 ppm and chlorides of 112 ppm.

## 4.2 STRATUM 2 – SILTY SAND

This stratum was encountered below the existing ground surface in Borings B-02, B-03 and B-13 and below Stratum 1 in all other borings, with a thickness of about 15 to 32 ft. All borings except for Boring B-01 were terminated in this stratum. The soils of this stratum generally consist of brown coarse to fine sand with varying amount of silt and gravel. The SPT values ranged from 1 to 45 bpf, generally from 8 to 24 bpf, which is indicative of a loose to medium dense condition.

Results of fifteen moisture content tests indicate moisture contents of 2 to 39 percent. Grain size distribution curves are shown in Appendix B. The result of one Atterberg limits test indicated a liquid limit of 27 percent, a plastic limit of 23 percent, and a plasticity index of 4 percent. The result of one Atterberg limits test indicates a non-plastic condition.

Two unconsolidated-undrained (UU) triaxial compression tests indicate undrained shear strengths of 1,545 and 1,615 pounds per square foot (psf), indicative of a firm consistency.

## 4.3 STRATUM 3 – SANDY CLAYEY SILT

This stratum was encountered below Stratum 2 in Boring B-01 below Stratum 2, extending to a depth of 71 ft below ground surface. Boring B-01 was terminated within this stratum. The soils of this stratum generally consist of dark gray fine sandy clayey silt. The SPT values ranged from 9 to 18 bpf. The Pocket Penetrometer Resistance (PPR) values varies between 2.25 to 3.5 tons per square foot (tsf). Based on the SPT values, PPR values as well as the lab testing results, the soils in Stratum 3 is judged to be in a stiff to very stiff consistency.

Results of three moisture content tests indicate moisture contents of 27 to 33 percent. Grain size distribution curves are shown in Appendix B. Results of three Atterberg limits tests indicate liquid limits of 37 to 50 percent, plastic limits of 25 to 29 percent, and plasticity indices of 13 to 22 percent.

One unconsolidated-undrained (UU) triaxial compression test indicates an undrained shear strengths of 3,160 psf, indicative of a very stiff consistency. One consolidation test indicates a pre-consolidation pressure of 11.3 tsf, a compression ratio of 0.19, and a recompression ratio of 0.01 (all strain based).

### 4.4 GROUNDWATER

Groundwater was observed in all test borings except for Borings B-10, B-12, and B-13 at depths of approximately 3 to 25 feet, corresponding to El. 13 and El. 55 ft. At Boring B-1, where the pump station is planned, groundwater was observed to be at approximately 11 ft below grade at the completion of drilling, and soil samples were observed to be wet starting at approximately 9 ft depth. It should be noted that groundwater levels are subject to tidal, seasonal, and long-term variations due to climatic and man-made influences.

## 5.1 PUMP STATION

Based on Boring B-01 where the pump station is proposed at, the subsurface generally consists of firm to stiff brown medium to fine sandy silty clay overlying loose to medium dense brown medium to fine sand, underlain by stiff to very stiff dark gray micaceous fine sandy clayey silt.

The dimension and loading condition of the proposed pump station is not available at time of this report. However, it is understood that the bottom of the pump will be at approximately 35 ft below existing ground surface is considered. Based on the subsurface conditions, a net (less existing overburden pressure) bearing pressure of 2,000 psf may be used for the design of the pump station foundation.

## 5.2 GEOTECHNICAL DATA

The geotechnical data for the directional drilling, including test boring logs and lab testing report are presented in Appendix A and Appendix B.

Recommendations pertaining to the design and construction of the foundations for the proposed structures are presented below.

6.1 PUMP STATION

Foundations for the support of the proposed pump station may be supported on shallow spread footings bearing on competent site soils or structural fill at a depth of 35 ft below ground surface. The footings should be proportioned such that the combined dead and live load will not exceed a net (less existing overburden pressure) bearing pressure of 2,000 psf. The recommended bearing value may be increased by 33 percent for short-term loading such as wind and seismic loads. The foundation should be based at minimum of 2 feet below finished grades for frost protection.

A design groundwater table of El. 23 ft is recommended.

**Foundation Construction:** Foundation excavations should be protected from freezing and the accumulation of ponded water. Concrete should be placed as soon as the excavation is completed. All footing excavation surfaces should be protected until the concrete and backfill are placed. Footing bearing surfaces should be cleaned of all material loosened by the excavation process prior to concrete placement.

6.2 DESIGN SOIL PARAMETERS

The following design soil parameters should be used:

Items	Stratum 1 Fill	Stratum 2 Silty Sand	Stratum 3 Sandy Clayey Silt
Total Unit Weight (pcf) <sup>(1)</sup>	110	120	125
Internal Friction Angle (°)	0	32	0
Cohesion (psf)	1,000	0	2,000

Note: (1) Refer to the nearest test boring logs for groundwater depth.

6.3 SEISMIC DESIGN

Based on the 2021 edition of the International Building Code (IBC), the site soil classification is Site Class D.

6.4 STRUCTURAL FILL

Structural fill may be required for backfilling below the proposed structures and equipment and for replacement of unsuitable materials under loaded areas. Structural fill should consist of predominately granular soil or crushed stone with a maximum particle size of 2 inches, and not greater than 10 percent passing the No. 200 sieve, such as DelDOT Borrow Type G-1 or DelDOT Graded Aggregate Type “A” (CR-1). Any fine-grained soils from the excavation should not be used as structural fill.

Structural fill below the foundations should be placed in horizontal lifts with a loose thickness of not more than 9 inches. Structural fill should be compacted to an average of no less than 95



percent of the maximum dry density as determined in the laboratory by the “Modified Proctor” compaction test, ASTM D 1557, or not less than 80 percent of the relative density as determined by the “Maximum Index Density and Unit Weight of Soils Using a Vibratory Table” ASTM D 4253/4254 for free-draining fill materials. Structural fill should not be placed on wet, muddy, or frozen soils.

### 6.5 EARTH PRESSURES

The design of retaining walls that are restrained from movement should be based on the at-rest earth pressure. The earth pressure should be calculated assuming the backfill to be an equivalent fluid with a weight of 60 pcf. In addition, a uniform pressure equal to one-half of any surcharge pressure on the surface of the backfill should be added.

For unrestrained walls, the active earth pressure should have an equivalent fluid unit weight of 40 pcf, plus a surcharge coefficient of one-third.

For resistance to sliding, a coefficient of friction of 0.3 may be used at the base of the foundation. If passive resistance of the soil is utilized in the design, an equivalent fluid weight of 360 pcf may be used. A factor of safety of at least 2.0 should be provided against sliding.

### 6.6 EXCAVATION SLOPES

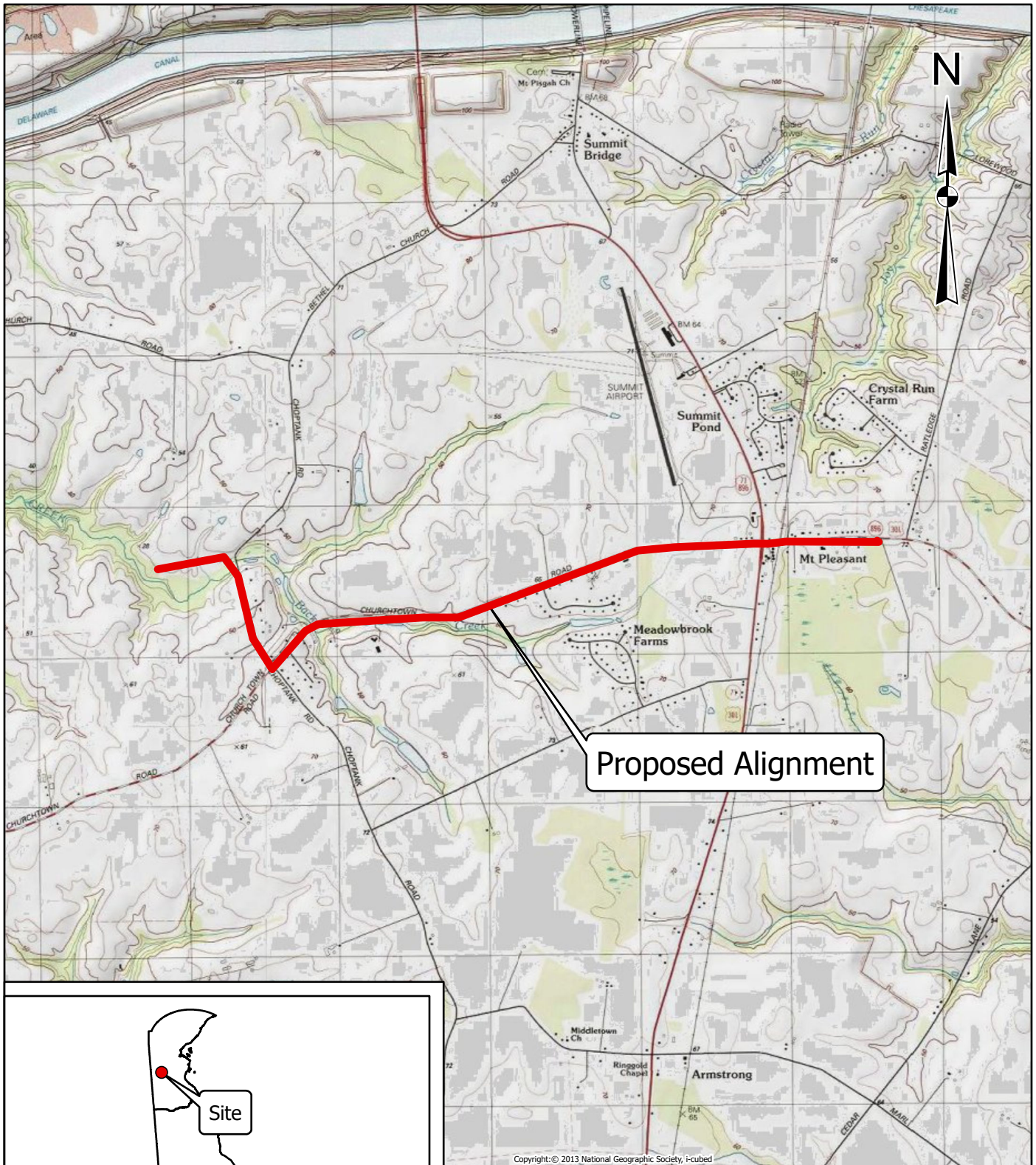
Temporary excavations above the groundwater level should have side slopes not steeper than 1.5H:1V. Pertinent OSHA and local regulations should be followed where they require flatter side slopes than given above. Sheet piling and shoring for excavations, if required, should be designed by an Engineer registered in the State of Delaware.

### 6.7 CONSTRUCTION MONITORING

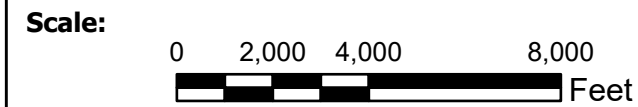
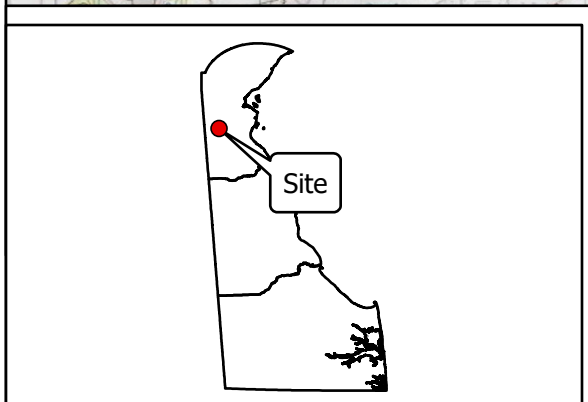
It is recommended that construction monitoring be provided full time during foundation construction by AECOM or an equally qualified geotechnical engineering firm that is familiar with the subsurface conditions and foundation design criteria. The items that should be observed, monitored, and/or tested include subgrade preparation, evaluation of foundations soils, suitability of compaction equipment, placement and compaction of structural fill, and backfill.

The services described in this report were provided in accordance with the standard of care. No warranty or guarantee, expressed or implied, is intended. The conclusions and recommendations are based on the assumptions that the subsurface conditions do not deviate appreciably from those revealed by the test borings drilled during this investigation, and that the loads are similar to those given in the project description. If the structures are moved or loads have changed, AECOM should be given the opportunity to modify recommendations accordingly. The conclusions and recommendations are also based on competent field engineering, monitoring, and testing during construction. The recommendations presented in this report are solely for the use of our client for the design of this particular project. Any re-use of this document, particularly by third parties, without the express written permission of AECOM is solely at their own risk.

Plates



Proposed Alignment



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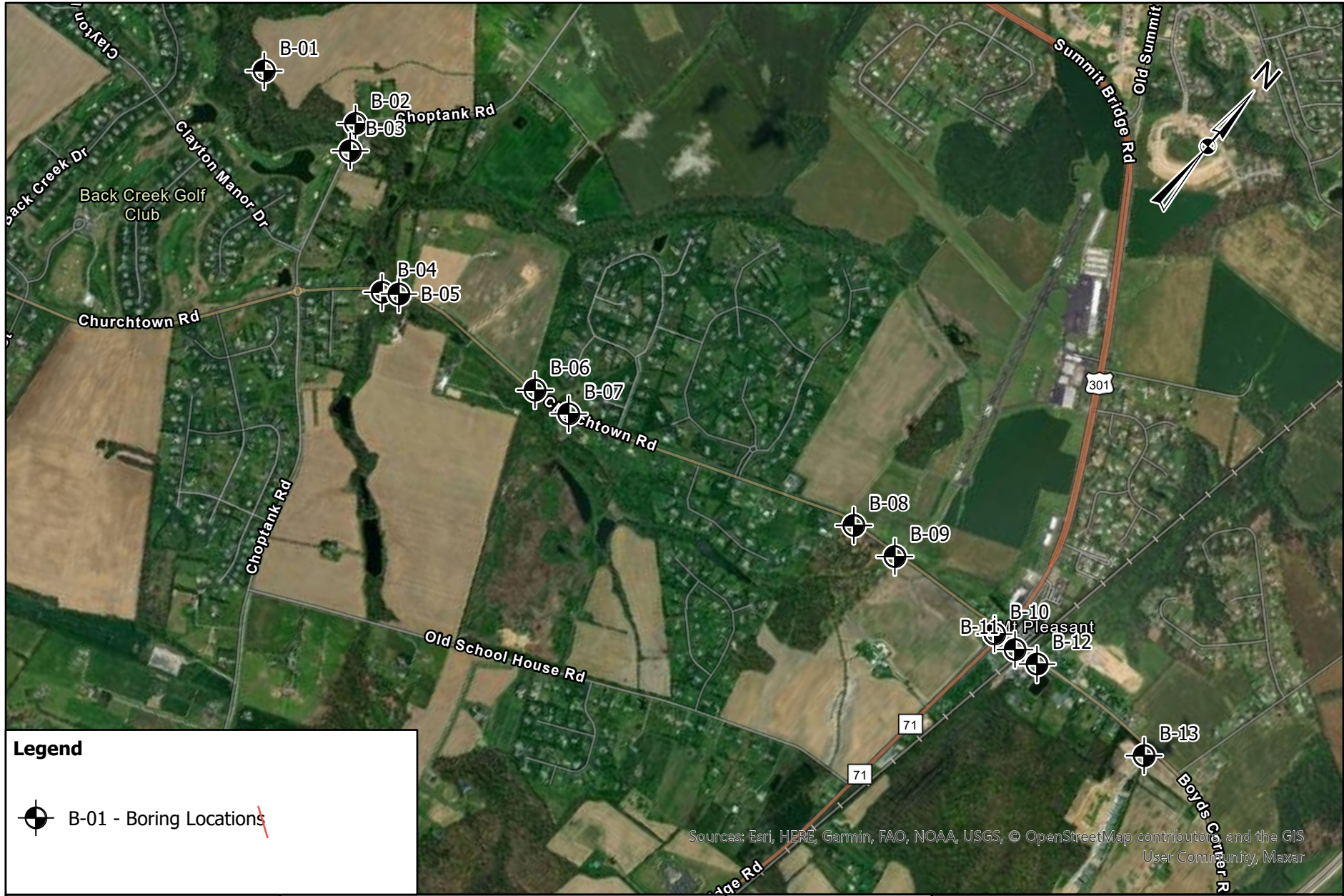


625 West Ridge Pike, Suite E-100  
Conshohocken, PA 19428


Project No.: 60602492
Drawn By: XM
Check By: NS
Date: 10/17/2022

**Regional Location Map**

NCC West Wing Service Area  
New Castle County  
New Castle County, Delaware



**Legend**

 B-01 - Boring Locations


Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Maxar

User: xiaoyi.ma Date Printed: 10/30/2020 11:25 AM  
 Path: L:\DCS\Projects\Private-Sector\AGC\AmericanWater\NCC West Wing\GIS\NCC West Wing\NCC West Wing.aprx

**AECOM**

625 West Ridge Pike, Suite E-100  
 Conshohocken, PA 19428

**Scale:**

0 1,250 2,500 5,000  
 Feet

Project No.: 60602492
Drawn By: XM
Check By: NS
Date: 10/17/2022

**Boring Location Plan**

NCC West Wing Service Area  
 New Castle County  
 New Castle County, Delaware

Plate 2

Appendix A  
Subsurface Exploration

The subsurface exploration consisted of thirteen test borings located as shown on Plate 2, Test Boring Location Plan. The borings were drilled on September 12 through 20, 2022, by CGC Geoservices, LLC, located in Newark, Delaware. The test borings were conducted under full-time technical supervision of AECOM. The test borings were located in the field by AECOM. Boring locations are based on field measurements by AECOM. Ground surface elevations were estimated based on a topographic map. Utility clearance was conducted by CGC Geoservices using hand tools for the top 5 ft of each boring.

The soil conditions at the top 5 ft of each boring were evaluated based on resistance to the hand auger. Soil samples were obtained with a hand auger at various depths.

The test borings were performed using a CME-55 truck mounted drilling rig and were advanced by hollow stem auger and mud rotary drilling techniques. Samples of the subsoils were recovered from the borings for identification and classification purposes by means of a 2-inch O.D. split-barrel sampler driven 24 inches by a 140-pound hammer freely falling 30 inches (the Standard Penetration Test, ASTM D1586). The number of hammer blows required to drive the sampler during the interval from 6 to 18 inches, or fraction thereof, is reported on the test boring logs as the sampling resistance.

Where fine-grained materials were encountered, Pocket Penetrometer Resistance (PPR) readings were taken to obtain an indication of the unconfined compressive strength of cohesive soils. These values are shown on the boring logs under "Pocket Penetrometer (tsf)".

At the completion of the test borings, the boreholes were backfilled with bentonite/cement grout.

A "Key to Soil Symbols and Terms" used in this report is included on page A-2. The logs of the test borings in the final investigation are presented on Pages A-3 through A-16.





# LOG of BORING No. B-01

DATE 9/19/22 SURFACE ELEVATION 30.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Stiff to very stiff brown medium to fine sandy silty CLAY			5.0	29	17	M X
			AU							
5		23	SS	(Stratum 1 - Fill)	23.0		3.5			M
10		10	SS	Loose to medium dense brown medium to fine SAND, trace silt						
10		3	SS							
		2	SS							
		8	SS				18.4			M
15										
20		14	SS							
25		9	SS				16.2			M
30		11	SS	- with fine gravel						
				(Stratum 2)	-2.5					
35		9	SS	Stiff to very stiff dark gray fine sandy clayey SILT, micaceous						
40		16	SS							
		P	P			2.3	26.9	37	25	M T C

(Continued on Sheet 2 of 2)

Completion Depth: 71.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

122222 BORLOGR NCC WEST WING LOGS.GPJ

# LOG of BORING No. B-01

DATE 9/19/22 SURFACE ELEVATION 30.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45		17	SS	Stiff to very stiff dark gray fine sandy clayey SILT, micaceous		2.3				
50		11	SS			2.5				
55		14	SS			2.3	33.4	50	29	M
60		15	SS			2.8				
65		17	SS			2.8				
70		18	SS		- becoming clayey sand		3.5	28.1	46	25
				(Stratum 3)	-41.0					
				(END OF BORING)						
75				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was observed at 11.0 ft depth at the completion of drilling.						
80										
85										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 71.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

# LOG of BORING No. B-02

DATE 9/12/22 SURFACE ELEVATION 31.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	30.7					
			AU	Medium dense to dense brown coarse to fine SAND, with gravel, trace silt						
5		29	SS							
		18	SS							
10		12	SS							
		17	SS							
		19	SS							
15										
20		31	SS				20.7			M
25		9	SS							
		P	P	- becoming micaceous dark gray silty fine sand			32.1	NP	NP	M T
30		13	SS	(Stratum 2)	1.0					
				(END OF BORING)						
35				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 12.8 ft depth.						
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 30.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

# LOG of BORING No. B-03

DATE 9/13/22 SURFACE ELEVATION 35.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	34.7					
			AU	Loose to medium dense brown silty coarse to fine SAND						
5		3	SS							
		7	SS							
10		10	SS							
		16	SS							
		16	SS	- becoming sandy silt						
15										
		10	SS	- becoming silty sand						
20										
		11	SS							
25										
		11	SS							
30				(Stratum 2)	5.0					
				(END OF BORING)						
				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 22.3 ft depth.						
35										
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 30.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

# LOG of BORING No. B-04

DATE 9/13/22 SURFACE ELEVATION 32.5 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	32.2					
			AU	Loose brown to dark brown fine gravelly coarse to fine SAND, trace silt						
5	1		SS	(Stratum 1 - Fill)	25.5	0.25-0.5				
15			SS	Loose to medium dense to loose brown and gray coarse to fine SAND, with gravel, trace silt			16.0			M
10	10		SS							
11			SS							
8			SS							
20	5		SS							
25	14		SS	- becoming silty sand						
	P		P			3.25-3.5	23.3	27	23	M T
30	14		SS	(Stratum 2)	1.5					
				(END OF BORING)						
35				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 3.0 ft depth.						
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 31.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

# LOG of BORING No. B-05

DATE 9/13/22 SURFACE ELEVATION 30.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	29.7					
			AU	Soft gray brown coarse to fine sandy SILT, trace gravel						
5				(Stratum 1 - Fill)	25.0					
	1		SS	Loose to medium dense brown medium to fine SAND, trace silt						
	24		SS							
10	18		SS							
	10		SS							
	4		SS							
15										
20	11		SS	- trace gravel			25.7			M
25	16		SS	- becoming sandy silt		3.8				
30	18		SS	(Stratum 2)	0.0	3.75-4.5+				
				(END OF BORING)						
35				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 3.5 ft depth.						
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 30.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

# LOG of BORING No. B-06

DATE 9/14/22 SURFACE ELEVATION 48.5 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	48.2					
			AU	Medium dense brown coarse to fine sandy clayey SILT, trace gavel						
5		5	SS	(Stratum 1 - Fill)	42.5					
		36	SS	Dense brown silty coarse to fine SAND with gravel			6.0			M
		45	SS							
10		14	SS							
		10	SS							
15		16	SS							
		4	SS	- becoming loose						
25		5	SS							
30		3	SS	(Stratum 2)	17.5					
				(END OF BORING)						
35				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 25.0 ft depth.						
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 31.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

# LOG of BORING No. B-07

DATE 9/14/22 SURFACE ELEVATION 50.5 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	50.3					
			AU	Medium dense to dense brown silty fine SAND, trace gravel						
5	7		SS	(Stratum 1 - Fill)	44.0					
	34		SS	Medium dense to dense brown silty medium to fine SAND			2.1			M
	29		SS							
10	12		SS							
	13		SS							
15	7		SS							
	34		SS							
20			SS							
	37		SS							
25			SS							
	26		SS	(Stratum 2)	22.5					
30				(END OF BORING)						
				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 13.0 ft depth.						
35										
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 28.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.





# LOG of BORING No. B-08

DATE 9/16/22 SURFACE ELEVATION 62.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	61.7					
			AU	Soft gray to dark brown fine sandy silty CLAY (Stratum 1 - Fill)	59.0					
5		5	SS	Loose to medium dense brown silty coarse to fine SAND, trace clay  - becoming silty coarse to fine sand and gravel						
20		20	SS							
10		7	SS							
		8	SS							
		10	SS							
15										
20		14	SS							
25		16	SS							
30		22	SS							
35		21	SS	(Stratum 2)	27.0					
				(END OF BORING)						
40				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 6.7 ft depth.						

12/22/22 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 35.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.

**LOG of BORING No. B-09**

DATE 9/15/22 SURFACE ELEVATION 61.5 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Topsoil	61.3					
			AU	Loose to medium dense brown gray silty fine to medium SAND, trace fine gravel (Stratum 1 - Fill)	58.5					
5			6 SS	Loose to medium dense brown silty coarse to fine SAND						
			15 SS							
10			6 SS							
			4 SS							
			8 SS							
15										
			11 SS							
20										
			12 SS							
25										
			22 SS							
30										
			23 SS							
35				(Stratum 2)	26.5					
				(END OF BORING)						
40				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 14.0 ft depth.						

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 35.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.



# LOG of BORING No. B-10

DATE 9/15/22 SURFACE ELEVATION 69.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS	
0			AU	Soft brown fine sandy SILT, trace gravel (Stratum 1 - Fill)	66.0						
5		22	SS	Medium dense brown gray silty coarse to fine SAND, trace gravel			6.3			M	
		14	SS								
10		7	SS								
		11	SS					20.2			M
15		13	SS								
20		2	SS	(Stratum 2)	49.0						
				(END OF BORING)							
				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was not measured.							

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 20.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.



# LOG of BORING No. B-11

DATE 9/15/22 SURFACE ELEVATION 69.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Loose to medium dense dark gray silty medium to fine SAND, with gravel  (Stratum 1 - Fill)	64.0					
			AU							
5		13	SS	Loose to medium dense brown silty medium to fine SAND  - with gravel						
			SS							
		18	SS							
10		4	SS							
		13	SS							
		10	SS							
15										
		6	SS	(Stratum 2)	49.0					
20				(END OF BORING)						
25				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was measured at 16.5 ft depth.						
30										
35										
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 20.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.



# LOG of BORING No. B-12

DATE 9/15/22 SURFACE ELEVATION 68.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Loose brown fine sandy SILT (Stratum 1 - Fill)	65.0					
5		11	SS	Loose to medium dense brown silty medium to fine SAND  - trace gravel						
		12	SS							
10		7	SS							
		5	SS							
15		11	SS							
20		5	SS	(Stratum 2)	48.0		11.5			M
				(END OF BORING)			39.0			M
25				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was not measured.						
30										
35										
40										

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 20.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.



**LOG of BORING No. B-13**

DATE 9/20/22 SURFACE ELEVATION 69.0 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			AU	Medium dense light brown gray silty coarse to fine SAND, trace gravel						
			AU							
5		11	SS				12.6			M
		8	SS							
10		6	SS							
		7	SS							
15		13	SS	(Stratum 2)	54.0		25.5			M
				(END OF BORING)						
				Notes: 1. The boring was advanced to 5 ft depth using hand tools. Samples were obtained using hand tools at various depths. The relative density/consistency was evaluated based on the resistance to hand tools. 2. Groundwater was not measured.						

122222 BORLOGR NCC WEST WING LOGS.GPJ

Completion Depth: 15.0 ft. Water Depth: See ft., After \_\_\_\_\_ hrs.  
 Project No.: 60602492 Notes ft., After \_\_\_\_\_ hrs.  
 Project Name: West Wing Sanitary Sewer Force Main Project \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.  
 Drilling Method: Hollow Stem Augers \_\_\_\_\_ ft., After \_\_\_\_\_ hrs.



Appendix B  
Laboratory Testing

Physical property tests were conducted in the laboratory on selected representative soil samples to aid in classification and for correlation with engineering behavior of the soils. These tests included natural water content (ASTM D2216), and grain-size distribution (ASTM D422). Three unconsolidated-undrained (UU) triaxial compression tests (ASTM D2850) and one constant rate of strain consolidation test (CRS, ASTM D4186) were performed on three relatively undisturbed Shelby tube samples. One sample was tested for corrosivity evaluation, including pH, resistivity, chlorides, and sulfates.

The numerical results are summarized on Pages B-2 through B-3 and are also shown on the appropriate boring logs. Grain-size distribution curves are presented on Pages B-4 through B-10. Results of the UU triaxial compression tests are presented on Pages B-11 through B-13. Results of the CRS test are presented on Pages B-14 through B-16.



**Project: NCC West Wing**  
**Project No.: 60602492**



**SUMMARY OF LABORATORY TEST RESULTS**

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Analytical Results (ppm)			Triaxial Compression		Resistivity (Ohm-cm)	pH
						Liquid Limit	Plastic Limit			<#200 (%)	<2µ (%)			Chloride	Sulfate	Sulfide	UU	CIU		
B-01 GS-1	1.0-3.0	Brown SANDY LEAN CLAY	CL	5.0		29	17			68				112.4	54.5				7560	8.1
B-01 S-1	5.0-7.0	Brown POORLY GRADED SAND with SILT and GRAVEL	SP-SM	3.5						5										
B-01 S-5	13.0-15.0	Brown POORLY GRADED SAND with SILT	SP-SM	18.4						9										
B-01 S-7	24.0-26.0	Brown POORLY GRADED SAND with SILT	SP-SM	16.2						10										
B-01 ST-1	42.0-44.0	Gray SILTY SAND	SM	26.9		37	25			41	11		*							
B-01 S-13	54.0-56.0	Gray SANDY ELASTIC SILT	MH	33.4		50	29			50										
B-01 S-16	69.0-71.0	Gray CLAYEY SAND	SC	28.1		46	25			48										
B-02 S-6	19.0-21.0	Brown SILTY SAND	SM	20.7						20										
B-02 ST-1	26.0-28.0	Gray SILTY SAND	SM	32.1		NP	NP			36	11									*
B-04 S-3	9.0-11.0	Brown WELL-GRADED SAND with SILT and GRAVEL	SW-SM	16.0						12										
B-04 ST-1	27.0-29.0	Gray SILTY SAND	SM	23.3	106.4	27	23			31	10									*
B-05 S-6	19.0-21.0	Brown POORLY GRADED SAND with SILT	SP-SM	25.7						7										
B-06 S-3	8.0-10.0	Brown WELL-GRADED SAND with SILT and GRAVEL	SW-SM	6.0						10										
B-07 S-3	8.0-10.0	Brown POORLY GRADED SAND with SILT and GRAVEL	SP-SM	2.1						8										
B-10 S-1	5.0-7.0	Brown SILTY SAND	SM	6.3						13										
B-10 S-4	11.0-13.0	Brown POORLY GRADED SAND with SILT	SP-SM	20.2						8										
B-12 S-5	13.0-15.0	Brown SILTY SAND with GRAVEL	SM	11.5						14										
B-12 S-6	18.0-20.0	Brown SILTY SAND	SM	39.0						19										
B-13 S-1	5.0-7.0	Brown SILTY SAND	SM	12.6						26										

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

\* Refer to Laboratory Test Curves

**Project: NCC West Wing**  
**Project No.: 60602492**



**SUMMARY OF LABORATORY TEST RESULTS**

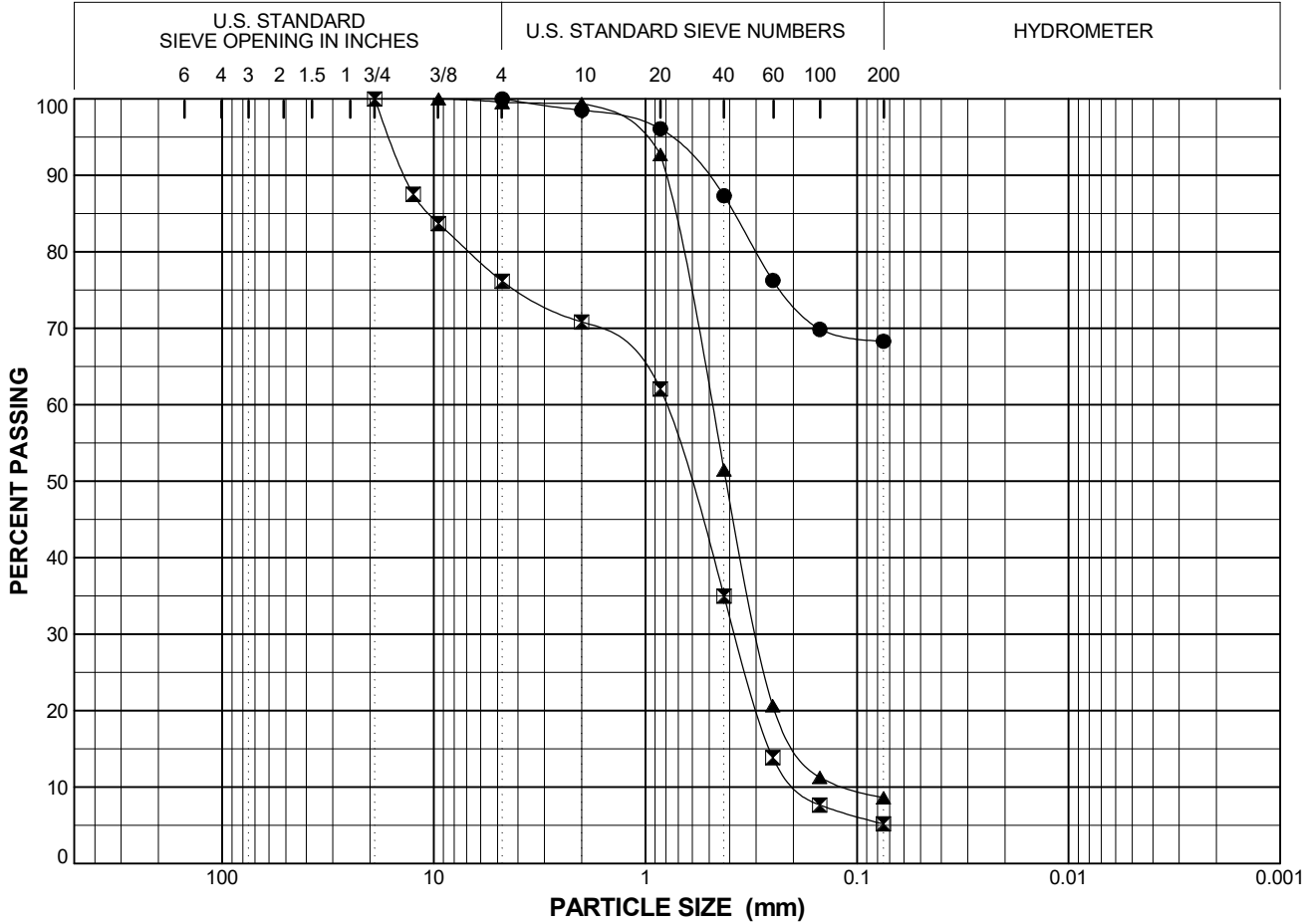
Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Analytical Results (ppm)			Triaxial Compression		Resistivity (Ohm-cm)	pH
						Liquid Limit	Plastic Limit			<#200 (%)	<2μ (%)			Chloride	Sulfate	Sulfide	UU	CIU		
B-13 S-4	13.0-15.0	Brown SILTY SAND	SM	25.5						23										

Note: The soil classification is based partially on visual classification unless both grain size and Atterberg limits are performed.

\* Refer to Laboratory Test Curves

SIEVE\_BLUEBELL\_NO FIG 60602492\_2022-10-09\_NCC WEST.GPJ\_URS\_BLUE.GDT 11/14/22

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-01	B-01	B-01
Sample	GS-1	S-1	S-5
Spec			
Depth (ft)	1.0-3.0	5.0-7.0	13.0-15.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	23.9	0.5
% Sand	31.7	71.0	90.9
% Fines	68.3	5.2	8.6
% -2μ			
Cc		0.96	1.64
Cu		4.43	4.56
LL	29		
PL	17		
PI	12		
USCS	CL	SP-SM	SP-SM
w (%)	5.0	3.5	18.4

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1-1/2"			
1"			
3/4"		100.0	
1/2"		87.5	
3/8"		83.7	100.0
4	100.0	76.1	99.5
10	98.5	70.8	99.4
20	96.1	62.0	92.7
40	87.3	35.0	51.5
60	76.3	13.9	20.7
100	69.9	7.7	11.3
200	68.3	5.2	8.6

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SANDY LEAN CLAY (CL)
☒	Brown POORLY GRADED SAND with SILT and GRAVEL (SP-SM)
▲	Brown POORLY GRADED SAND with SILT (SP-SM)

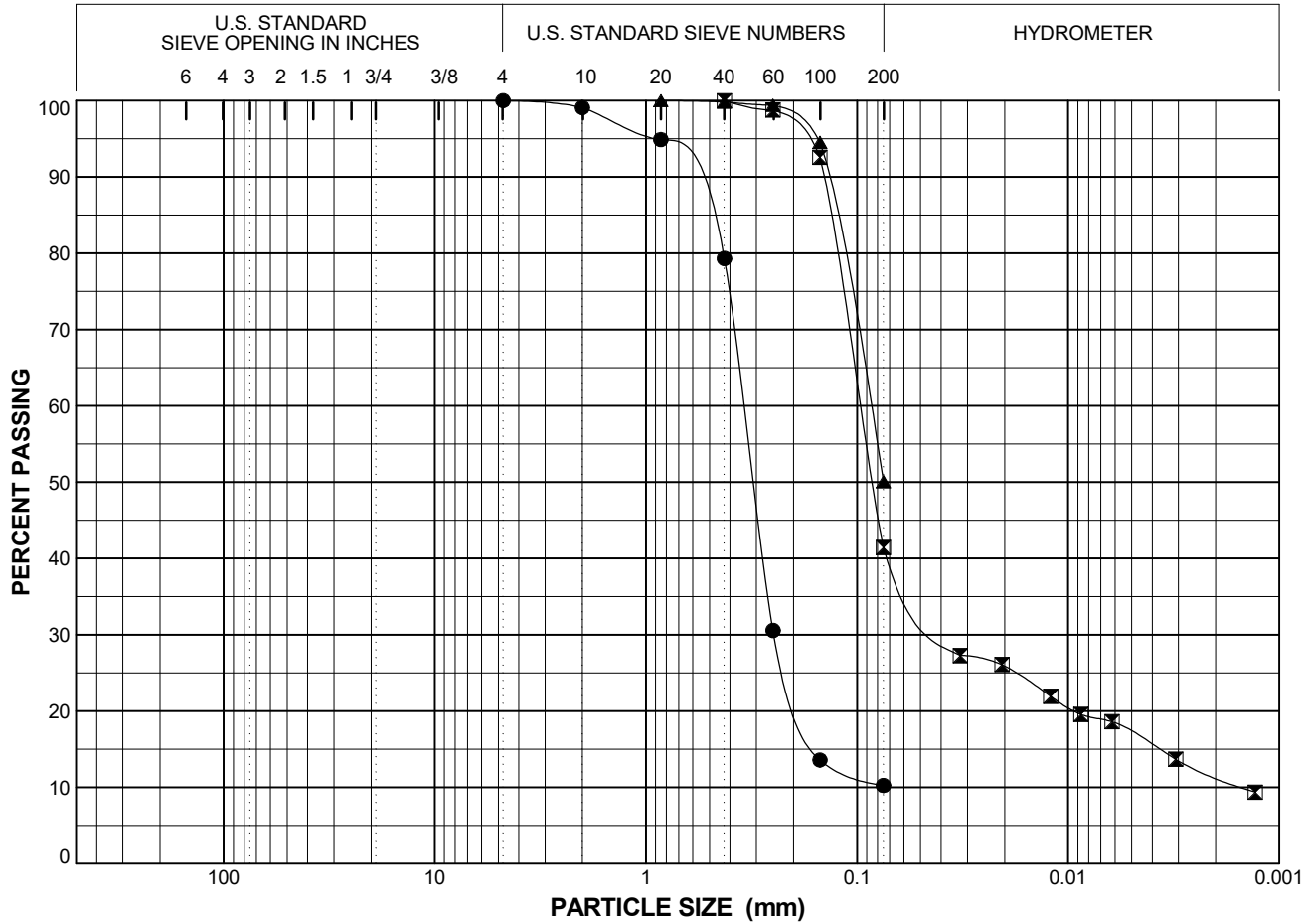
**PARTICLE SIZE DISTRIBUTION**  
NCC West Wing

Project Number 60602492	November 2022
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SIEVE\_BLUEBELL\_NO FIG 60602492\_2022-10-09\_NCC WEST.GPJ\_URS\_BLUE.GDT 11/14/22

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-01	B-01	B-01
Sample	S-7	ST-1	S-13
Spec			
Depth (ft)	24.0-26.0	42.0-44.0	54.0-56.0
% +3"	0.0	0.0	0.0
% Gravel	0.0	0.0	0.0
% Sand	89.8	58.6	49.9
% Fines	10.2	41.4	50.1
% -2 $\mu$		11.5	
Cc	2.46	10.15	
Cu	4.82	65.22	
LL		37	50
PL		25	29
PI		12	21
USCS	SP-SM	SM	MH
w (%)	16.2	26.9	33.4

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1-1/2"			
1"			
3/4"			
1/2"			
3/8"			
4	100.0		
10	99.1		
20	94.9		100.0
40	79.3	100.0	99.8
60	30.6	98.8	99.4
100	13.6	92.5	94.5
200	10.2	41.4	50.1

SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)
☒	Gray SILTY SAND (SM)
▲	Gray SANDY ELASTIC SILT (MH)

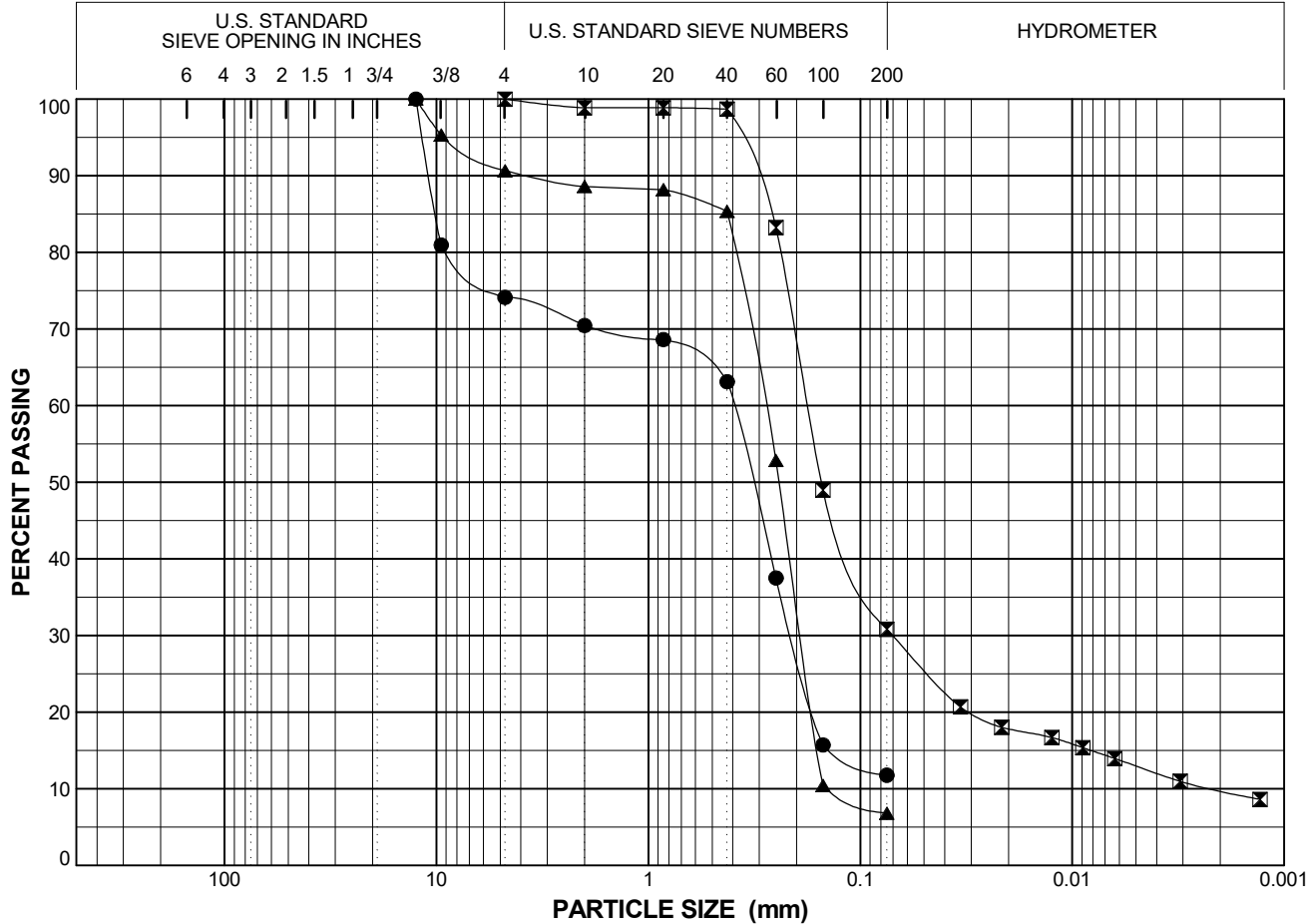
**PARTICLE SIZE DISTRIBUTION**  
NCC West Wing

Project Number 60602492    November 2022



SIEVE\_BLUEBELL\_NO FIG 60602492\_2022-10-09\_NCC WEST.GPJ\_URS\_BLUE.GDT 11/14/22

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-04	B-04	B-05
Sample	S-3	ST-1	S-6
Spec			
Depth (ft)	9.0-11.0	27.0-29.0	19.0-21.0
% +3"	0.0	0.0	0.0
% Gravel	25.9	0.0	9.3
% Sand	62.4	69.2	83.9
% Fines	11.8	30.8	6.8
% -2 $\mu$		9.8	
Cc	2.00	12.90	0.93
Cu	7.24	81.54	2.04
LL		27	
PL		23	
PI		4	
USCS	SW-SM	SM	SP-SM
w (%)	16.0	23.3	25.7

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1-1/2"			
1"			
3/4"			
1/2"	100.0		100.0
3/8"	81.0		95.3
4	74.1	100.0	90.7
10	70.4	98.9	88.6
20	68.6	98.9	88.2
40	63.1	98.7	85.4
60	37.5	83.2	52.9
100	15.7	49.0	10.4
200	11.8	30.8	6.8

SYMBOL	DESCRIPTION AND REMARKS
●	Brown WELL-GRADED SAND with SILT and GRAVEL (SW-SM)
☒	Gray SILTY SAND (SM)
▲	Brown POORLY GRADED SAND with SILT (SP-SM)

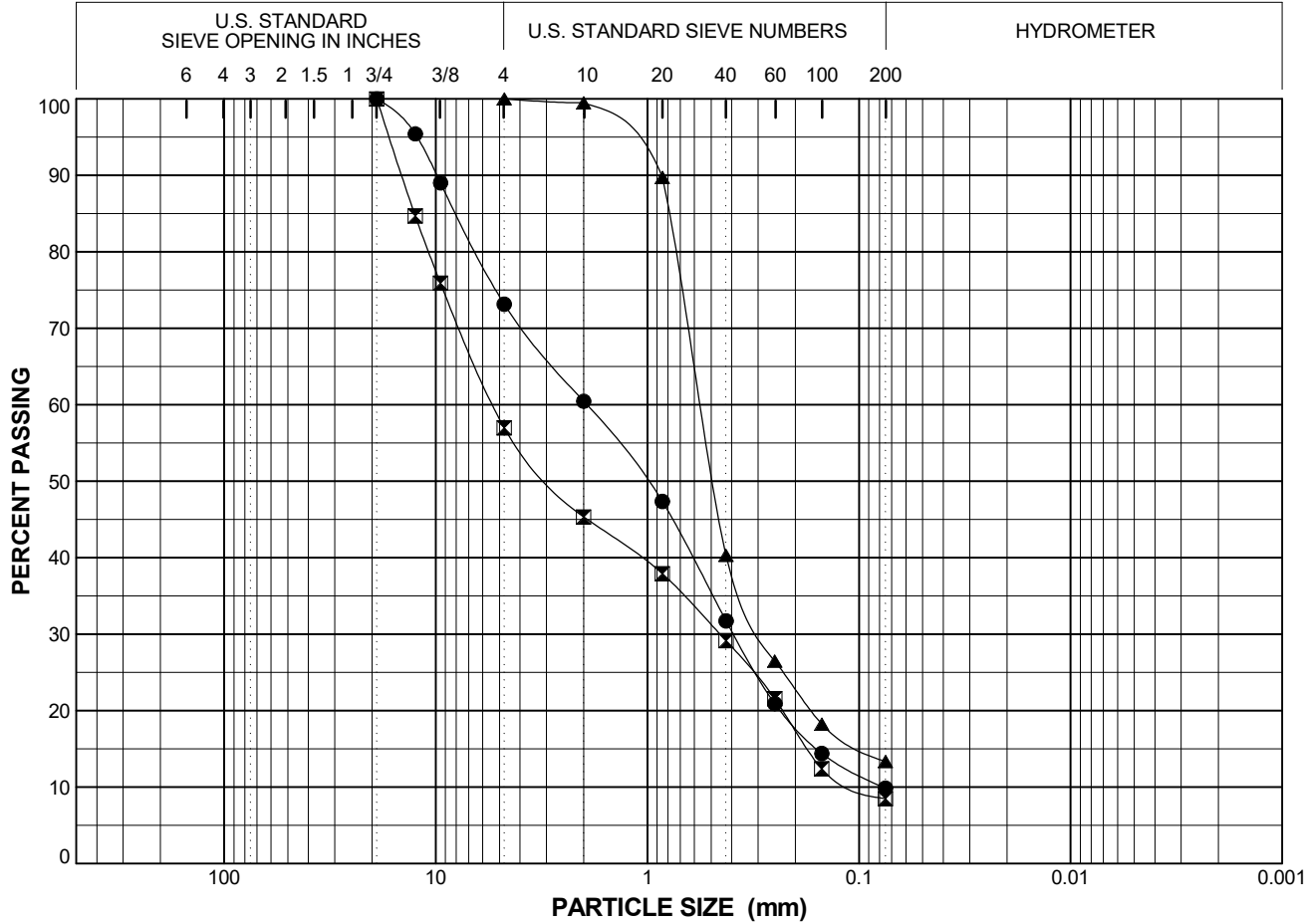
**PARTICLE SIZE DISTRIBUTION**  
NCC West Wing

Project Number 60602492    November 2022

**AECOM**

SIEVE\_BLUEBELL\_NO FIG 60602492\_2022-10-09\_NCC WEST.GPJ\_URS\_BLUE.GDT 11/14/22

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-06	B-07	B-10
Sample	S-3	S-3	S-1
Spec			
Depth (ft)	8.0-10.0	8.0-10.0	5.0-7.0
% +3"	0.0	0.0	0.0
% Gravel	26.9	43.0	0.0
% Sand	63.3	48.5	86.7
% Fines	9.9	8.5	13.3
% -2 $\mu$			
Cc	1.03	0.40	
Cu	25.36	54.10	
LL			
PL			
PI			
USCS	SW-SM	SP-SM	SM
w (%)	6.0	2.1	6.3

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1-1/2"			
1"			
3/4"	100.0	100.0	
1/2"	95.4	84.7	
3/8"	89.0	75.9	
4	73.1	57.0	100.0
10	60.5	45.3	99.5
20	47.4	37.9	89.7
40	31.7	29.1	40.3
60	20.9	21.6	26.5
100	14.4	12.4	18.2
200	9.9	8.5	13.3

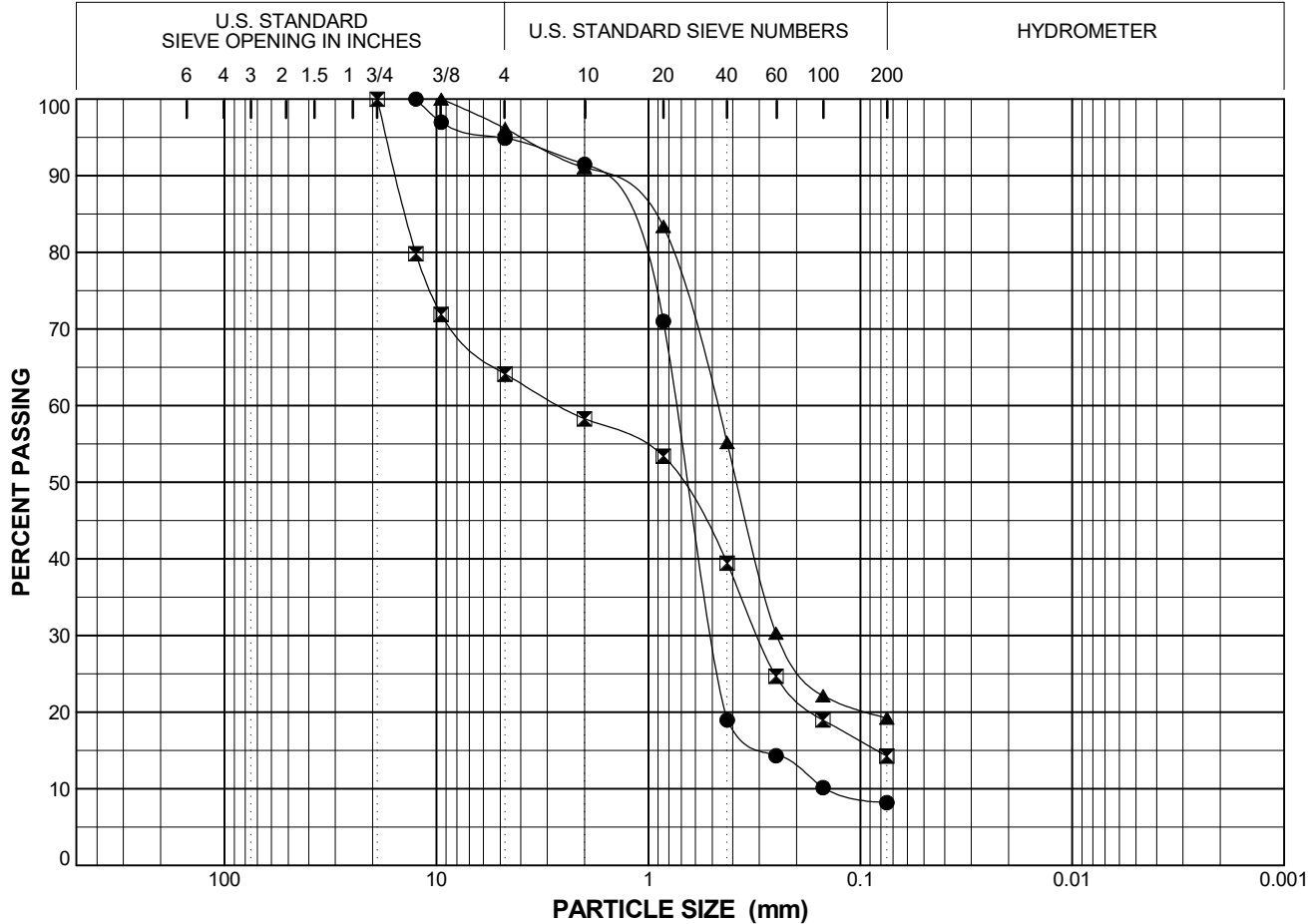
SYMBOL	DESCRIPTION AND REMARKS
●	Brown WELL-GRADED SAND with SILT and GRAVEL (SW-SM)
☒	Brown POORLY GRADED SAND with SILT and GRAVEL (SP-SM)
▲	Brown SILTY SAND (SM)

**PARTICLE SIZE DISTRIBUTION**  
NCC West Wing

Project Number 60602492    November 2022

SIEVE\_BLUEBELL\_NO FIG 60602492\_2022-10-09\_NCC WEST.GPJ\_URS\_BLUE.GDT 11/14/22

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒	▲
Boring	B-10	B-12	B-12
Sample	S-4	S-5	S-6
Spec			
Depth (ft)	11.0-13.0	13.0-15.0	18.0-20.0
% +3"	0.0	0.0	0.0
% Gravel	5.1	35.9	3.8
% Sand	86.7	49.8	76.9
% Fines	8.2	14.3	19.2
% -2 $\mu$			
Cc	2.32		
Cu	5.16		
LL			
PL			
PI			
USCS	SP-SM	SM	SM
w (%)	20.2	11.5	39.0

Particle Size (Sieve #)	PERCENT FINER		
	●	☒	▲
2"			
1-1/2"			
1"			
3/4"		100.0	
1/2"	100.0	79.8	
3/8"	97.0	71.9	100.0
4	94.9	64.1	96.2
10	91.5	58.3	91.0
20	71.0	53.4	83.4
40	19.0	39.4	55.2
60	14.3	24.7	30.3
100	10.2	19.0	22.1
200	8.2	14.3	19.2

SYMBOL	DESCRIPTION AND REMARKS
●	Brown POORLY GRADED SAND with SILT (SP-SM)
☒	Brown SILTY SAND with GRAVEL (SM)
▲	Brown SILTY SAND (SM)

**PARTICLE SIZE DISTRIBUTION**  
NCC West Wing

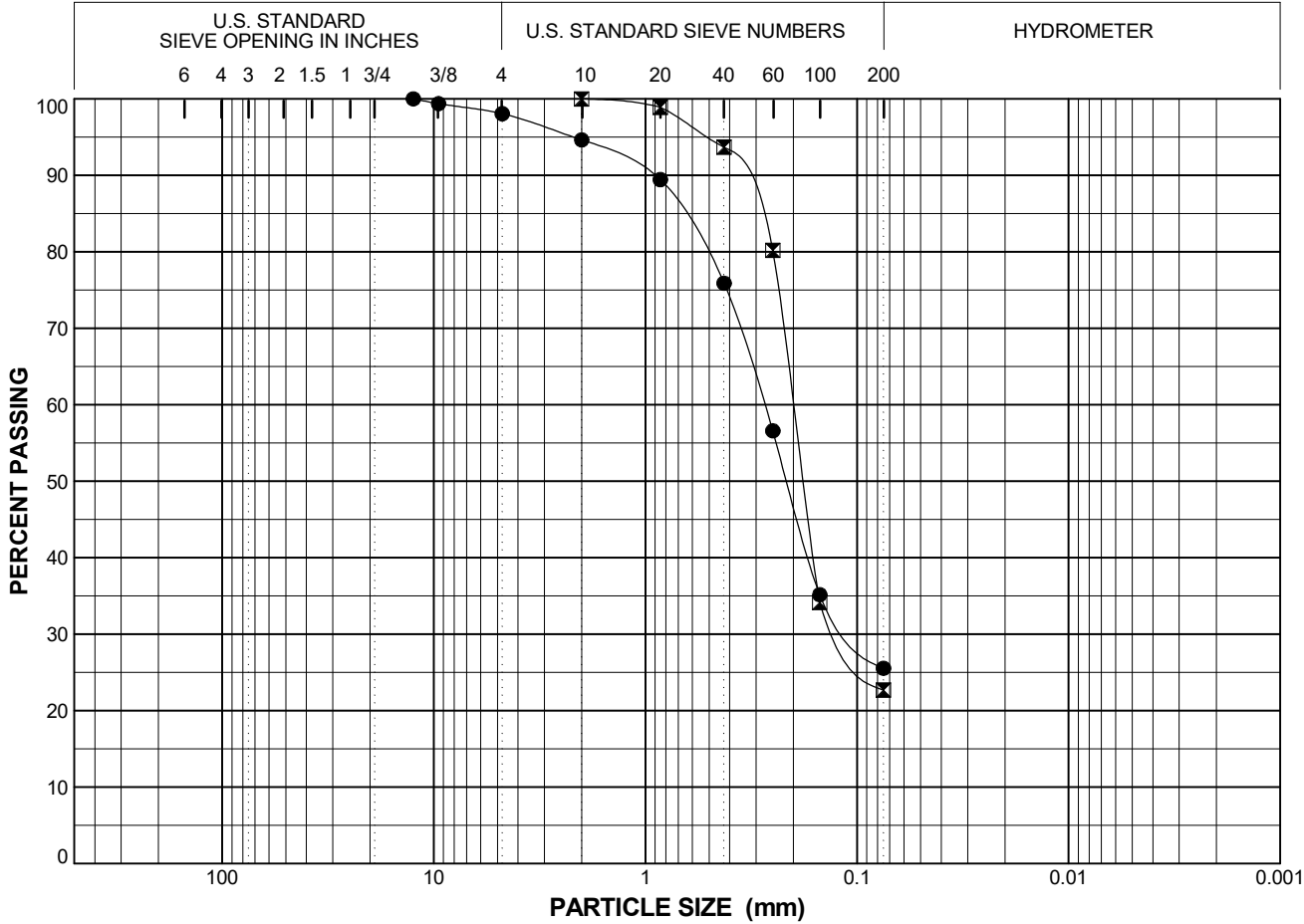
Project Number 60602492	November 2022
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**AECOM**



SIEVE\_BLUEBELL\_NO FIG 60602492\_2022-10-09\_NCC WEST.GPJ\_URS\_BLUE.GDT 11/14/22

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	



SYMBOL	●	☒
Boring	B-13	B-13
Sample	S-1	S-4
Spec		
Depth (ft)	5.0-7.0	13.0-15.0
% +3"	0.0	0.0
% Gravel	1.9	0.0
% Sand	72.5	77.3
% Fines	25.5	22.7
% -2 $\mu$		
Cc		
Cu		
LL		
PL		
PI		
USCS	SM	SM
w (%)	12.6	25.5

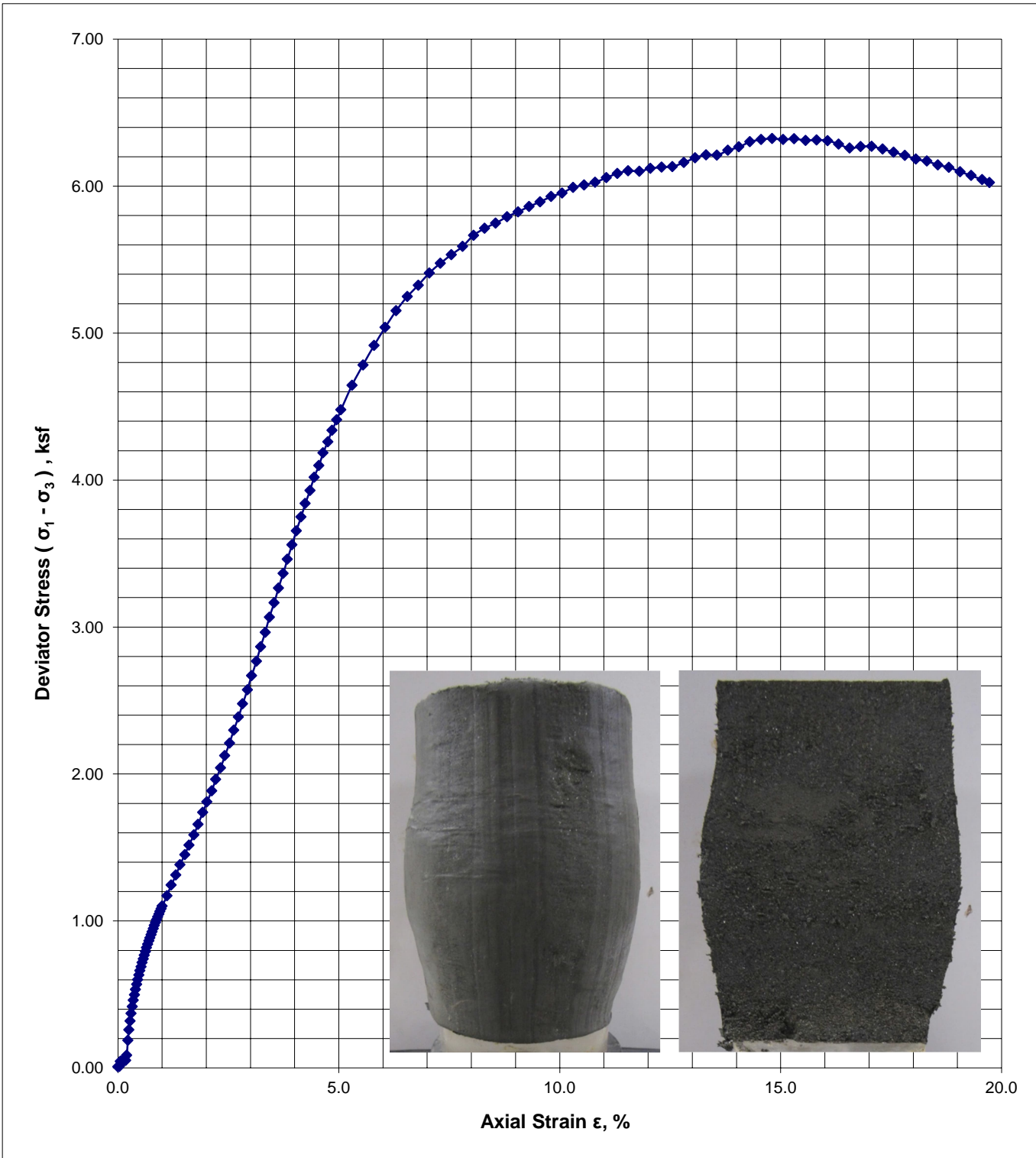
Particle Size (Sieve #)	PERCENT FINER	
	●	☒
2"		
1-1/2"		
1"		
3/4"		
1/2"	100.0	
3/8"	99.4	
4	98.1	
10	94.6	100.0
20	89.4	98.9
40	75.9	93.7
60	56.6	80.2
100	35.2	34.1
200	25.5	22.7

SYMBOL	DESCRIPTION AND REMARKS
●	Brown SILTY SAND (SM)
☒	Brown SILTY SAND (SM)

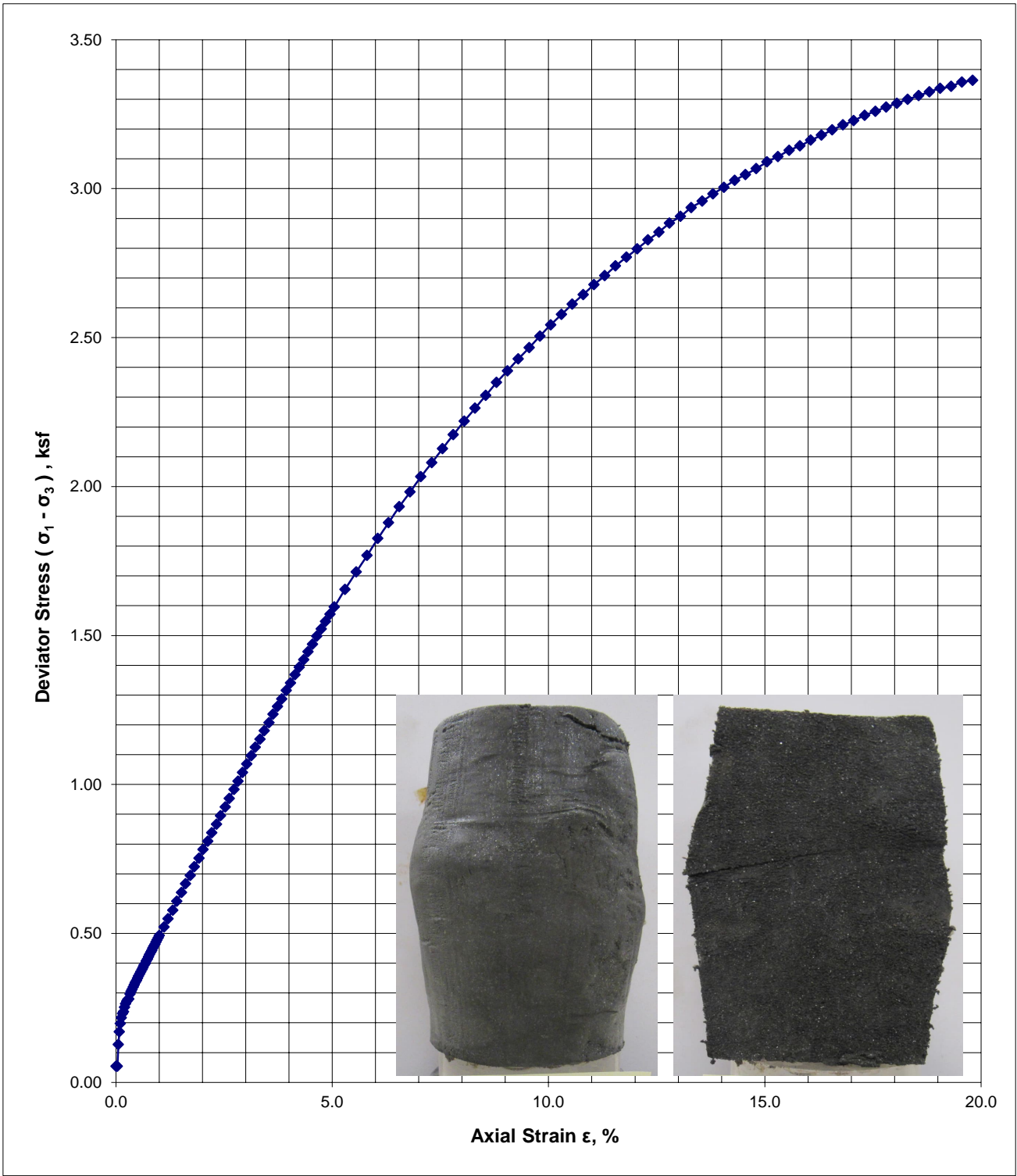
**PARTICLE SIZE DISTRIBUTION**  
NCC West Wing

Project Number 60602492	November 2022
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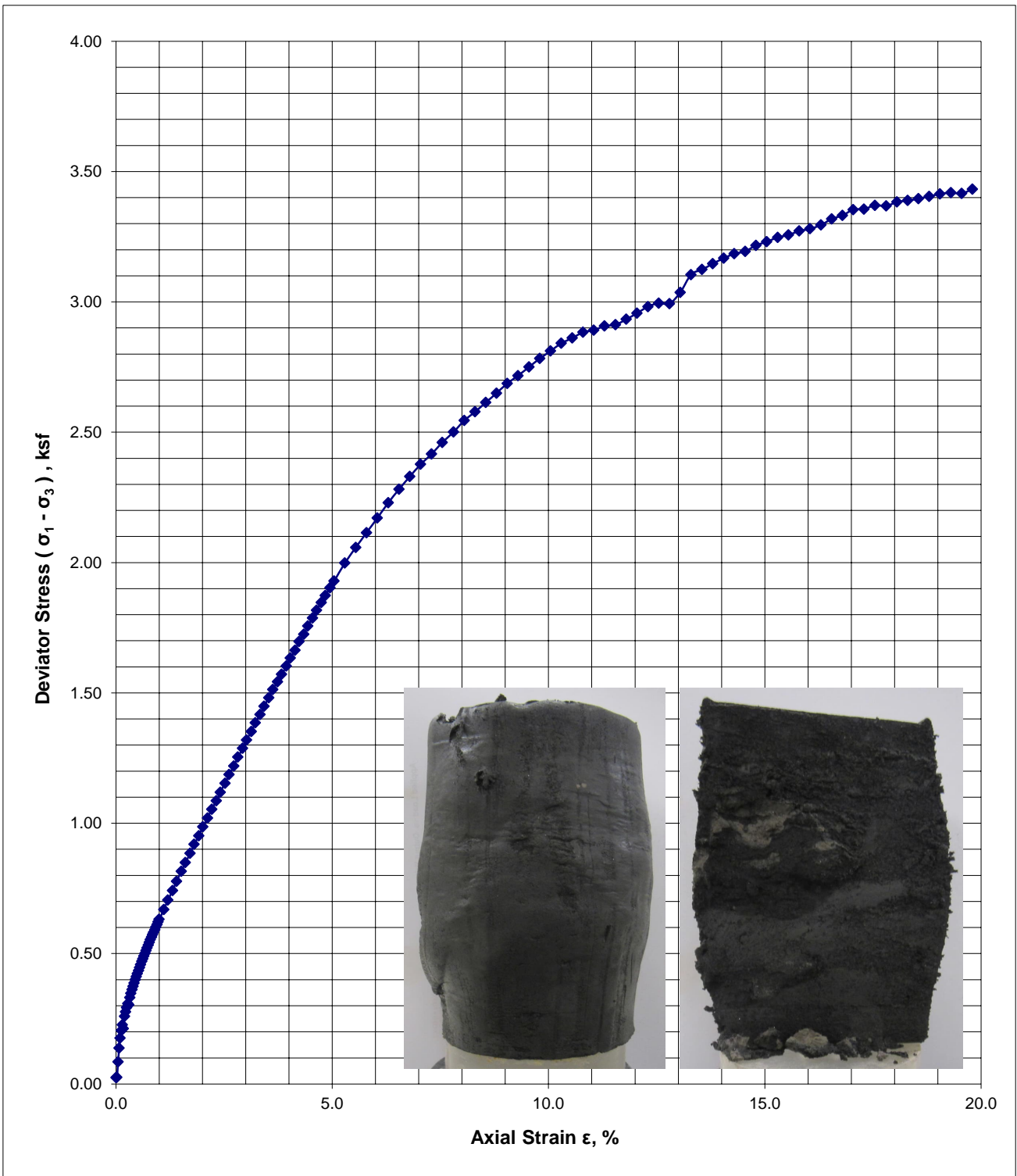
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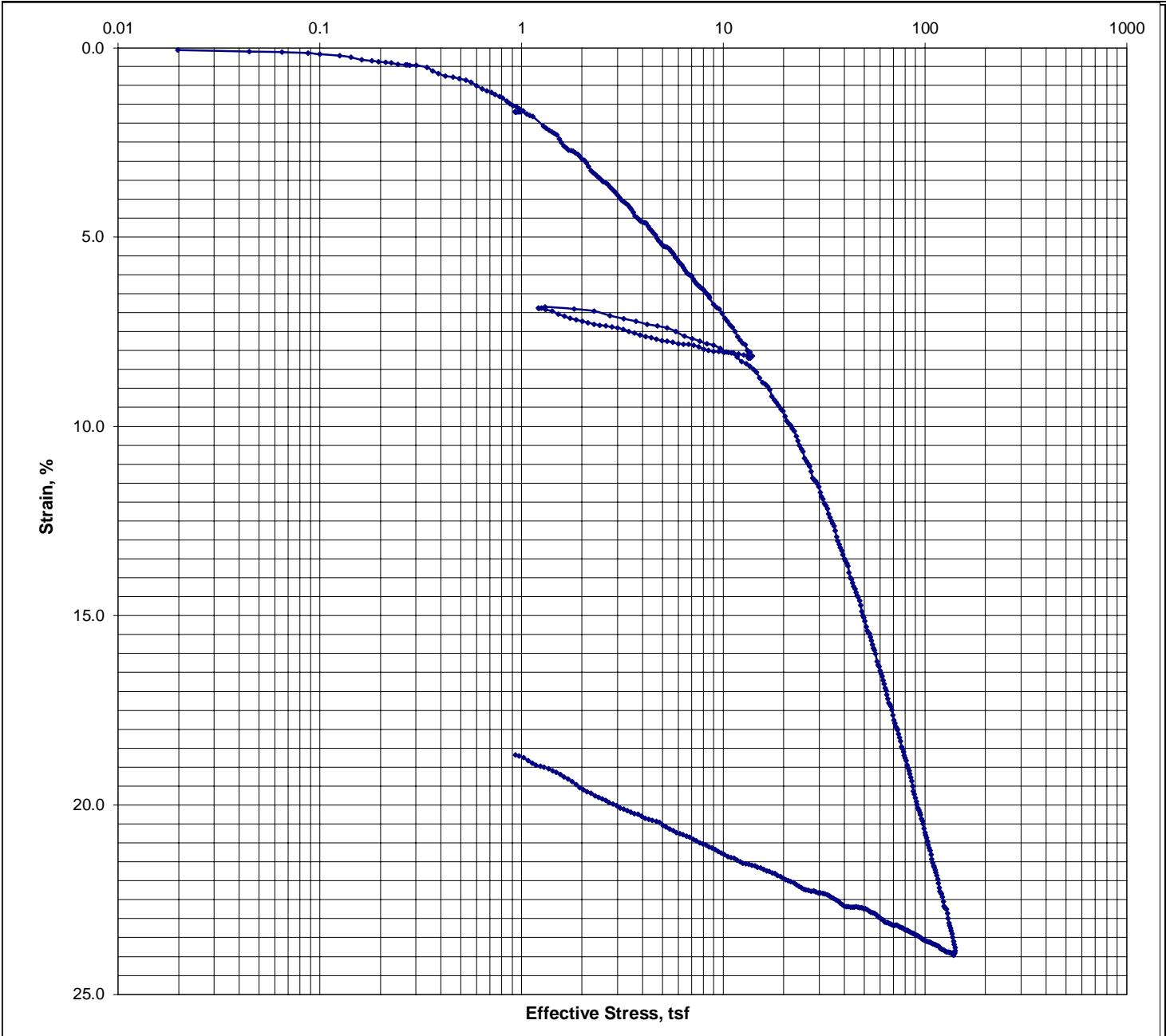
Specimen Information					Test Summary					
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits		Initial Length (in)	Initial Dia. (in)	$\sigma_3$ (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	$\epsilon_f$ %	Strain Rate (%/min)
30.2	119.6	91.9	LL	PL	5.77	2.85	2.02	6.32	14.8	1.0
Description:			Gray SILTY SAND			Tested by: TV		Reviewed by: MHD		
Project No.: 60602492		Project Name: NCC West Wing			Unconsolidated-Undrained Triaxial Compression (UU) Test ASTM D 2850					
Boring No.: B-01			Sample No.: ST-1		Sample Depth (ft): 43.0-43.5		Date: 11/2/2022			



Specimen Information						Test Summary				
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits		Initial Length (in)	Initial Dia. (in)	σ <sub>3</sub> (ksf)	(σ <sub>1</sub> - σ <sub>3</sub> ) <sub>max</sub> (ksf)	ε <sub>f</sub> %	Strain Rate (%/min)
			LL	PL						
31.7	121.2	92.1	NP	NP	5.75	2.83	0.72	3.09	15.0	1.0
Description:		Gray SILTY SAND				Tested by: TV		Reviewed by: MHD		
Project No.: 60602492		Project Name: NCC West Wing		Unconsolidated-Undrained Triaxial Compression (UU) Test ASTM D 2850						
Boring No.: B-02		Sample No.: ST-1		Sample Depth (ft): 27.3-27.8			Date: 11/14/2022			



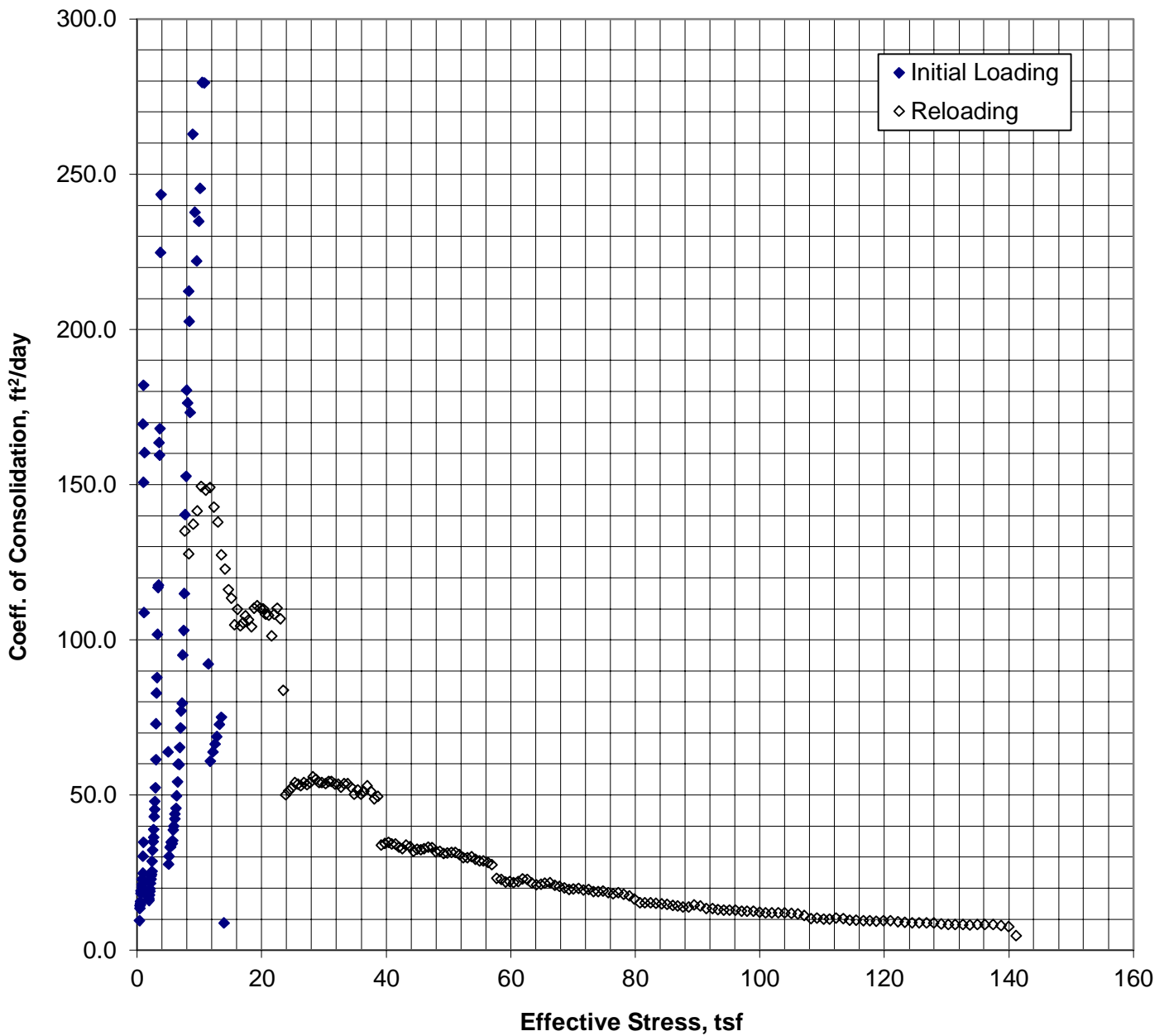
Specimen Information						Test Summary				
Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Atterberg Limits		Initial Length (in)	Initial Dia. (in)	$\sigma_3$ (ksf)	$(\sigma_1 - \sigma_3)_{max}$ (ksf)	$\epsilon_f$ %	Strain Rate (%/min)
			LL	PL						
24.4	131.4	105.6	27	23	5.77	2.85	1.51	3.23	15.0	1.0
Description:		Gray SILTY SAND				Tested by: TV		Reviewed by: MHD		
Project No.: 60602492		Project Name: NCC West Wing			Unconsolidated-Undrained Triaxial Compression (UU) Test ASTM D 2850					
Boring No.: B-04		Sample No.: ST-1		Sample Depth (ft): 28.1-28.6			Date: 11/14/2022			



**One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading (ASTM D 4186)**

Description of Specimen:		Gray SILTY SAND			
Nat. Water Content (%)	26.9 (From Trims.)	<b>Consolidation Properties (Unit Strain Basis)</b>		Project No:	60602492
Liquid Limit (%)	37 (From Trims.)	Compression Ratio (Cc)*	0.19	Project Name	NCC West Wing
Plastic Limit (%)	25 (From Trims.)	Recompression Ratio (Cr)*	0.01	Project Client	AECOM
Plastic Index (%)	12 (From Trims.)	Swelling Ratio (Cs)*	0.02	Boring No.	B-01
Specific Gravity	2.7 (Assumed)	Preconsolidation Stress, Pc (tsf)*	11.3	Sample No.	ST-1
<b>Test Specimen Properties</b>		Existing Overburden Stress, Po (tsf)*		Depth, ft.	43.5-43.7
Diameter, inch.	2.50			Tested By	CD
Initial And Final Thickness, inch.	0.751	0.662		Reviewed By	YM
Initial And Final Water Content (%)	26.7	22.4		Date	02-Nov-22
Initial And Final Void Ratio	0.826	0.609		Assignment #	2022-10-09
Initial And Final Saturation (%)	87.2	99.6			
Unit Dry Weight (pcf)	92.3	104.8			

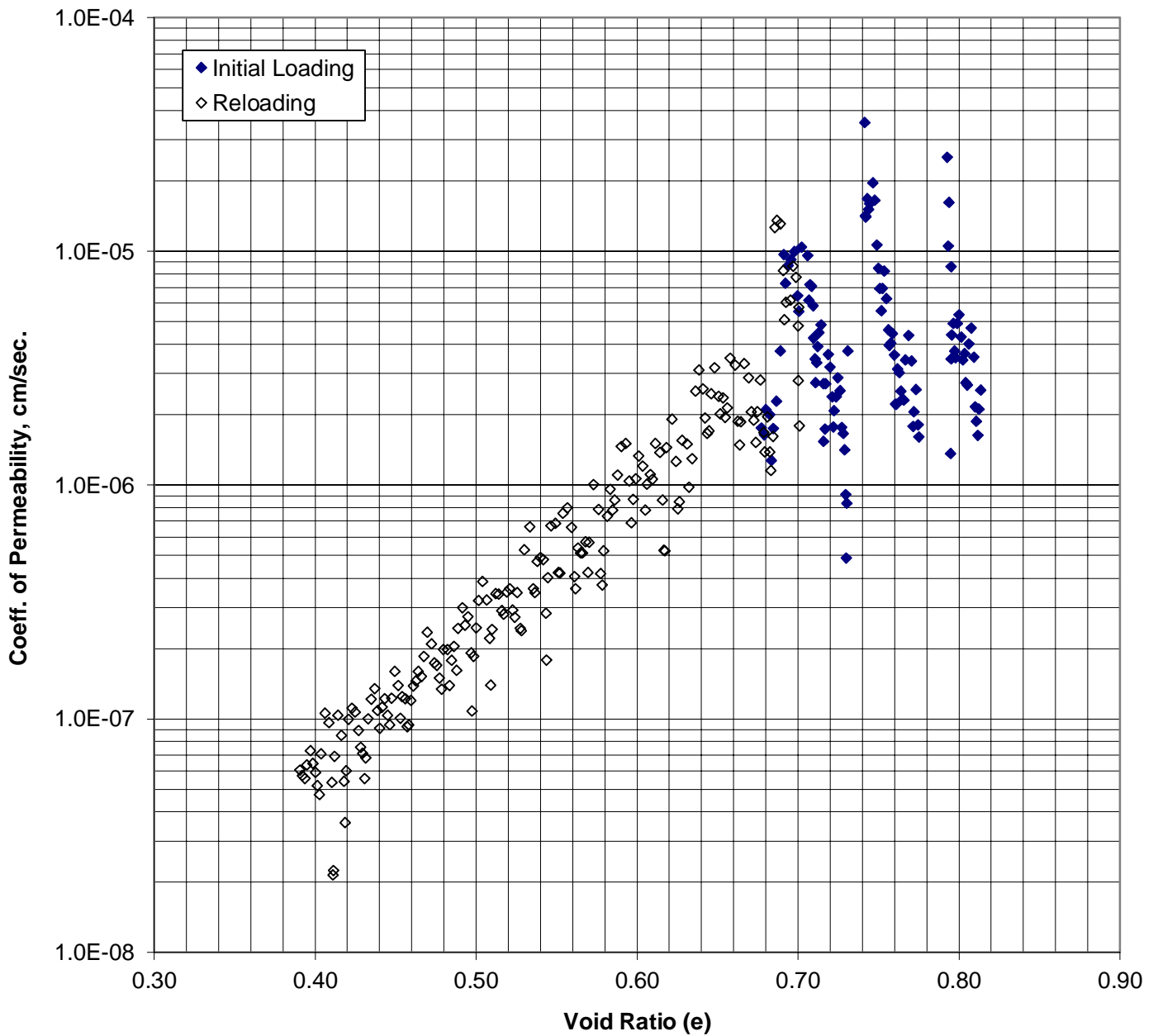




**One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading (ASTM D 4186)**

Description of Specimen:		Gray SILTY SAND			
Nat. Water Content (%)	26.9 (From Trims.)	<b>Consolidation Properties (Unit Strain Basis)</b>			
Liquid Limit (%)	37 (From Trims.)	Compression Ratio (Cc') *	0.19	Project No:	60602492
Plastic Limit (%)	25 (From Trims.)	Recompression Ratio (Cr)*	0.01	Project Name	NCC West Wing
Plastic Index (%)	12 (From Trims.)	Swelling Ratio (Cs)*	0.02		
Specific Gravity	2.7 (Assumed)	Preconsolidation Stress, Pc (tsf)*	11.3	Project Client	AECOM
<b>Test Specimen Properties</b>		Existing Overburden Stress, Po (tsf)*		Boring No.	B-01
Diameter, inch.	2.50			Sample No.	ST-1
Initial And Final Thickness, inch.	0.751	0.662		Depth, ft.	43.5-43.7
Initial And Final Water Content (%)	26.7	22.4		Tested By	CD
Initial And Final Void Ratio	0.826	0.609		Reviewed By	YM
Initial And Final Saturation (%)	87.2	99.6		Date	2-Nov-22
Unit Dry Weight (pcf)	92.3	104.8		Assignment #	2022-10-09





**One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading (ASTM D 4186)**

Description of Specimen:		Gray SILTY SAND			
Nat. Water Content (%)	26.9 (From Trims.)	<b>Consolidation Properties (Unit Strain Basis)</b>			
Liquid Limit (%)	37 (From Trims.)	Compression Ratio (Cc') *	0.19	Project No:	60602492
Plastic Limit (%)	25 (From Trims.)	Recompression Ratio (Cr)*	0.01	Project Name	NCC West Wing
Plastic Index (%)	12 (From Trims.)	Swelling Ratio (Cs)*	0.02		
Specific Gravity	2.7 (Assumed)	Preconsolidation Stress, Pc (tsf)*	11.3	Project Client	AECOM
<b>Test Specimen Properties</b>		Existing Overburden Stress, Po (tsf)*		Boring No.	B-01
Diameter, inch.	2.50			Sample No.	ST-1
Initial And Final Thickness, inch.	0.751	0.662		Depth, ft.	43.5-43.7
Initial And Final Water Content (%)	26.7	22.4		Tested By	CD
Initial And Final Void Ratio	0.826	0.609		Reviewed By	YM
Initial And Final Saturation (%)	87.2	99.6		Date	2-Nov-22
Unit Dry Weight (pcf)	92.3	104.8		Assignment #	2022-10-09



**DNREC WPCC**