VOLUME 2 of 2
DIVISIONS 2 THROUGH 16

CONTRACT DOCUMENTS

ARLINGTON WASTEWATER TREATMENT PLANT

UPGRADE

FOR THE

TOWN OF POUGHKEEPSIE
1 OVEROCKER ROAD
POUGHKEEPSIE, NEW YORK

CCONTRACT NO. 14-014 GC GENERAL CONSTRUCTION
CONTRACT NO.14-014 EC ELECTRICAL CONSTRUCTION
CONTRACT NO. 14-014 HC HVAC CONSTRUCTION

MA#60401.30

TOWN SUPERVISOR	TODD TANCREDI
BOARD MEMBERS	JON BAISLEY - FIRST WARD BILL CARLOS - SECOND WARD JOSEPH CONTE - THIRD WARD MICHAEL CIFONE - FOURTH WARD STEPHEN KRAKOWER - FIFTH WARD ANN SHERSHIN - SIXTH WARD
TOWN CLERK	FELICIA SALVATORE

Date: January 2014
Revised: March 2015
Revised: November 2015
PREPARED BY:

MORRIS ASSOCIATES
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SECTION 02010 – SUBSURFACE INVESTIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Subsurface soil investigations have been made and a geotechnical report prepared by a Geotechnical Engineer. The investigations and resulting report were prepared for design purposes and the opinions expressed in the report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. The location of each exploration is shown on the Contract Drawings. The Boring Logs are included within this Section for the Contractors convenience, however, the Owner and Engineer assume no responsibility for the accuracy of this information or for interpretations or conclusions drawn from this data. The Contractor is expected to examine the sites and the Boring Logs and then determine for themselves the character of the materials to be encountered.

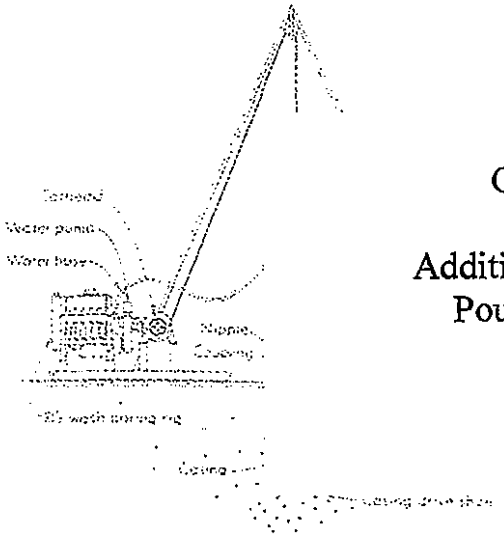
PART 2 - PRODUCTS (Not Applicable)

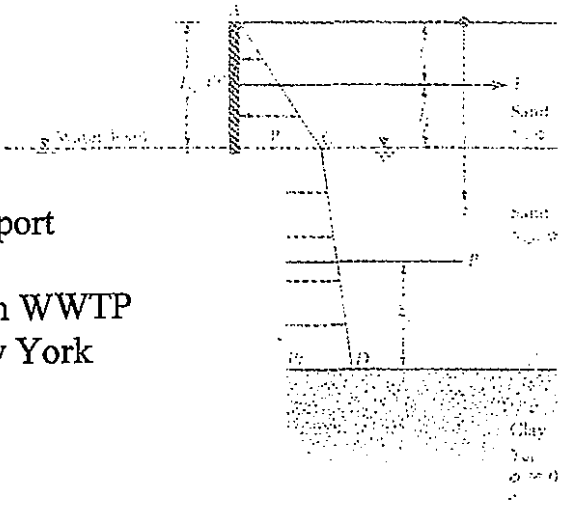
PART 3 - EXECUTION(Not Applicable)

END OF SECTION 02010

DANIEL G. LOUCKS, P.E.

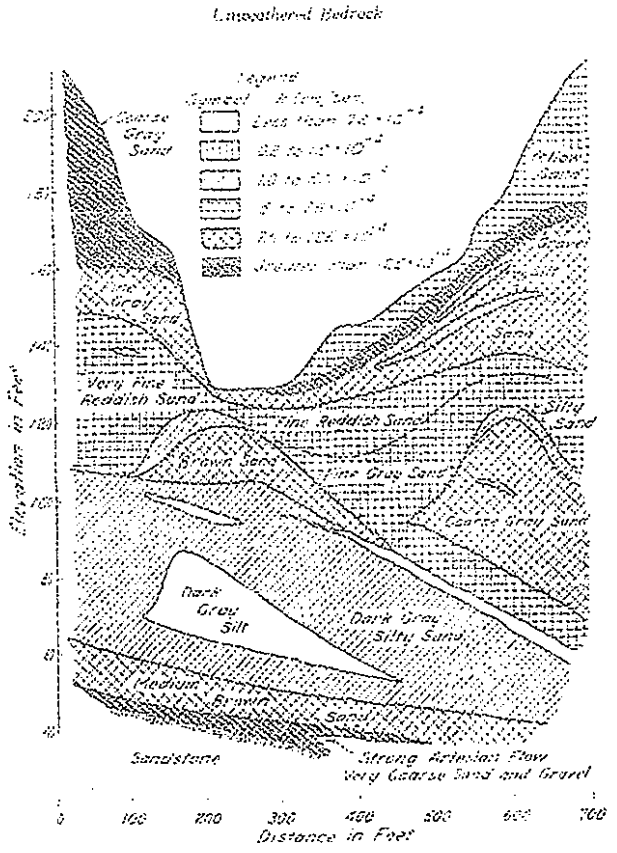
GEOTECHNICAL ENGINEERING

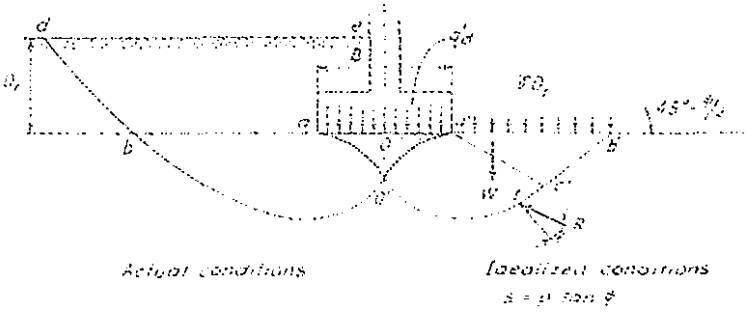


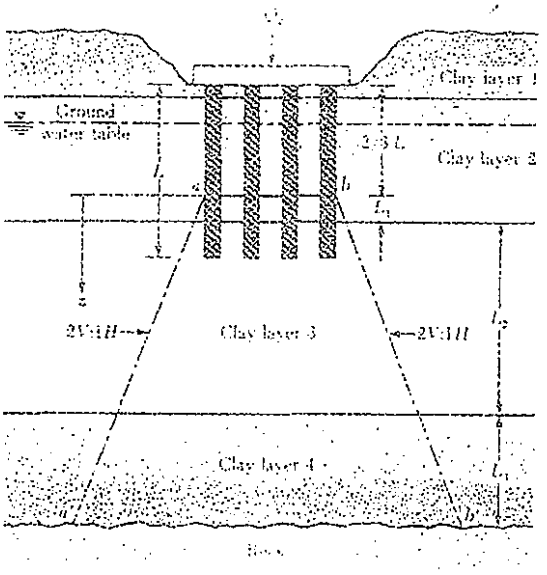


Geotechnical Report
For
Additions to Arlington WWTP
Poughkeepsie, New York

File No. 2138







P.O. BOX 163, BALLSTON SPA, NY 12020

Geotechnical Report
For
Additions to Arlington WWTP
Poughkeepsie, New York

File No. 2138

Prepared For:

Morris Associates

Prepared By:

Daniel G Loucks, PE
NYSPE 068389

17 December 2009

RECEIVED
DEC 21 2009
MORRIS ASSOCIATES

INTRODUCTION:

The subsurface investigation for the proposed Additions to the Arlington WWTP, Poughkeepsie, New York has been completed. Soil & Material Testing of Castleton, New York has completed four (4) soil borings at the site. The logs of these borings, along with a location diagram, have been included in the appendix of this report.

It is my understanding that the proposed construction will include two buildings. The Grit/Ash building will be a single-story building located approximately as indicated on the boring location diagram. The Headworks building will be single-story with some lower tank structures, located approximately as indicated on the boring location diagram. The grit/ash building will have a steel frame design and the headworks building will a reinforced concrete design for the lower tank structures and a steel frame or masonry wall design for the upper portion of the building.

The maximum column loadings will range from 50 to 75 kips. Bearing wall loads will range from 1 to 4 kips per foot of wall. The settlement tolerances are normal. Settlement tolerances are considered to include up to 1 inch of total settlement and 3/4 inch of differential settlement between column locations.

The first floor slab will be established at approximately elevation 82 for the grit/ash building. This will require up to approximately 6 feet of cut. The deepest tank elevation in the headworks building will be 66.8 feet. This will require approximately 12 feet of cut. The finished floor elevation for the headworks building will be placed at elevation 80. This will require up to 3 feet of fill and 3 feet of cut.

The purpose of this report is to describe the investigation conducted and the results obtained; to analyze and interpret the data obtained; and to make recommendations for the design and construction of the feasible foundation types and earthworks for the project.

The scope of my services has been limited to coordinating the boring and laboratory investigation, analyzing the soils information, and providing a geotechnical report with foundation recommendations and seismic site classifications as per NYS Building Code. Environmental aspects of the project as well as grading and site design should be performed by qualified others.

FIELD INVESTIGATION PROCEDURES:

The borings were extended by means of 3.25 inch ID, hollow-stem augers and by using various cutting bits using circulating drilling fluid to remove the cuttings from the hole.

Representative samples were obtained from the boring holes by means of the split-spoon sampling procedure performed in accordance with ASTM D 1586. The standard penetration values obtained from this procedure have been indicated on the soil boring logs.

Soil samples obtained from these procedures were examined in the field, sealed in containers, and shipped to the laboratory for further examination, classification and testing, as applicable.

Representative samples of the rock materials were obtained by means of the diamond-bit sampling procedure performed in accordance with ASTM D 2113. NX-size core barrels were used for this sampling procedure. Rock samples obtained from this procedure were examined in the field, placed in wooden core-sample boxes and shipped to the laboratory for further examination and classification.

During the investigation, water level readings were obtained at various times where water accumulated in the boring hole. The water level readings, along with an indication of the time of the reading relative to the boring procedure, have been indicated on the soil boring logs.

In addition to the field boring investigation, the soil engineer visited the site to observe the surface conditions.

LABORATORY INVESTIGATION:

All samples were examined in the laboratory by the soil engineer and classified according to the Unified Soil Classification System. In this system, the soils are visually classified according to texture and plasticity. The appropriate group symbol is indicated on the soil boring logs.

No formal laboratory tests were performed on the soil samples.

SITE CONDITIONS:

At the time of my site visit the ground surface at the proposed headworks building sloped generally down to the south. The ground surface was covered with asphalt pavement and soil. At the proposed location of the grit/ash building, it is my

understanding that there are old buried tanks. I understand that the depth to the bottom of the tanks is not known. To the east of the proposed buildings there is a large rock outcrop.

SUBSURFACE CONDITIONS:

The specific subsurface conditions encountered at each boring location are indicated on the individual soil boring logs. However, to aid in the evaluation of this data, I have prepared a generalized description of the soil conditions based on the boring data.

The borings for the grit/ash building, borings 14 & 16, encountered an upper layer of uncontrolled fill that extended to between approximately 2 and 4 feet. This uncontrolled fill is sand with varying amounts of gravel/weathered shale and a trace to some silt. It is medium dense to very dense. Beneath the uncontrolled fill is a layer of clayey silt/silt and sand with a trace of gravel. This layer is loose to medium dense and extended to between 7.0 and 9.5 feet. Underlying the clayey silt/silt and sand is a layer of weathered shale with a trace of silt. This weathered shale is very dense. Rock core taken, at each boring, encountered fractured shale with an RQD (Rock Quality Designation) of between 7 and 18 percent.

The borings for the headworks building, borings 2 and 8, encountered an upper layer of sand and gravel with a trace to some silt. This sand and gravel is medium dense and extended to approximately 3 feet. It is possible portions of this soil is fill. Underlying the sand and gravel is a layer of weathered shale with a trace of silt. This weathered shale is very dense and extended to between 3.5 and 6.5 feet. Rock core taken, in each boring, encountered fractured shale with occasional dolostone seams. The rock cores had a RQD (Rock Quality Designation) of between 16 and 18 percent.

GROUNDWATER CONDITIONS:

Accurate groundwater levels are difficult to determine in clayey silt soils with only short term readings or observations. Clayey silt soils typically do not allow an adequate amount of water to flow through the soil to produce a water level reading during the drilling operation. I have indicated where water was observed on the boring logs.

Based on the groundwater levels observed during the boring investigation, the moisture condition of the samples recovered from the boring holes and coloration of the soil samples, I judge that the groundwater level was located below depth of 9 feet.

Perched groundwater tables may occur at higher elevations in the soil profile due to groundwater being retained by layers or lenses of silt or clay soils. Perched or seasonal groundwater levels are sometimes indicated by mottled brown/gray soils. These soil conditions were observed as shallow as 4 feet below the existing ground surface.

Some fluctuation in hydrostatic groundwater levels and perched water conditions should be anticipated with variations in the seasonal rainfall and surface runoff.

It should be noted that the groundwater levels were obtained during the drilling procedure. Actual water levels may vary at the time of construction. Some groundwater could be encountered in soil layers labeled moist to wet on the boring logs.

ANALYSIS AND RECOMMENDATIONS:

Site Work:

The proposed construction areas should be cleared and grubbed and all organic topsoil and vegetation along with any uncontrolled fill and debris. It is my understanding that any existing buried tanks will be removed from the building sites. The site should be observed by a qualified engineer to verify that all the tanks have been removed. The subgrade should be proof-rolled with a 10-ton roller. This proof rolling will compact the subgrade and reveal the presence of soft spots. All the vacant tank areas and any soft spots should be backfilled with controlled fill material.

The removal of any uncontrolled fill should extend to a minimum horizontal distance past the edge of the footings equal to the depth that the fill extends under the footing. This is equal to a 1:1 slope down from the outer edge of the footing to the virgin soil. All uncontrolled fill within the proposed building area should also be removed.

A way to stabilize a spongy, but suitable, virgin, subgrade would be to spread a reinforcement or separation type of geotextile on the subgrade and follow with a lift of clean, granu-

lar fill or stone. The thickness of the controlled fill can range from 1.0 to 2.5 feet, as necessary, to achieve a working mat upon which to construct the remainder of the controlled fill or to place footings. If open graded stone is used as controlled fill a layer of geotextile should be placed between the stone and any sand/gravel controlled fill or virgin soil.

Controlled Fill:

Before any controlled fill is placed the site should be inspected to verify that the site has been prepared according to the recommendations contained in this report as required by the NYS Building Code Section 1704.7.1.

Controlled, relatively clean, granular fill can be spread in lifts not exceeding 12 inches in loose thickness. These materials should be compacted to a minimum of 95 percent of the maximum ASTM Specification D 1557-91 density, modified proctor.

On-site material may be difficult to compact during wet weather or poor drying conditions. Given good drying conditions, the on-site soils with more than 10 percent silt/clayey silt could be compacted using disc harrows and sheepsfoot rollers or rubber-tired rollers, as applicable. These types of soils are sensitive to moisture content and weather conditions. During freezing or wet weather conditions these materials may not be able to be adequately compacted for use as structural fill.

If crushed stone is used as controlled fill it should have a layer of geotextile with a minimum tensile strength of 200 lbs and a minimum burst strength of 400 psi placed between the stone and existing soils. The stone should be placed in lifts not exceeding 12 inches in thickness and should be compacted with a minimum of 5 passes of a vibratory roller rated at 5 tons or larger.

Free Draining Controlled Fill Material: Naturally or artificially graded mixture of sand, natural or crushed stone or gravel conforming to NYS DOT Item 304-2.03, Type 4 or 2 as follows:

U.S. Sieve No.	Percent Passing by Weight
2 inch	100
1/4 inch	35-60
No. 40	5-40
No. 200	0-10

NYS DOT Table 703-4, Size 2 crushed stone, clean, durable, angular, and of uniform quality throughout:

U.S. Sieve No.	Percent Passing by Weight
1 ½ inch	100
1 inch	90-100
1/2 inch	0-15

All controlled fill should be free of organic and/or frozen material.

Free-draining controlled fill should have less than 10 percent fines passing the #200 sieve.

I recommend performing one field density test for every 2,000 square feet of controlled fill placed, within the overlaying building footprint, but in no case fewer than three tests per lift.

I recommend that for foundation wall and footing backfill that in each compacted backfill layer have at least one field in place density test for each 50 feet or less of wall or footing length, but not fewer than two tests along a wall face or footing be performed per lift.

Building Foundations:

I recommend that the proposed grit/ash building be supported by spread footing foundations resting on virgin, inorganic, soils or on controlled fill which, in turn, rests on these virgin materials. Footings can be designed for a maximum, net, allowable soil bearing pressure of 3000 psf.

I recommend that the proposed headworks building be supported by spread footing foundations resting on virgin, inorganic, soils/rock or on controlled fill which, in turn, rests on these virgin materials. It appears from the soil borings and the proposed elevations of the lower tanks that most of the proposed foundations will rest on weathered or sound shale bedrock, but depending on the regularity of the rock surface it is possible that portions of the building footings could rest on existing soils. Because if this I recommend that the allowable soil/rock bearing pressure be relatively low to reduce the potential for differential settlements. I recommend that these footings be

designed for a maximum, net, allowable soil/rock bearing pressure of 3000 psf. Because of the relatively light loads of the proposed structures this allowable soil/rock bearing pressure, shouldn't significantly increase the costs for the foundations.

The other option would be to have all the footings extend to weathered shale bedrock. A maximum net allowable weathered rock bearing pressure of 8,000 psf could be used for the design of footings. This however, would require that all the footings extend to the weathered shale rock. If the rock dipped below the proposed footing bottom the area would have to be excavated and filled with lean concrete or the bottom of the footing would have to be extended to the weathered rock surface. Depending on the regularity of the rock surface, this approach maybe more expensive than designing the footing for the lower allowable soil/rock bearing pressure.

The soil engineer should observe the footing subgrade at the beginning of the project or if soil/rock conditions change to verify the allowable bearing pressure of the soil/rock encountered.

Loads from adjacent footings or structures should be assumed to distribute based on the elastic theory. Typical Boussinesq charts can be used to approximate loads at various depths and locations due to adjacent structures.

A minimum footing width of 2.0 feet is recommended for load bearing strip footings. Isolated footings should be at least 3.0 feet wide. Any strip footings, designed to rest on soils and rock, should have a minimum of two #5 bars placed in them, top and bottom, separated by a minimum of 12 inches vertically or an equivalent amount of reinforcement in foundation walls. This reinforcement is intended to resist possible negative as well as positive moments due to non-uniform bearing.

Exterior footings or footings in unheated areas should have a minimum of 4.0 feet of embedment for protection from frost action. Interior footings should have a minimum embedment of 1.5 feet below finished grade to develop the bearing value of the soils.

All walls that retain soil on only one side should have a drain tile placed along the base of the wall. The drain tile should be a minimum of 4 inches in diameter, surrounded by a minimum of 6 inches of properly graded washed sand or crushed stone wrapped with a non woven filter fabric with a maximum apparent opening

size of 70 and a minimum trapezoid tearing strength of 100 lbs. The drain tile should drain to a stormwater sewer, daylight, or a sump equipped with a pump.

The wall should then be backfilled with a controlled, well graded, free-draining granular material. The material should extend away from the wall a horizontal distance of two-thirds the height of the fill being placed. The upper 1 foot of material should be a fairly impermeable material to shed surface water.

If these procedures are used, a static lateral soil pressure of 40 psf per foot of retained soil can be used for design of the wall. This static, active lateral soil pressure is based on a moist unit weight of 125 pcf and an angle of internal friction of 32 degrees. A wall soil friction angle of 18 degrees and a coefficient of base sliding of 0.35 can also be used for design. If the foundations are designed to rest on weathered shale then a coefficient of base sliding of 0.45 can be used for design.

If the retaining wall is braced or if the deflection is limited prior to backfilling so the active soil pressure is not achieved, a static, at-rest lateral soil pressure of 63 psf per foot of retained soil can be used for design. If drainage cannot be provided then a lateral soil and water pressure of 85 psf per foot of soil retained should be used for design.

To resist overturning and sliding a static lateral passive pressure of 250 psf per foot of embedment can be used. This static, passive pressure resistance value has been reduced from the calculated full passive pressure because of stress/strain characteristics of the soil. To develop the full, calculated resistance a certain amount of movement or deflection in the structure is required. The amount of movement required to generate this resistance generally greater then is acceptable for structures. I therefore recommend that the full passive pressure not be used.

The passive resistance of the upper two feet of soil should be ignored due to surface effects of frost and moisture.

Any surcharge loading of existing adjacent building foundations or other adjacent structures/utilities should be addressed by the structural engineer using Boussinesq charts.

For the analysis of seismic loading the allowable soil bearing pressure and passive soil resistance may be increased by a factor of one-third.

Floor/Tank Slabs:

Concrete floor/tank slabs can be designed to rest on controlled fills resting on virgin materials. A 6-inch layer of well-graded, free-draining, granular material should be placed beneath the floor/tank slab to provide drainage, act as a capillary break, and to provide better and more uniform support.

If vehicle loadings are to be applied to the floor slab, the proposed slab and supporting soils should be analyzed as a pavement structure. I recommend that a minimum of 12 inches of free draining controlled granular fill be placed below any concrete pavements.

A modulus of subgrade reaction of 125 psi per inch can be used to design concrete slabs resting on a minimum of 6 inches of free draining controlled fill that in turn rests on virgin soils or controlled fill. A modulus of subgrade reaction of 300 psi per inch can be used to design concrete slabs resting on a minimum of 6 inches of free draining controlled fill that in turn rests on weathered shale. A modulus of subgrade reaction of 100 psi per inch can be used to design exterior slabs or pavements resting on a minimum of 12 inches of free draining controlled fill. This reduced value is recommended due to seasonal variations that occur due to frost in the soils.

Exterior concrete or asphalt pavements will experience some frost heave movements during the winter and spring. If these movements are not acceptable then a minimum of 4.0 feet of approved subbase material and properly designed drains would be required below the concrete or asphalt pavements or sidewalks. The use of properly designed footing drains can also be used to reduce possible frost heave movements adjacent to the proposed structure.

If the moisture levels of floor slab areas are critical additional drainage materials and vapor barriers will be required beneath the floor slab. Also the moisture content of the subbase soils should be carefully monitored to prevent excess water from saturating these subbase soils before the floor slab is poured. This aspect of the design should be performed by qualified others.

Seismic Conditions:

The potential seismic conditions at the proposed site have been investigated using the information provided in the NYS Building

Code Section 1613 and 18 and the boring information obtained during my investigation.

Based on the soil boring information it is my opinion that the Site Classification (Table 1615.1.1) could be assumed to be C. Using figures 1615 (1 and 2) and the USGS 2003 NEHRP Seismic Design Provisions, I estimate that the MCE spectral acceleration (S_{MS}) at short periods is 32.5 and the MCE spectral acceleration (S_{M1}) at 1 s period is 11.3.

The probabilistic ground motion values are expressed in %g for rock site class B. Peak ground accelerations in the upper soil profile may vary. If specific peak ground accelerations or shear wave velocities are required for the upper soil profile additional testing would be required. If it is determined by the structural engineer that the Seismic Design Category is D, E or F additional geotechnical recommendations can be provided.

The soil borings and my analysis do not indicate any significant potential seismic hazards such as liquefaction, sensitive clays, weakly cemented soil or surface rupture.

CONSTRUCTION PROCEDURES AND PROBLEMS:

The NYS Building Code Section 17 requires special inspections and follow up reports. These inspections should be performed to verify compliance with the recommendations contained in this report.

All excavations of more than a few feet should be sheeted and braced or laid back to prevent sloughing in of the sides.

Excavations should not extend below adjacent footings or structures unless properly designed sheeting and bracing or underpinning is installed.

Footing and floor slab subgrades should be tamped to compact any soil disturbed during the excavation process. If over excavation of subgrades are required to remove cobbles or possibly boulders, then the over excavated areas should be filled with controlled granular fill or lean concrete.

A layer of geotextile (min. tensile strength of 200 lbs and min. burst strength of 400 psi) and 4 to 8 inches of crushed stone may be required in footing excavations to prevent disturbance of the virgin subgrade during wet weather.

Sump-pit and sump-pump-type dewatering may be required in excavations or low areas during wet weather or if groundwater is encountered. All dewatering programs should be designed to prevent bottom heave. Any dewatering program should be performed with properly designed filtration protection on all pumps to prevent loss of ground.

Subgrades should be kept from freezing during construction. Water, snow, and ice should not be allowed to collect and stand in excavations or low areas of the subgrade.

Some obstacles, including foundations and utilities and possibly cobbles/boulders and bedrock, may be encountered in excavations.

The use of hydraulically operated rippers, pneumatic tools, or drilling and blasting may be required to remove bedrock or large boulders if encountered. Based on the borings taken, I estimate that the upper 1 to 4 feet of weathered shale could be removed with a large track mounted excavator with a rock bucket. Deeper or harder areas of rock may require blasting.

Design and construction procedures should include measures to limit the potential for slab curl and vapor transmission. The shrinkage properties of the concrete should be controlled and the curing of the concrete controlled. Differential shrinkage between the top and bottom of the slabs could otherwise result in curling of the slabs. The control of vapor transmission through the slab should also be addressed. These phenomena may be only indirectly related to soil conditions. The architect/ structural engineer should address this aspect of the design.

Current American Concrete Institute recommendations for the design and construction of floor slabs and the control of shrinkage, slab curl and vapor transmission can be referred to.

Additions to Arlington WWTP
Poughkeepsie, New York
File No. 2138

CONTENTS OF APPENDIX:

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2. Boring Location Diagram
3. Boring Logs
4. 2003 NEHRP Seismic Design Values
5. Unified Soil Classification System
6. Soil Use Chart
7. General Qualifications

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS

SS : Split-Spoon — 1¾" I.D., 2" O.D., except where noted
S : Shelby Tube — 2" O.D., except where noted
PA : Power Auger Sample
DB : Diamond Bit — NX: BX: AX:
CB : Carboloy Bit — NX: BX: AX:
OS : Osterberg Sampler — 3" Shelby Tube
HS : Housel Sampler
WS : Wash Sample
FT : Fish Tail
RB : Rock Bit
WO : Wash Out

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted

WATER LEVEL MEASUREMENT SYMBOLS

WL : Water Level
WCI : Wet Cave In
DCI : Dry Cave In
WS : While Sampling
WD : While Drilling
BCR : Before Casing Removal
ACR : After Casing Removal
AB : After Boring

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable ground water levels. In impervious soils the accurate determination of ground water elevations is not possible in even several day's observation, and additional evidence on ground water elevations must be sought.

CLASSIFICATION

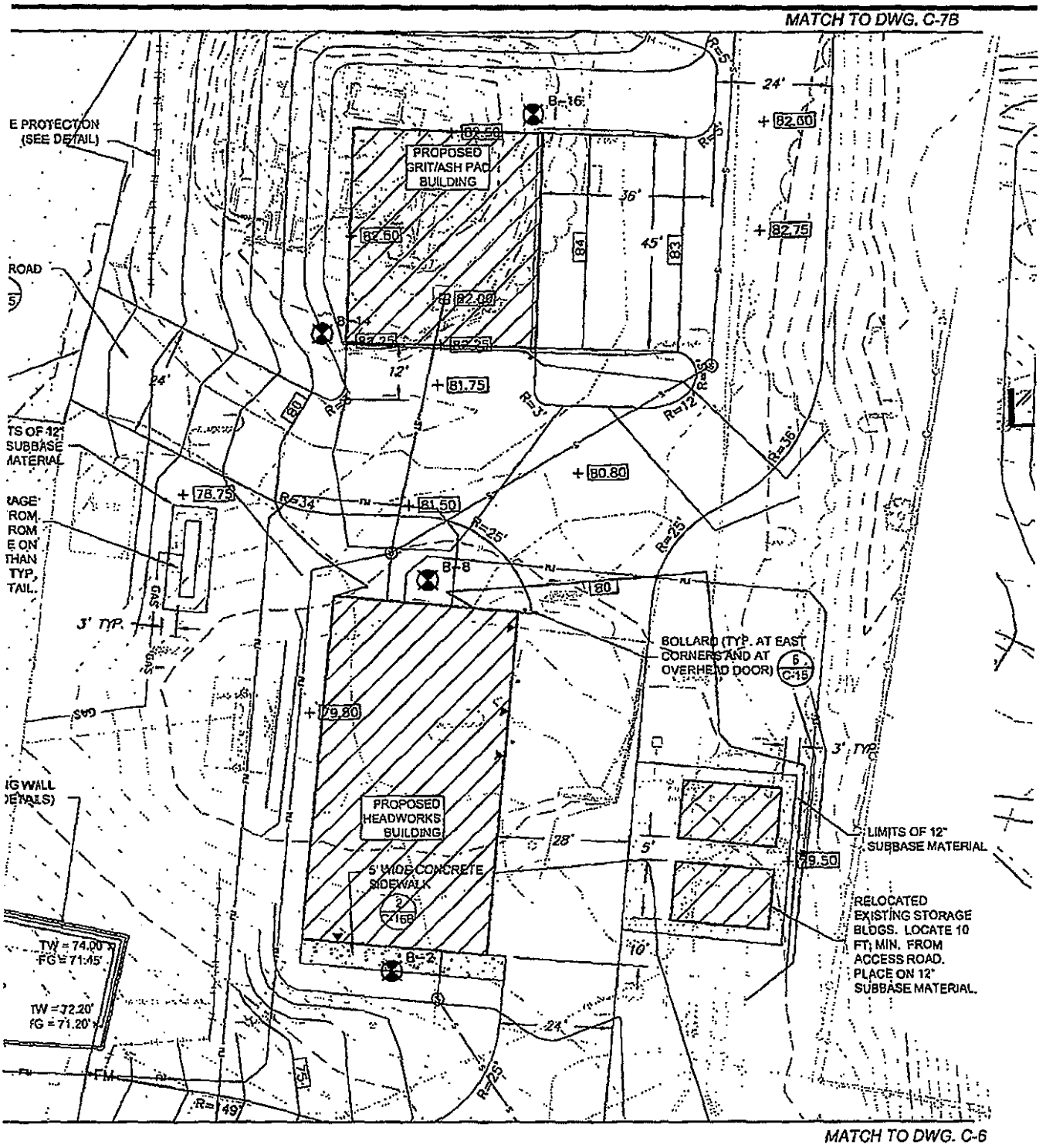
COHESIONLESS SOILS

"Trace"	: 1% to 10%	
"Trace to some"	: 10% to 20%	
"Some"	: 20% to 35%	
"And"	: 35% to 50%	
Loose	: 0 to 9 Blows	or equivalent
Medium Dense	: 10 to 29 Blows	or equivalent
Dense	: 30 to 59 Blows	or equivalent
Very Dense	: ≥60 Blows	or equivalent

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, then clay becomes the principle noun with the other major soil constituent as modifiers: i.e., silty clay. Other minor soil constituents may be added according to classification breakdown for cohesionless soils; i.e., silty clay, trace to some sand, trace gravel.

Soft	: 0.00 — 0.59 tons/ft^2
Medium	: 0.60 — 0.99 tons/ft^2
Stiff	: 1.00 — 1.99 tons/ft^2
Very Stiff	: 2.00 — 3.99 tons/ft^2
Hard	: ≥ 4.00 tons/ft^2



MORRIS ASSOCIATES, P.L.L.C.
ENGINEERING CONSULTANTS

9 Ellis Lane.
Poughkeepsie, New York 12601
Phone No. (845) 454-3411
Fax No. (845) 473-1982

389 Fairview Ave.
Hudson, New York 12534
Phone No. (518) 828-2300
Fax No. (518) 828-3963

DATE	SCALE	DESIGNED BY:	FILE No.
04/01/07	1"=30'	DRAWN BY:	60401.27
		CHECKED BY:	

BORING LOG

BORING NO: 2

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: 11.0 ft **TIME:** WS

FILE NUMBER: 2138

OFFSET: None

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
1, 2, 3		HD				Hand Dug By Driller
4, 5	1	SS	26-39-24-22	63		Weathered Shale, trace Silt, Gray, Dry, Very Dense (GM-GP)
6	2	SS	16-21-100	100+		Weathered Shale, trace Silt, Weathered Dolostone, Gray, Dry, Dense to Very Dense (GM-GP)
7, 8, 9, 10, 11	Run 1	DB				Run 1 Gray Fractured Shale with Occasional Dolostone Seams RQD = 18 percent
12, 13, 14, 15						End of Boring at 11.5 Feet

BORING LOG

BORING NO: 8

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: None Observed **TIME:** WS

FILE NUMBER: 2138

OFFSET: None

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
		PA				Asphalt Pavement Driller Notes Sand and Gravel Subbase
1 2	1	SS	8-12-12-19	24		Fine to Coarse Sand and Gravel, trace to some Silt, Dark Gray, Moist, Medium Dense (SM-GM) Possible Fill
3	2	SS	50	100		Weathered Shale, trace Silt, Gray, Dry, Very Dense (GM-GP)
4 5 6 7 8	Run 1	SS				Run1 Dark Gray Fractured Shale, Occcasional Dolostone Seams RQD = 16 percent
9 10 11 12 13 14 15						End of Boring at 8.5 Feet

BORING LOG

BORING NO: 14

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: None Observed **TIME:** WS

FILE NUMBER: 2138

OFFSET: 15' toward road

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
1	1	SS	3-3-7-8	10		Fine to Coarse Sand, some Gravel, trace to some Silt, Dark Brown, Moist, Medium Dense (SM) Possible Fill
2						
3	2	SS	6-5-4-3	9		Fine Sand, some Clayey Silt, Brown, Moist to Wet, Loose (SM)
4						
5	3	SS	2-5-5-6	10		Clayey Silt and Sand, Brown/Gray, Moist, Medium Dense (ML-SM)
6						
7	4	SS	5-5-50/.3	10		Clayey Silt, trace to some Sand, Brown/Gray, Moist, Medium Dense (ML)
						Weathered Shale, trace Silt, Gray, Moist, Very Dense (GM-GP)
8						Run 1 Gray Fractured Shale RQD = 7 percent
9						
10	Run 1	DB				
11						
12						
13						End of Boring at 12.3 Feet
14						
15						

BORING LOG

BORING NO: 16

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: 9.2 ft **TIME:** WS

FILE NUMBER: 2138

OFFSET: None

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
1	1	SS	5-6-11-20	17		Fine to Coarse Sand, trace to some Weathered Shale, Gray, Moist, Medium Dense to Very Dense (SM) FILL
2	2	SS	50	100		
3		PA				
4	3	SS	4-4-5-7	9		Fine Sand, some Silt, trace Gravel, Roots, Brown/Gray, Moist, Loose (SM)
5						Silt, some Sand, trace to some Gravel, Brown, Moist to Wet, Loose (ML)
6	4	SS	5-5-4-4	9		Silt, trace to some Clay, Brown/Gray, Wet, Loose/Medium Stiff (ML)(CL) Occasional Thin Clay Layers
7						
8	5	SS	4-4-4-5	8		
9		PA				
	6			100+		Weathered Shale, trace Silt, Dark Gray, Wet, Very Dense (GM-GP)
10						Run1
11						Dark Gray Fractured Shale
12	Run 1	DB				RQD = 18 percent
13						
14						
15						End of Boring at 14.6 Feet

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 12601
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Data are based on a 0.05000000074505806 deg grid spacing

Period (sec)	Centroid Sa (g)	
0.2	0.258	(Ss)
1.0	0.066	(S1)

Period (sec)	Maximum Sa (g)	
0.2	0.270	(Ss)
1.0	0.066	(S1)

Period (sec)	Minimum Sa (g)	
0.2	0.247	(Ss)
1.0	0.065	(S1)

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 12601
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class C

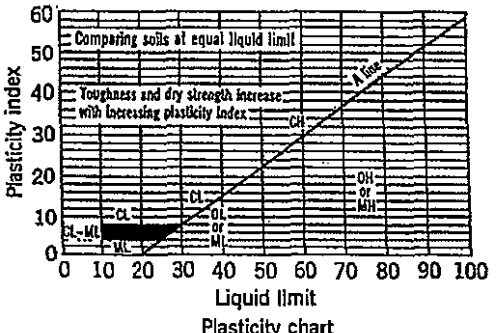
Period (sec)	Centroid Sa (g)	
0.2	0.310	(SMs, Fa = 1.200)
1.0	0.112	(SM1, Fv = 1.700)

Period (sec)	Maximum Sa (g)	
0.2	0.325	(SMs, Fa = 1.200)
1.0	0.113	(SM1, Fv = 1.700)

Period (sec)	Minimum Sa (g)

Table 3.5 Unified Soil Classification

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)						Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria			
Coarse-grained soils More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3		
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*			
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics	Atterberg limits below "A" line, or *PI* less than 4		Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols	
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7			
	Sands More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3			
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*			
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5		Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols	
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7			
Fine-grained soils More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size											
	Silts and clays liquid limit less than 50		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)							
			None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses				
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays					
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions				
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts					
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)				
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity					
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils					



Plasticity chart for laboratory classification of fine grained soils

From Wagner, 1957.

[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.

[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):

After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Soil Characteristics Pertinent to Roads and Airfields

Major Divisions		Letter (1)	Name	Value as Subgrade When Not Subject to Frost Action	Value as Subbase When Not Subject to Frost Action	Value as Base When Not Subject to Frost Action	Potential Frost Action	Compressibility and Expansion	Drainage Characteristics	Compaction Equipment	Unit Dry Weight lb. per cu. ft.	Typical Design Values: CBR (2)	Typical Design Values: Subgrade Modulus k lb. per cu. in.
Coarse-Grained Soils	Gravel and Gravelly Soils	GW	Well-graded gravels or gravel-sand mixtures, little or no fines	Excellent	Excellent	Good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	125-140	40-80	300-500
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines	Good to excellent	Good	Fair to good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	110-140	30-60	300-500
		GM d	Silty gravels, gravel-sand-silt mixtures	Good to excellent	Good	Fair to good	Slight to medium	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	125-145	40-60	300-500
		GM u		Good	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	115-135	20-30	200-500
		GC	Clayey gravels, gravel-sand-clay mixtures	Good	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	130-145	20-40	200-500
	Sand and Sandy Soils	SW	Well-graded sands or gravelly sands, little or no fines	Good	Fair to good	Poor	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	110-130	20-40	200-400
		SP	Poorly graded sands or gravelly sands, little or no fines	Fair to good	Fair	Poor to not suitable	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	105-135	10-40	150-400
		SM d	Silty sands, sand-silt mixtures	Fair to good	Fair to good	Poor	Slight to high	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	120-135	15-40	150-400
		SM u		Fair	Poor to fair	Not suitable	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-130	10-20	100-300
		SC	Clayey sands, sand-clay mixtures	Poor to fair	Poor	Not suitable	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-135	5-20	100-300
Fine-Grained Soils	Silts and Clays LL is less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Poor to fair	Not suitable	Not suitable	Medium to very high	Slight to medium	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	90-130	15 or less	100-200
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Poor to fair	Not suitable	Not suitable	Medium to high	Medium	Practically impervious	Rubber-tired roller, sheepsfoot roller	90-130	15 or less	50-150
		OL	Organic silts and organic silt-clays of low plasticity	Poor	Not suitable	Not suitable	Medium to high	Medium to high	Poor	Rubber-tired roller, sheepsfoot roller	90-105	5 or less	50-100
	Silts and Clays LL is Greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	Not suitable	Not suitable	Medium to very high	High	Fair to poor	Sheepsfoot roller, rubber-tired roller	80-105	10 or less	50-100
		CH	Inorganic clays of medium to high plasticity, organic silts	Poor to fair	Not suitable	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	90-115	15 or less	50-150
		OH	Organic clays of high plasticity, fat clays	Poor to very poor	Not suitable	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	80-110	5 or less	25-100
Highly Organic Soils		Pt	Peat and other highly organic soils	Not suitable	Not suitable	Not suitable	Slight	Very high	Fair to poor	Compaction not practical	—	—	—

Note:

(1) Unit Dry Weights are for compacted soil at optimum moisture content for modified AASHO compaction effort. Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is basis of Atterberg limits; suffix d (e.g., GMd) will be used when the liquid limit (L.L.) is 25 or less and the plasticity index is 6 or less; the suffix u will be used otherwise.

(2) The maximum value that can be used in design of airfields is, in some cases, limited by gradation and plasticity requirements.

GENERAL QUALIFICATIONS

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope of the project and location described herein, and my description of the project represents my understanding of the significant aspects relevant to soil and foundation characteristics. In the event that any changes in the design or location of the proposed facilities, as outlined in this report, are planned, I should be informed so the changes can be reviewed and the conclusions of this report modified or approved in writing by myself.

It is recommended that all construction operations dealing with earthwork and foundations be inspected by an experienced soil engineer to assure that the design requirements are fulfilled in the actual construction. If you wish, I would welcome the opportunity to review the plans and specifications when they have been prepared so that I may have the opportunity of commenting on the effect of soil conditions on the design and specifications.

The analysis and recommendations submitted in this report are based upon the data obtained from the soil borings and/or test pits performed at the locations indicated on the location diagram and from any other information discussed in the report. This report does not reflect any variations which may occur between these boring and/or test pits. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations and also such situations as groundwater conditions vary from time to time. The nature and extent of variations may may not become evident until the course of construction. If variations then appear evident, it will be necessary for a reevaluation of the recommendations of this report after performing on-site observations during the construction period and noting the characteristics of any variations.

Soil & Material Testing, Inc.
57 South Main Street, Castleton, New York 12033

Albany, NY (518) 732-7205
Kingston, NY (845) 336-4471
Pittsfield, MA (413) 499-5338

Visit us Online: www.SMTESTING.com

February 26, 2010

Mr. Thomas Carver, P.E.
Morris Associates
15 Elks Lane
Poughkeepsie, NY 12601

Re: Laboratory Testing–Arlington WTP SMT No. 6224

Soil & Material Testing, Inc. is pleased to submit test results for the above referenced project. A representative sample was selected from each core, and the density of the sample was determined.

Sample ID	Density (g/cm^3)	Density (lb/ft^3)
B2–R1	2.80	174.8
B8–R1	2.67	166.7
B14–R1	2.76	172.3
B16–R1	2.69	167.9
B19–R1	2.73	170.4
B21–R1	2.62	163.6
B22–R1	2.71	169.2
B23–R1	2.73	170.4

If you have any questions, please do not hesitate to contact us.

Yours truly,

SOIL & MATERIAL TESTING, INC.

William Lewis
Vice President Of Operations

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-19

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0	Ground Surface	0					
	light br clayey SILT, layer gr silty clay (moist-wet)	-5	S1	SS	1.7	8	2 3 5 4
	br clayey SILT, s-m gravel, shale end of ss, ss refusal 10.8'	-7					
		-10	S2	SS	0.7	15/	3 15/
	gr angular SHALE w/rust stain seams	-10.8	R1	NX	3.9		
	End of Borehole	-15.8					

Standard Penetration Test — SPT (N) 0 10 20 30 40 50 60
Split Spoon Blows — blows/ft. 0 10 20 30 40 50 60
Water Content % — Wp |-------0------| Wl 10 20 30 40 50

Completion Depth: 15.8'
Drill Date: 12/04-12/07/09
Water Level: Not Encountered
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-20a

Elevation:
Station/Offset:

SUBSURFACE PROFILE			SAMPLE					Standard Penetration Test	Water Content %
Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows	SPT (N) 0 10 20 30 40 50 60 / Split Spoon Blows blows/ft. 0 10 20 30 40 50 60	Wp |-------0-------| Wl 10 20 30 40 50
0	Ground Surface	0							
5		-5							
6	br-gr SILT, so v f sand, cobble and shale fragments (moist), ss refusal 6.3'	-6.3	S1	SS	0.5	85/	15 15 70/		
	End of Borehole								

Completion Depth: 6.3'
Drill Date: 12/04/09
Water Level: Not Encountered
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-20b

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0 / 0	Ground Surface	0					
		-10					
10 / 3 – 12	gr SHALE; change at 11.3' br clayey SILT, tr organics (moist-wet)	-12	S1	SS	1.6	53	95 46 7 4
15		-15					
15 – 17	gr-br clayey SILT, so v f sand (wet)	-17	S2	SS	1.5	6	2 3 3 2
19 / 6		-20					
20 – 22	br clayey SILT, so v f sand, yellow clay layers, cobble fragments at 21.5' (wet)	-22	S3	SS	1.6	6	2 2 4 9
24		-24.6					
25	black SHALE (moist), ss refusal 24.6'		S4	SS	0.1	50	50
	End of Borehole						

Standard Penetration Test — SPT (N) 0 10 20 30 40 50 60
Split Spoon Blows — blows/ft. 0 10 20 30 40 50 60
Water Content % — Wp |-------0------| Wl 10 20 30 40 50

Completion Depth: 24.6'
Drill Date: 12/04/09
Water Level: 22.3' BCR-19.0' ACR(CI)
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

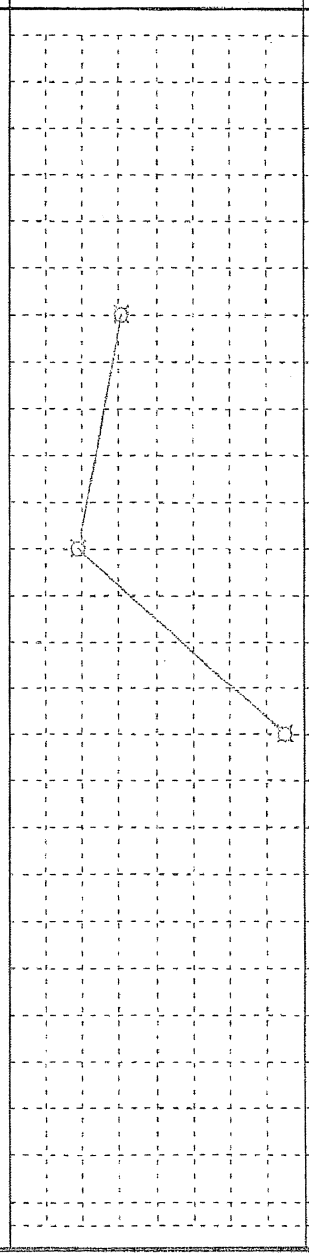
Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-21

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0 / 0	Ground Surface	0					
		-5					
	br vf SAND, so silt, s gravel (wet); change at 6.0' gr clayey SILT, shale fragments (moist)	-7	S1	SS	1.5	21	0 1 20 12
		-10					
	br v f SAND and SILT; change at 10.5' br-gr clayey SILT, so v f sand; change at 11.0' gr f SAND, so silt (moist)	-12	S2	SS	1.7	9	3 4 5 5
		-15	S3	SS	0.2	65	65
	gr weathered SHALE (wet-dry), ss and pa refusal 15.2'						
	gr angular SHALE	-20.2	R1	NX	4.2		
	End of Borehole						

Standard Penetration Test — SPT (N) 0 10 20 30 40 50 60
Split Spoon Blows — blows/ft. 0 10 20 30 40 50 60
Water Content % — Wp |-------0------| Wl 10 20 30 40 50



Completion Depth: 20.2'
Drill Date: 12/04/09
Water Level: Not Encountered
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

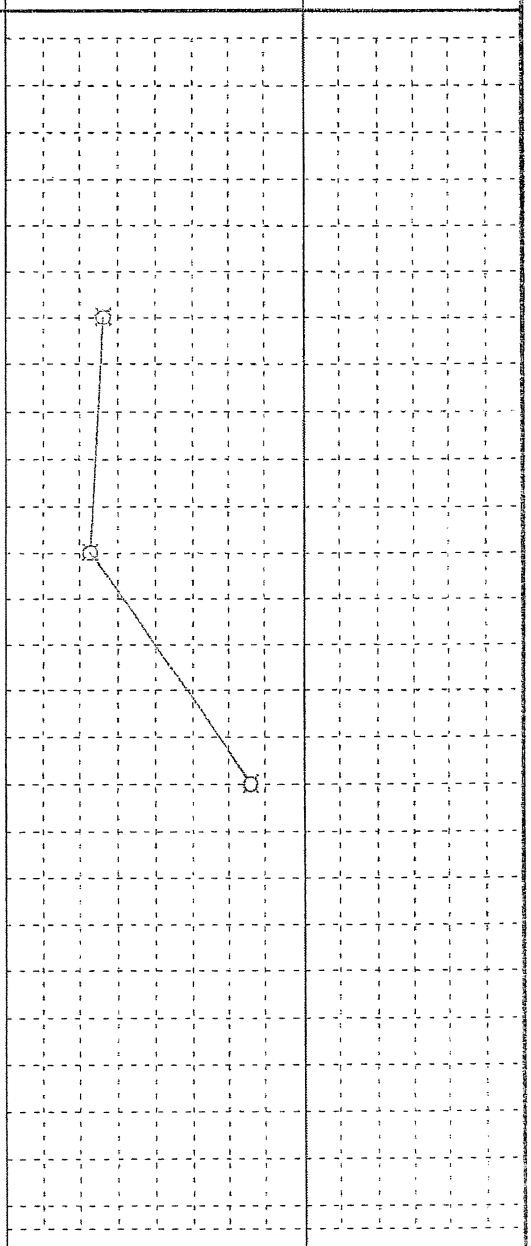
Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-22

Elevation:
Station/Offset:

Depth (ft)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0	Ground Surface	0					
	br clayey SILT, so v f sand, yellow clay layers, cobble fragments at 21.5' (wet)	-5 to -7	S1	SS	0.7	16	12 10 6 6
	gr SHALE; change at 11.3' br clayey SILT, tr organics (moist-wet)	-10 to -12	S2	SS	1.8	13	3 6 7 5
	gr-br clayey SILT, so v f sand (wet)	-15 to -16.2	S3	SS	1.2	56	5 6 50
	gr dolomite ROCK w/quartz stringers, rust staining; change at 17.2' gr-black angular SHALE	-16.2 to -21.2	R1	NX	4.0		
	End of Borehole	-21.2					



Completion Depth: 21.2'
Drill Date: 12/04/09
Water Level: 6.0' BCR-7.0' ACR
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

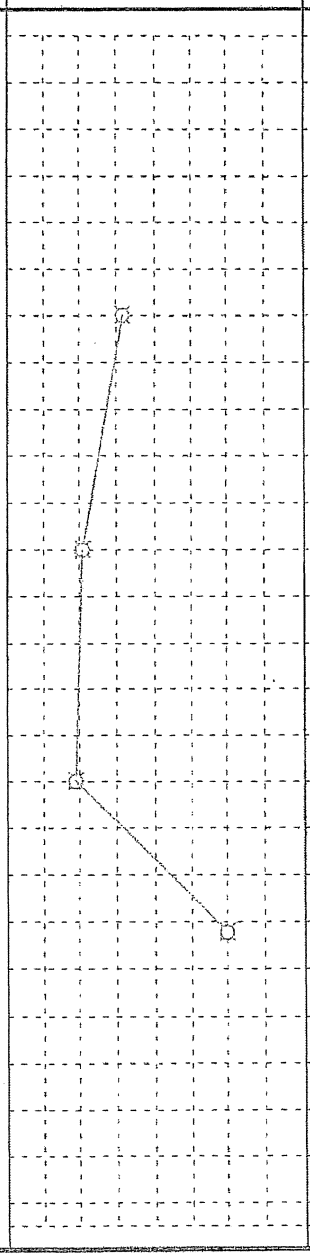
Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

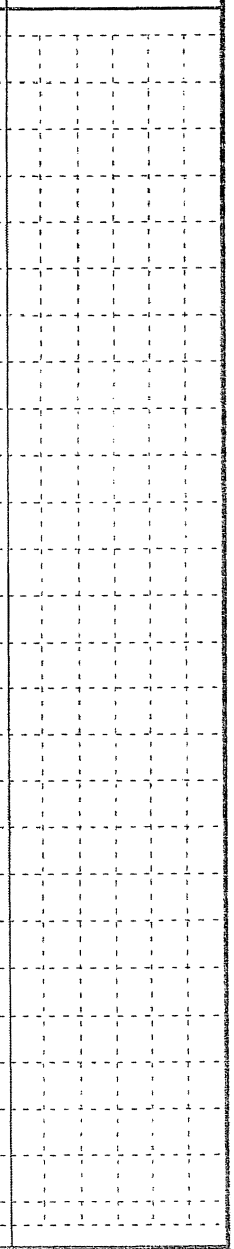
Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-23

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0 / 0	Ground Surface	0					
	br f-m SAND, tr-so silt, s-m gravel s cobbles; chnage at 6.2' br f SAND, tr-so silt (damp)	-5 to -7	S1	SS	1.5	22	19 12 10 5
	br v f SAND, so silt w/layered staining (moist-wet)	-10 to -12	S2	SS	1.6	11	7 5 6 5
	change at 14.5'	-15					
	br clayey SILT, so v f sand, layer of br f-m sand and silt, w/s-m gravel at 15.5'; change at 16.0' br TILL (wet)	-17	S3	SS	1.6	9	3 4 5 6
	gr TILL; change at end of ss gr dolomite ROCK, ss refusal 19.6'	-19.5	S4	SS	0.1	50	50
	gr-black dolomite ROCK, stringers of quartzite at steep angle	-24.6	R1	NX	3.6		
	End of Borehole						





Completion Depth: 24.6'
Drill Date: 12/03/09
Water Level: 5.5' BCR-10.6' ACR
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Soil & Material Testing, Inc.
57 South Main Street, Castleton, New York 12033

Albany, NY (518) 732-7205
Kingston, NY (845) 336-4471
Pittsfield, MA (413) 499-5338

Visit us Online: www.SMTESTING.com

February 26, 2010

Mr. Thomas Carver, P.E.
Morris Associates
15 Elks Lane
Poughkeepsie, NY 12601

Re: Laboratory Testing–Arlington WTP SMT No. 6224

Soil & Material Testing, Inc. is pleased to submit test results for the above referenced project. A representative sample was selected from each core, and the density of the sample was determined.

Sample ID	Density (g/cm^3)	Density (lb/ft^3)
B2–R1	2.80	174.8
B8–R1	2.67	166.7
B14–R1	2.76	172.3
B16–R1	2.69	167.9
B19–R1	2.73	170.4
B21–R1	2.62	163.6
B22–R1	2.71	169.2
B23–R1	2.73	170.4

If you have any questions, please do not hesitate to contact us.

Yours truly,

SOIL & MATERIAL TESTING, INC.

William Lewis
Vice President Of Operations

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-19

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0	Ground Surface	0					
	light br clayey SILT, layer gr silty clay (moist-wet)	-5	S1	SS	1.7	8	2 3 5 4
	br clayey SILT, s-m gravel, shale end of ss, ss refusal 10.8'	-7					
		-10	S2	SS	0.7	15/	3 15/
	gr angular SHALE w/rust stain seams	-10.8	R1	NX	3.9		
	End of Borehole	-15.8					

Standard Penetration Test — SPT (N) 0 10 20 30 40 50 60
Split Spoon Blows — blows/ft. 0 10 20 30 40 50 60
Water Content % — Wp |-------0------| Wl 10 20 30 40 50

Completion Depth: 15.8'
Drill Date: 12/04-12/07/09
Water Level: Not Encountered
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-20a

Elevation:
Station/Offset:

SUBSURFACE PROFILE			SAMPLE					Standard Penetration Test	Water Content %
Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows	SPT (N) 0 10 20 30 40 50 60 / Split Spoon Blows blows/ft. 0 10 20 30 40 50 60	Wp |-------0-------| Wl 10 20 30 40 50
0	Ground Surface	0							
5		-5							
6	br-gr SILT, so v f sand, cobble and shale fragments (moist), ss refusal 6.3'	-6.3	S1	SS	0.5	85/	15 15 70/		
	End of Borehole								

Completion Depth: 6.3'
Drill Date: 12/04/09
Water Level: Not Encountered
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-20b

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0 / 0	Ground Surface	0					
		-10					
10 / 3 – 12	gr SHALE; change at 11.3' br clayey SILT, tr organics (moist-wet)	-12	S1	SS	1.6	53	95 46 7 4
15		-15					
15 – 17	gr-br clayey SILT, so v f sand (wet)	-17	S2	SS	1.5	6	2 3 3 2
19 / 6		-20					
20 – 22	br clayey SILT, so v f sand, yellow clay layers, cobble fragments at 21.5' (wet)	-22	S3	SS	1.6	6	2 2 4 9
24		-24.6					
25	black SHALE (moist), ss refusal 24.6'		S4	SS	0.1	50	50
	End of Borehole						

Standard Penetration Test — SPT (N) 0 10 20 30 40 50 60
Split Spoon Blows — blows/ft. 0 10 20 30 40 50 60
Water Content % — Wp |-------0------| Wl 10 20 30 40 50

Completion Depth: 24.6'
Drill Date: 12/04/09
Water Level: 22.3' BCR-19.0' ACR(CI)
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

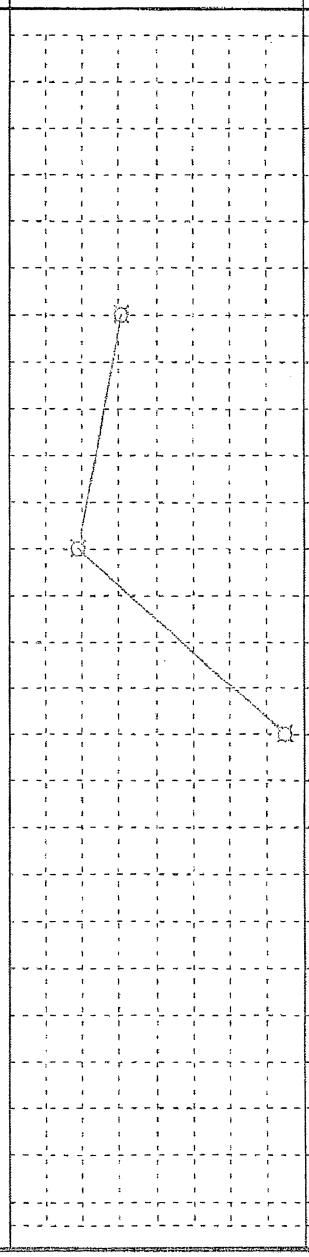
Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-21

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0 / 0	Ground Surface	0					
		-5					
	br vf SAND, so silt, s gravel (wet); change at 6.0' gr clayey SILT, shale fragments (moist)	-7	S1	SS	1.5	21	0 1 20 12
		-10					
	br v f SAND and SILT; change at 10.5' br-gr clayey SILT, so v f sand; change at 11.0' gr f SAND, so silt (moist)	-12	S2	SS	1.7	9	3 4 5 5
		-15	S3	SS	0.2	65	65
	gr weathered SHALE (wet-dry), ss and pa refusal 15.2'						
	gr angular SHALE	-20.2	R1	NX	4.2		
	End of Borehole						

Standard Penetration Test — SPT (N) 0 10 20 30 40 50 60
Split Spoon Blows — blows/ft. 0 10 20 30 40 50 60
Water Content % — Wp |-------0------| Wl 10 20 30 40 50



Completion Depth: 20.2'
Drill Date: 12/04/09
Water Level: Not Encountered
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

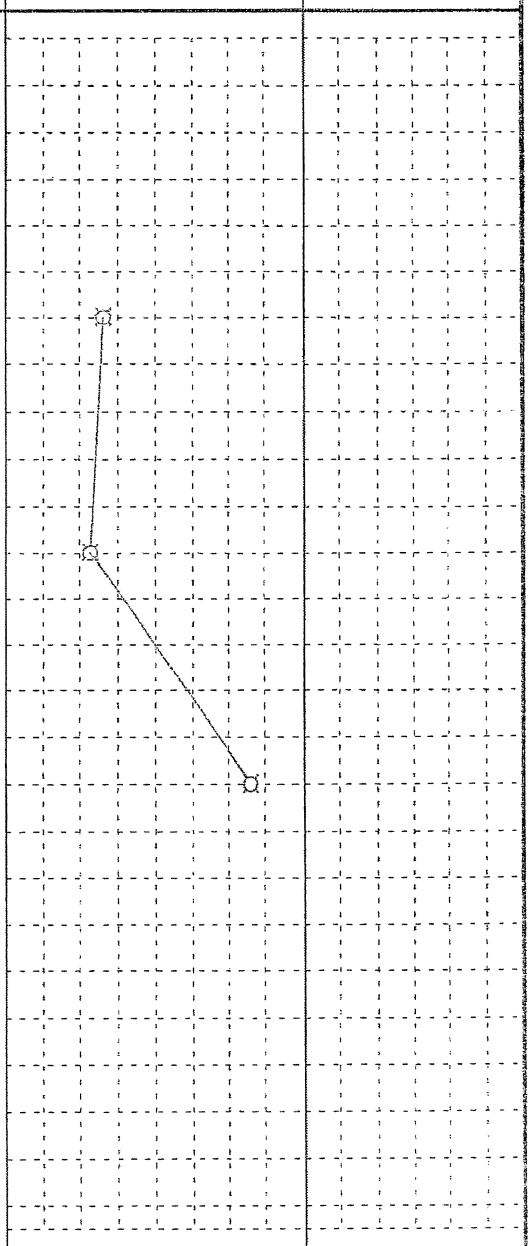
Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-22

Elevation:
Station/Offset:

Depth (ft)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0	Ground Surface	0					
	br clayey SILT, so v f sand, yellow clay layers, cobble fragments at 21.5' (wet)	-5 to -7	S1	SS	0.7	16	12 10 6 6
	gr SHALE; change at 11.3' br clayey SILT, tr organics (moist-wet)	-10 to -12	S2	SS	1.8	13	3 6 7 5
	gr-br clayey SILT, so v f sand (wet)	-15 to -16.2	S3	SS	1.2	56	5 6 50
	gr dolomite ROCK w/quartz stringers, rust staining; change at 17.2' gr-black angular SHALE	-16.2 to -21.2	R1	NX	4.0		
	End of Borehole	-21.2					



Completion Depth: 21.2'
Drill Date: 12/04/09
Water Level: 6.0' BCR-7.0' ACR
Datum:

SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

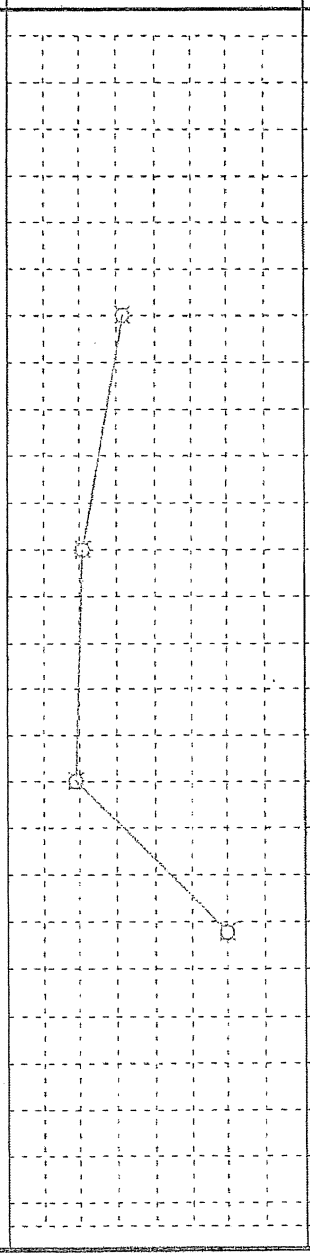
Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

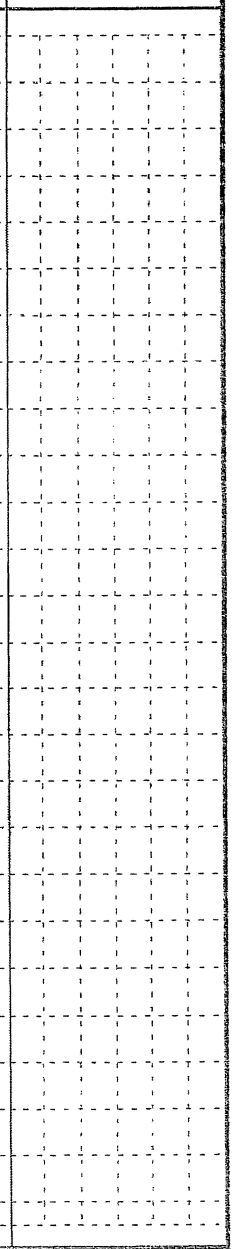
Project: Arlington WWTP
Location: Poughkeepsie, New York
Client: Morris Associates
Project No.: 6224

Log of Borehole: B-23

Elevation:
Station/Offset:

Depth (ft / m)	Description	Elevation	Number	Type	Recovery	SPT (N)	SS Blows
0 / 0	Ground Surface	0					
	br f-m SAND, tr-so silt, s-m gravel s cobbles; chnage at 6.2' br f SAND, tr-so silt (damp)	-5 to -7	S1	SS	1.5	22	19 12 10 5
	br v f SAND, so silt w/layered staining (moist-wet)	-10 to -12	S2	SS	1.6	11	7 5 6 5
	change at 14.5'	-15					
	br clayey SILT, so v f sand, layer of br f-m sand and silt, w/s-m gravel at 15.5'; change at 16.0' br TILL (wet)	-17	S3	SS	1.6	9	3 4 5 6
	gr TILL; change at end of ss gr dolomite ROCK, ss refusal 19.6'	-19.5	S4	SS	0.1	50	50
	gr-black dolomite ROCK, stringers of quartzite at steep angle	-24.6	R1	NX	3.6		
	End of Borehole						





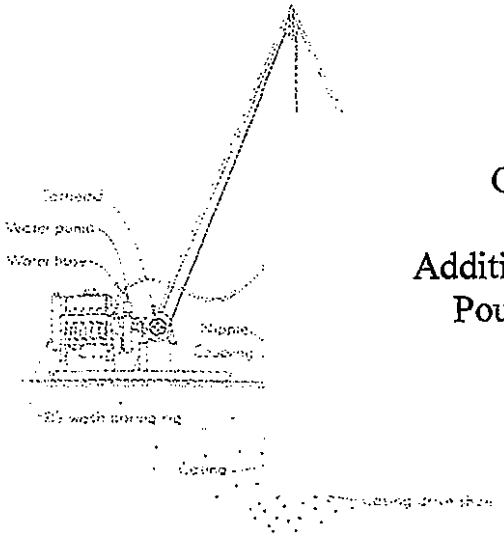
Completion Depth: 24.6'
Drill Date: 12/03/09
Water Level: 5.5' BCR-10.6' ACR
Datum:

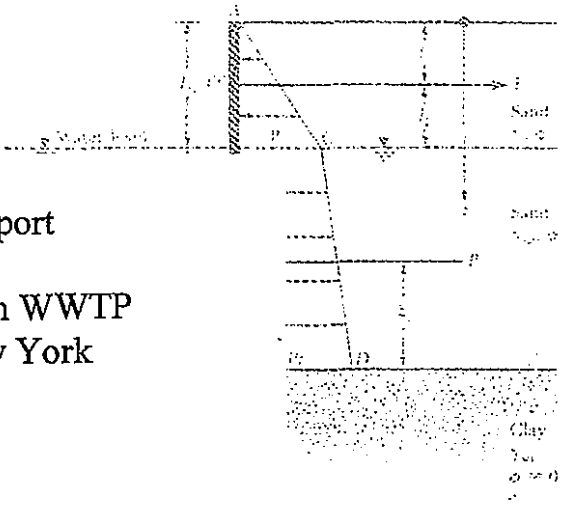
SOIL AND MATERIAL TESTING, INC.
57 South Main Street
Castleton, New York 12033

Casing Size: 3.25" HSA
Hammer Wt (lbs.): 140
Drop (in.): 30
Sheet: 1 of 1

DANIEL G. LOUCKS, P.E.

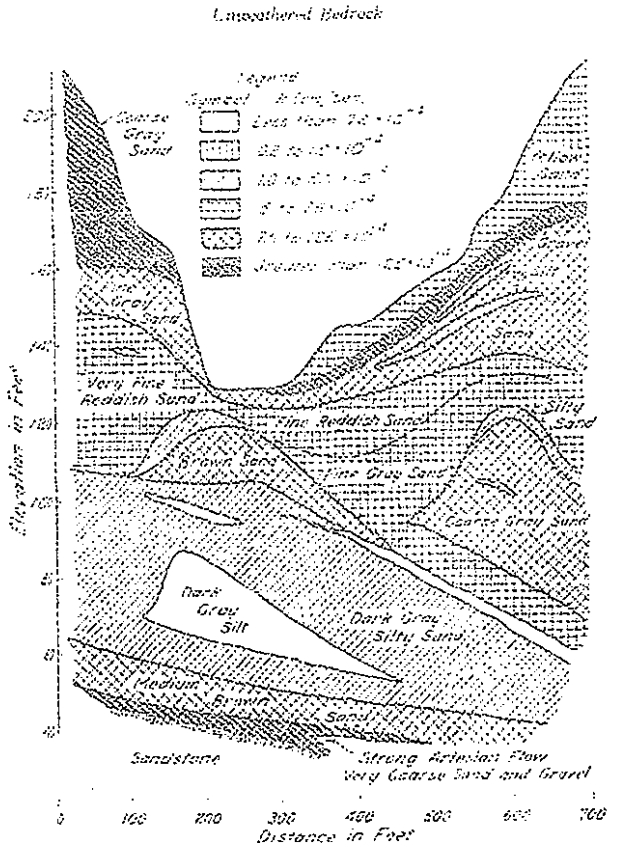
GEOTECHNICAL ENGINEERING

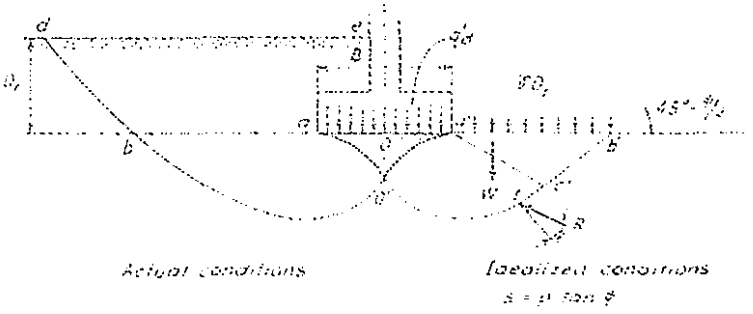


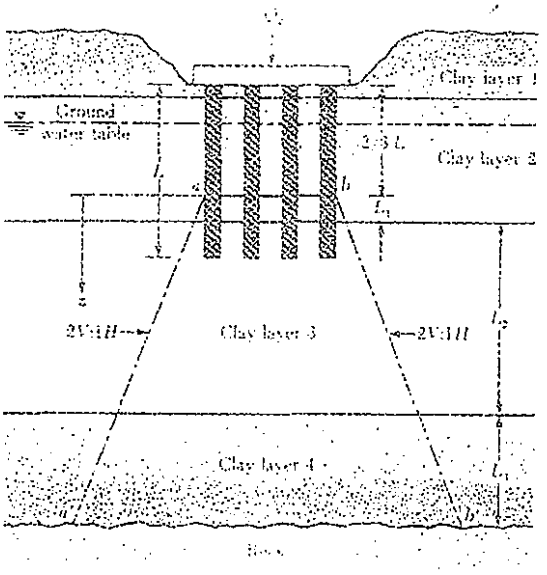


Geotechnical Report
For
Additions to Arlington WWTP
Poughkeepsie, New York

File No. 2138







P.O. BOX 163, BALLSTON SPA, NY 12020

Geotechnical Report
For
Additions to Arlington WWTP
Poughkeepsie, New York

File No. 2138

Prepared For:

Morris Associates

Prepared By:

Daniel G Loucks, PE
NYSPE 068389

17 December 2009

RECEIVED
DEC 21 2009
MORRIS ASSOCIATES

INTRODUCTION:

The subsurface investigation for the proposed Additions to the Arlington WWTP, Poughkeepsie, New York has been completed. Soil & Material Testing of Castleton, New York has completed four (4) soil borings at the site. The logs of these borings, along with a location diagram, have been included in the appendix of this report.

It is my understanding that the proposed construction will include two buildings. The Grit/Ash building will be a single-story building located approximately as indicated on the boring location diagram. The Headworks building will be single-story with some lower tank structures, located approximately as indicated on the boring location diagram. The grit/ash building will have a steel frame design and the headworks building will a reinforced concrete design for the lower tank structures and a steel frame or masonry wall design for the upper portion of the building.

The maximum column loadings will range from 50 to 75 kips. Bearing wall loads will range from 1 to 4 kips per foot of wall. The settlement tolerances are normal. Settlement tolerances are considered to include up to 1 inch of total settlement and 3/4 inch of differential settlement between column locations.

The first floor slab will be established at approximately elevation 82 for the grit/ash building. This will require up to approximately 6 feet of cut. The deepest tank elevation in the headworks building will be 66.8 feet. This will require approximately 12 feet of cut. The finished floor elevation for the headworks building will be placed at elevation 80. This will require up to 3 feet of fill and 3 feet of cut.

The purpose of this report is to describe the investigation conducted and the results obtained; to analyze and interpret the data obtained; and to make recommendations for the design and construction of the feasible foundation types and earthworks for the project.

The scope of my services has been limited to coordinating the boring and laboratory investigation, analyzing the soils information, and providing a geotechnical report with foundation recommendations and seismic site classifications as per NYS Building Code. Environmental aspects of the project as well as grading and site design should be performed by qualified others.

FIELD INVESTIGATION PROCEDURES:

The borings were extended by means of 3.25 inch ID, hollow-stem augers and by using various cutting bits using circulating drilling fluid to remove the cuttings from the hole.

Representative samples were obtained from the boring holes by means of the split-spoon sampling procedure performed in accordance with ASTM D 1586. The standard penetration values obtained from this procedure have been indicated on the soil boring logs.

Soil samples obtained from these procedures were examined in the field, sealed in containers, and shipped to the laboratory for further examination, classification and testing, as applicable.

Representative samples of the rock materials were obtained by means of the diamond-bit sampling procedure performed in accordance with ASTM D 2113. NX-size core barrels were used for this sampling procedure. Rock samples obtained from this procedure were examined in the field, placed in wooden core-sample boxes and shipped to the laboratory for further examination and classification.

During the investigation, water level readings were obtained at various times where water accumulated in the boring hole. The water level readings, along with an indication of the time of the reading relative to the boring procedure, have been indicated on the soil boring logs.

In addition to the field boring investigation, the soil engineer visited the site to observe the surface conditions.

LABORATORY INVESTIGATION:

All samples were examined in the laboratory by the soil engineer and classified according to the Unified Soil Classification System. In this system, the soils are visually classified according to texture and plasticity. The appropriate group symbol is indicated on the soil boring logs.

No formal laboratory tests were performed on the soil samples.

SITE CONDITIONS:

At the time of my site visit the ground surface at the proposed headworks building sloped generally down to the south. The ground surface was covered with asphalt pavement and soil. At the proposed location of the grit/ash building, it is my

understanding that there are old buried tanks. I understand that the depth to the bottom of the tanks is not known. To the east of the proposed buildings there is a large rock outcrop.

SUBSURFACE CONDITIONS:

The specific subsurface conditions encountered at each boring location are indicated on the individual soil boring logs. However, to aid in the evaluation of this data, I have prepared a generalized description of the soil conditions based on the boring data.

The borings for the grit/ash building, borings 14 & 16, encountered an upper layer of uncontrolled fill that extended to between approximately 2 and 4 feet. This uncontrolled fill is sand with varying amounts of gravel/weathered shale and a trace to some silt. It is medium dense to very dense. Beneath the uncontrolled fill is a layer of clayey silt/silt and sand with a trace of gravel. This layer is loose to medium dense and extended to between 7.0 and 9.5 feet. Underlying the clayey silt/silt and sand is a layer of weathered shale with a trace of silt. This weathered shale is very dense. Rock core taken, at each boring, encountered fractured shale with an RQD (Rock Quality Designation) of between 7 and 18 percent.

The borings for the headworks building, borings 2 and 8, encountered an upper layer of sand and gravel with a trace to some silt. This sand and gravel is medium dense and extended to approximately 3 feet. It is possible portions of this soil is fill. Underlying the sand and gravel is a layer of weathered shale with a trace of silt. This weathered shale is very dense and extended to between 3.5 and 6.5 feet. Rock core taken, in each boring, encountered fractured shale with occasional dolostone seams. The rock cores had a RQD (Rock Quality Designation) of between 16 and 18 percent.

GROUNDWATER CONDITIONS:

Accurate groundwater levels are difficult to determine in clayey silt soils with only short term readings or observations. Clayey silt soils typically do not allow an adequate amount of water to flow through the soil to produce a water level reading during the drilling operation. I have indicated where water was observed on the boring logs.

Based on the groundwater levels observed during the boring investigation, the moisture condition of the samples recovered from the boring holes and coloration of the soil samples, I judge that the groundwater level was located below depth of 9 feet.

Perched groundwater tables may occur at higher elevations in the soil profile due to groundwater being retained by layers or lenses of silt or clay soils. Perched or seasonal groundwater levels are sometimes indicated by mottled brown/gray soils. These soil conditions were observed as shallow as 4 feet below the existing ground surface.

Some fluctuation in hydrostatic groundwater levels and perched water conditions should be anticipated with variations in the seasonal rainfall and surface runoff.

It should be noted that the groundwater levels were obtained during the drilling procedure. Actual water levels may vary at the time of construction. Some groundwater could be encountered in soil layers labeled moist to wet on the boring logs.

ANALYSIS AND RECOMMENDATIONS:

Site Work:

The proposed construction areas should be cleared and grubbed and all organic topsoil and vegetation along with any uncontrolled fill and debris. It is my understanding that any existing buried tanks will be removed from the building sites. The site should be observed by a qualified engineer to verify that all the tanks have been removed. The subgrade should be proof-rolled with a 10-ton roller. This proof rolling will compact the subgrade and reveal the presence of soft spots. All the vacant tank areas and any soft spots should be backfilled with controlled fill material.

The removal of any uncontrolled fill should extend to a minimum horizontal distance past the edge of the footings equal to the depth that the fill extends under the footing. This is equal to a 1:1 slope down from the outer edge of the footing to the virgin soil. All uncontrolled fill within the proposed building area should also be removed.

A way to stabilize a spongy, but suitable, virgin, subgrade would be to spread a reinforcement or separation type of geotextile on the subgrade and follow with a lift of clean, granu-

lar fill or stone. The thickness of the controlled fill can range from 1.0 to 2.5 feet, as necessary, to achieve a working mat upon which to construct the remainder of the controlled fill or to place footings. If open graded stone is used as controlled fill a layer of geotextile should be placed between the stone and any sand/gravel controlled fill or virgin soil.

Controlled Fill:

Before any controlled fill is placed the site should be inspected to verify that the site has been prepared according to the recommendations contained in this report as required by the NYS Building Code Section 1704.7.1.

Controlled, relatively clean, granular fill can be spread in lifts not exceeding 12 inches in loose thickness. These materials should be compacted to a minimum of 95 percent of the maximum ASTM Specification D 1557-91 density, modified proctor.

On-site material may be difficult to compact during wet weather or poor drying conditions. Given good drying conditions, the on-site soils with more than 10 percent silt/clayey silt could be compacted using disc harrows and sheepsfoot rollers or rubber-tired rollers, as applicable. These types of soils are sensitive to moisture content and weather conditions. During freezing or wet weather conditions these materials may not be able to be adequately compacted for use as structural fill.

If crushed stone is used as controlled fill it should have a layer of geotextile with a minimum tensile strength of 200 lbs and a minimum burst strength of 400 psi placed between the stone and existing soils. The stone should be placed in lifts not exceeding 12 inches in thickness and should be compacted with a minimum of 5 passes of a vibratory roller rated at 5 tons or larger.

Free Draining Controlled Fill Material: Naturally or artificially graded mixture of sand, natural or crushed stone or gravel conforming to NYS DOT Item 304-2.03, Type 4 or 2 as follows:

U.S. Sieve No.	Percent Passing by Weight
2 inch	100
1/4 inch	35-60
No. 40	5-40
No. 200	0-10

NYS DOT Table 703-4, Size 2 crushed stone, clean, durable, angular, and of uniform quality throughout:

U.S. Sieve No.	Percent Passing by Weight
1 ½ inch	100
1 inch	90-100
1/2 inch	0-15

All controlled fill should be free of organic and/or frozen material.

Free-draining controlled fill should have less than 10 percent fines passing the #200 sieve.

I recommend performing one field density test for every 2,000 square feet of controlled fill placed, within the overlaying building footprint, but in no case fewer than three tests per lift.

I recommend that for foundation wall and footing backfill that in each compacted backfill layer have at least one field in place density test for each 50 feet or less of wall or footing length, but not fewer than two tests along a wall face or footing be performed per lift.

Building Foundations:

I recommend that the proposed grit/ash building be supported by spread footing foundations resting on virgin, inorganic, soils or on controlled fill which, in turn, rests on these virgin materials. Footings can be designed for a maximum, net, allowable soil bearing pressure of 3000 psf.

I recommend that the proposed headworks building be supported by spread footing foundations resting on virgin, inorganic, soils/rock or on controlled fill which, in turn, rests on these virgin materials. It appears from the soil borings and the proposed elevations of the lower tanks that most of the proposed foundations will rest on weathered or sound shale bedrock, but depending on the regularity of the rock surface it is possible that portions of the building footings could rest on existing soils. Because if this I recommend that the allowable soil/rock bearing pressure be relatively low to reduce the potential for differential settlements. I recommend that these footings be

designed for a maximum, net, allowable soil/rock bearing pressure of 3000 psf. Because of the relatively light loads of the proposed structures this allowable soil/rock bearing pressure, shouldn't significantly increase the costs for the foundations.

The other option would be to have all the footings extend to weathered shale bedrock. A maximum net allowable weathered rock bearing pressure of 8,000 psf could be used for the design of footings. This however, would require that all the footings extend to the weathered shale rock. If the rock dipped below the proposed footing bottom the area would have to be excavated and filled with lean concrete or the bottom of the footing would have to be extended to the weathered rock surface. Depending on the regularity of the rock surface, this approach maybe more expensive than designing the footing for the lower allowable soil/rock bearing pressure.

The soil engineer should observe the footing subgrade at the beginning of the project or if soil/rock conditions change to verify the allowable bearing pressure of the soil/rock encountered.

Loads from adjacent footings or structures should be assumed to distribute based on the elastic theory. Typical Boussinesq charts can be used to approximate loads at various depths and locations due to adjacent structures.

A minimum footing width of 2.0 feet is recommended for load bearing strip footings. Isolated footings should be at least 3.0 feet wide. Any strip footings, designed to rest on soils and rock, should have a minimum of two #5 bars placed in them, top and bottom, separated by a minimum of 12 inches vertically or an equivalent amount of reinforcement in foundation walls. This reinforcement is intended to resist possible negative as well as positive moments due to non-uniform bearing.

Exterior footings or footings in unheated areas should have a minimum of 4.0 feet of embedment for protection from frost action. Interior footings should have a minimum embedment of 1.5 feet below finished grade to develop the bearing value of the soils.

All walls that retain soil on only one side should have a drain tile placed along the base of the wall. The drain tile should be a minimum of 4 inches in diameter, surrounded by a minimum of 6 inches of properly graded washed sand or crushed stone wrapped with a non woven filter fabric with a maximum apparent opening

size of 70 and a minimum trapezoid tearing strength of 100 lbs. The drain tile should drain to a stormwater sewer, daylight, or a sump equipped with a pump.

The wall should then be backfilled with a controlled, well graded, free-draining granular material. The material should extend away from the wall a horizontal distance of two-thirds the height of the fill being placed. The upper 1 foot of material should be a fairly impermeable material to shed surface water.

If these procedures are used, a static lateral soil pressure of 40 psf per foot of retained soil can be used for design of the wall. This static, active lateral soil pressure is based on a moist unit weight of 125 pcf and an angle of internal friction of 32 degrees. A wall soil friction angle of 18 degrees and a coefficient of base sliding of 0.35 can also be used for design. If the foundations are designed to rest on weathered shale then a coefficient of base sliding of 0.45 can be used for design.

If the retaining wall is braced or if the deflection is limited prior to backfilling so the active soil pressure is not achieved, a static, at-rest lateral soil pressure of 63 psf per foot of retained soil can be used for design. If drainage cannot be provided then a lateral soil and water pressure of 85 psf per foot of soil retained should be used for design.

To resist overturning and sliding a static lateral passive pressure of 250 psf per foot of embedment can be used. This static, passive pressure resistance value has been reduced from the calculated full passive pressure because of stress/strain characteristics of the soil. To develop the full, calculated resistance a certain amount of movement or deflection in the structure is required. The amount of movement required to generate this resistance generally greater then is acceptable for structures. I therefore recommend that the full passive pressure not be used.

The passive resistance of the upper two feet of soil should be ignored due to surface effects of frost and moisture.

Any surcharge loading of existing adjacent building foundations or other adjacent structures/utilities should be addressed by the structural engineer using Boussinesq charts.

For the analysis of seismic loading the allowable soil bearing pressure and passive soil resistance may be increased by a factor of one-third.

Floor/Tank Slabs:

Concrete floor/tank slabs can be designed to rest on controlled fills resting on virgin materials. A 6-inch layer of well-graded, free-draining, granular material should be placed beneath the floor/tank slab to provide drainage, act as a capillary break, and to provide better and more uniform support.

If vehicle loadings are to be applied to the floor slab, the proposed slab and supporting soils should be analyzed as a pavement structure. I recommend that a minimum of 12 inches of free draining controlled granular fill be placed below any concrete pavements.

A modulus of subgrade reaction of 125 psi per inch can be used to design concrete slabs resting on a minimum of 6 inches of free draining controlled fill that in turn rests on virgin soils or controlled fill. A modulus of subgrade reaction of 300 psi per inch can be used to design concrete slabs resting on a minimum of 6 inches of free draining controlled fill that in turn rests on weathered shale. A modulus of subgrade reaction of 100 psi per inch can be used to design exterior slabs or pavements resting on a minimum of 12 inches of free draining controlled fill. This reduced value is recommended due to seasonal variations that occur due to frost in the soils.

Exterior concrete or asphalt pavements will experience some frost heave movements during the winter and spring. If these movements are not acceptable then a minimum of 4.0 feet of approved subbase material and properly designed drains would be required below the concrete or asphalt pavements or sidewalks. The use of properly designed footing drains can also be used to reduce possible frost heave movements adjacent to the proposed structure.

If the moisture levels of floor slab areas are critical additional drainage materials and vapor barriers will be required beneath the floor slab. Also the moisture content of the subbase soils should be carefully monitored to prevent excess water from saturating these subbase soils before the floor slab is poured. This aspect of the design should be performed by qualified others.

Seismic Conditions:

The potential seismic conditions at the proposed site have been investigated using the information provided in the NYS Building

Code Section 1613 and 18 and the boring information obtained during my investigation.

Based on the soil boring information it is my opinion that the Site Classification (Table 1615.1.1) could be assumed to be C. Using figures 1615 (1 and 2) and the USGS 2003 NEHRP Seismic Design Provisions, I estimate that the MCE spectral acceleration (S_{MS}) at short periods is 32.5 and the MCE spectral acceleration (S_{M1}) at 1 s period is 11.3.

The probabilistic ground motion values are expressed in %g for rock site class B. Peak ground accelerations in the upper soil profile may vary. If specific peak ground accelerations or shear wave velocities are required for the upper soil profile additional testing would be required. If it is determined by the structural engineer that the Seismic Design Category is D, E or F additional geotechnical recommendations can be provided.

The soil borings and my analysis do not indicate any significant potential seismic hazards such as liquefaction, sensitive clays, weakly cemented soil or surface rupture.

CONSTRUCTION PROCEDURES AND PROBLEMS:

The NYS Building Code Section 17 requires special inspections and follow up reports. These inspections should be performed to verify compliance with the recommendations contained in this report.

All excavations of more than a few feet should be sheeted and braced or laid back to prevent sloughing in of the sides.

Excavations should not extend below adjacent footings or structures unless properly designed sheeting and bracing or underpinning is installed.

Footing and floor slab subgrades should be tamped to compact any soil disturbed during the excavation process. If over excavation of subgrades are required to remove cobbles or possibly boulders, then the over excavated areas should be filled with controlled granular fill or lean concrete.

A layer of geotextile (min. tensile strength of 200 lbs and min. burst strength of 400 psi) and 4 to 8 inches of crushed stone may be required in footing excavations to prevent disturbance of the virgin subgrade during wet weather.

Sump-pit and sump-pump-type dewatering may be required in excavations or low areas during wet weather or if groundwater is encountered. All dewatering programs should be designed to prevent bottom heave. Any dewatering program should be performed with properly designed filtration protection on all pumps to prevent loss of ground.

Subgrades should be kept from freezing during construction. Water, snow, and ice should not be allowed to collect and stand in excavations or low areas of the subgrade.

Some obstacles, including foundations and utilities and possibly cobbles/boulders and bedrock, may be encountered in excavations.

The use of hydraulically operated rippers, pneumatic tools, or drilling and blasting may be required to remove bedrock or large boulders if encountered. Based on the borings taken, I estimate that the upper 1 to 4 feet of weathered shale could be removed with a large track mounted excavator with a rock bucket. Deeper or harder areas of rock may require blasting.

Design and construction procedures should include measures to limit the potential for slab curl and vapor transmission. The shrinkage properties of the concrete should be controlled and the curing of the concrete controlled. Differential shrinkage between the top and bottom of the slabs could otherwise result in curling of the slabs. The control of vapor transmission through the slab should also be addressed. These phenomena may be only indirectly related to soil conditions. The architect/ structural engineer should address this aspect of the design.

Current American Concrete Institute recommendations for the design and construction of floor slabs and the control of shrinkage, slab curl and vapor transmission can be referred to.

Additions to Arlington WWTP
Poughkeepsie, New York
File No. 2138

CONTENTS OF APPENDIX:

1. General Notes
2. Boring Location Diagram
3. Boring Logs
4. 2003 NEHRP Seismic Design Values
5. Unified Soil Classification System
6. Soil Use Chart
7. General Qualifications

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS

SS : Split-Spoon — 1¾" I.D., 2" O.D., except where noted
S : Shelby Tube — 2" O.D., except where noted
PA : Power Auger Sample
DB : Diamond Bit — NX: BX: AX:
CB : Carboloy Bit — NX: BX: AX:
OS : Osterberg Sampler — 3" Shelby Tube
HS : Housel Sampler
WS : Wash Sample
FT : Fish Tail
RB : Rock Bit
WO : Wash Out

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted

WATER LEVEL MEASUREMENT SYMBOLS

WL : Water Level
WCI : Wet Cave In
DCI : Dry Cave In
WS : While Sampling
WD : While Drilling
BCR : Before Casing Removal
ACR : After Casing Removal
AB : After Boring

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable ground water levels. In impervious soils the accurate determination of ground water elevations is not possible in even several day's observation, and additional evidence on ground water elevations must be sought.

CLASSIFICATION

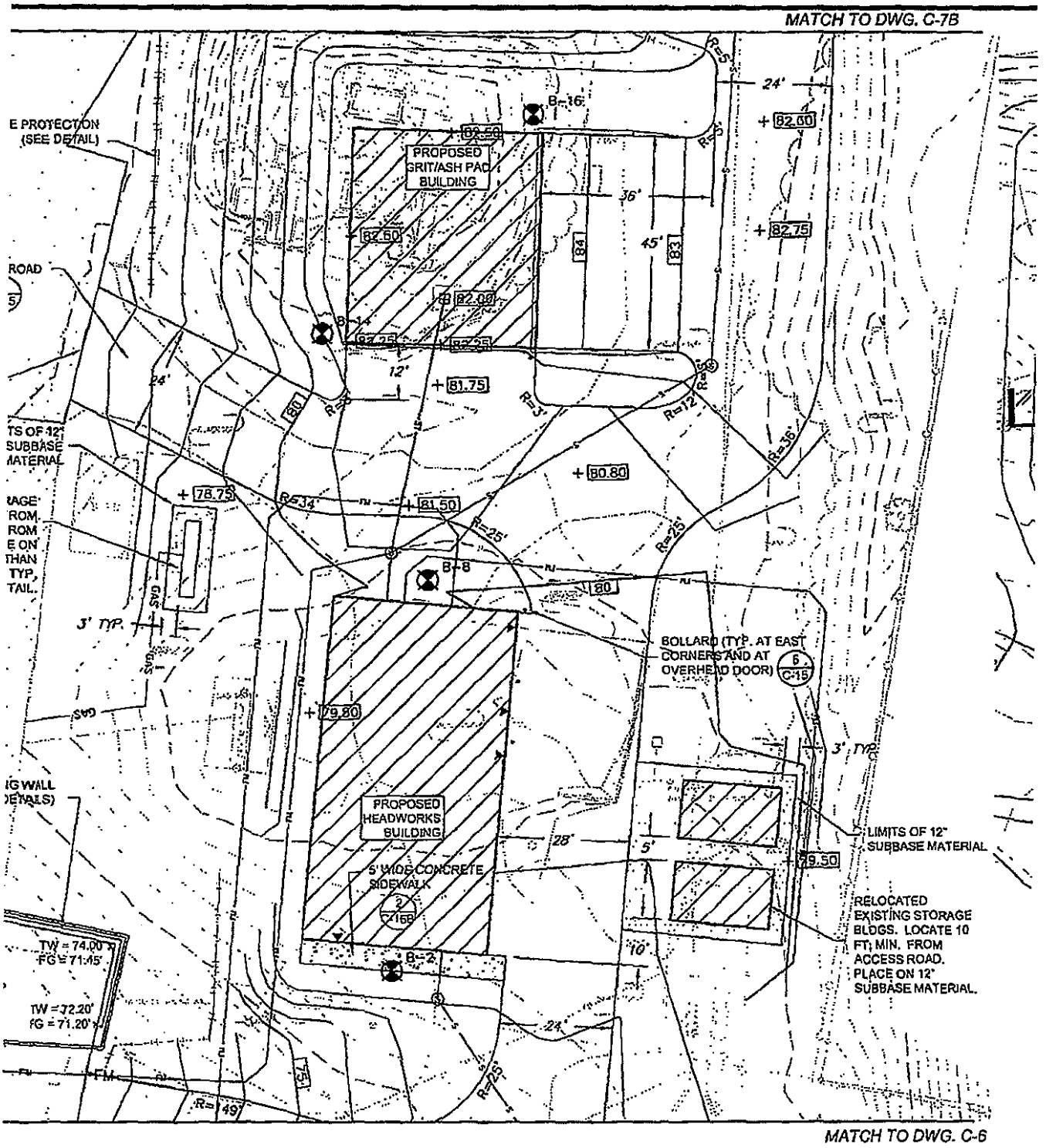
COHESIONLESS SOILS

"Trace"	: 1% to 10%	
"Trace to some"	: 10% to 20%	
"Some"	: 20% to 35%	
"And"	: 35% to 50%	
Loose	: 0 to 9 Blows	or equivalent
Medium Dense	: 10 to 29 Blows	or equivalent
Dense	: 30 to 59 Blows	or equivalent
Very Dense	: ≥60 Blows	or equivalent

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, then clay becomes the principle noun with the other major soil constituent as modifiers: i.e., silty clay. Other minor soil constituents may be added according to classification breakdown for cohesionless soils; i.e., silty clay, trace to some sand, trace gravel.

Soft	: 0.00 — 0.59 tons/ft^2
Medium	: 0.60 — 0.99 tons/ft^2
Stiff	: 1.00 — 1.99 tons/ft^2
Very Stiff	: 2.00 — 3.99 tons/ft^2
Hard	: ≥ 4.00 tons/ft^2



MORRIS ASSOCIATES, P.L.L.C.
ENGINEERING CONSULTANTS

9 Ellis Lane.
Poughkeepsie, New York 12601
Phone No. (845) 454-3411
Fax No. (845) 473-1982

389 Fairview Ave.
Hudson, New York 12534
Phone No. (518) 828-2300
Fax No. (518) 828-3963

DATE	SCALE	DESIGNED BY:	FILE No.
04/01/07	1"=30'	DRAWN BY:	60401.27
		CHECKED BY:	

BORING LOG

BORING NO: 2

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: 11.0 ft **TIME:** WS

FILE NUMBER: 2138

OFFSET: None

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
1, 2, 3		HD				Hand Dug By Driller
4, 5	1	SS	26-39-24-22	63		Weathered Shale, trace Silt, Gray, Dry, Very Dense (GM-GP)
6	2	SS	16-21-100	100+		Weathered Shale, trace Silt, Weathered Dolostone, Gray, Dry, Dense to Very Dense (GM-GP)
7, 8, 9, 10, 11	Run 1	DB				Run 1 Gray Fractured Shale with Occasional Dolostone Seams RQD = 18 percent
12, 13, 14, 15						End of Boring at 11.5 Feet

BORING LOG

BORING NO: 8

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: None Observed **TIME:** WS

FILE NUMBER: 2138

OFFSET: None

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
		PA				Asphalt Pavement Driller Notes Sand and Gravel Subbase
1 2	1	SS	8-12-12-19	24		Fine to Coarse Sand and Gravel, trace to some Silt, Dark Gray, Moist, Medium Dense (SM-GM) Possible Fill
3	2	SS	50	100		Weathered Shale, trace Silt, Gray, Dry, Very Dense (GM-GP)
4 5 6 7 8	Run 1	SS				Run1 Dark Gray Fractured Shale, Occcasional Dolostone Seams RQD = 16 percent
9 10 11 12 13 14 15						End of Boring at 8.5 Feet

BORING LOG

BORING NO: 14

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: None Observed **TIME:** WS

FILE NUMBER: 2138

OFFSET: 15' toward road

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
1	1	SS	3-3-7-8	10		Fine to Coarse Sand, some Gravel, trace to some Silt, Dark Brown, Moist, Medium Dense (SM) Possible Fill
2						
3	2	SS	6-5-4-3	9		Fine Sand, some Clayey Silt, Brown, Moist to Wet, Loose (SM)
4						
5	3	SS	2-5-5-6	10		Clayey Silt and Sand, Brown/Gray, Moist, Medium Dense (ML-SM)
6						
7	4	SS	5-5-50/.3	10		Clayey Silt, trace to some Sand, Brown/Gray, Moist, Medium Dense (ML)
						Weathered Shale, trace Silt, Gray, Moist, Very Dense (GM-GP)
8						Run 1 Gray Fractured Shale RQD = 7 percent
9						
10	Run 1	DB				
11						
12						
13						End of Boring at 12.3 Feet
14						
15						

BORING LOG

BORING NO: 16

SHEET 1 of 1

PROJECT NAME: Arlington WWTP

LOCATION: Poughkeepsie, NY

DATE STARTED/COMPLETED: December 2009

ENGINEER/ARCHITECT: Morris Associates

DRILLING METHOD: Hollow Stem Auger

DRILL RIG TYPE: Truck Mount

HAMMER WEIGHT: 140 Lbs

DROP: 30 Inches

CASING DIAMETER: OD/ID: 3.25 inch ID

WATER LEVEL DEPTH: 9.2 ft **TIME:** WS

FILE NUMBER: 2138

OFFSET: None

SURFACE ELEV.: N/A

DRILL CONTRACTOR: Soil & Material Testing Inc.

Daniel G Loucks PE
PO Box 163
Ballston Spa, New York 12020
Phone: 518-371-7622
Fax: 518-383-2069

DEPTH	Sample Number	Sample Type	BLOW COUNTS per 6 inches	"N" Value	Recovery	DESCRIPTION
1	1	SS	5-6-11-20	17		Fine to Coarse Sand, trace to some Weathered Shale, Gray, Moist, Medium Dense to Very Dense (SM) FILL
2	2	SS	50	100		
3		PA				
4	3	SS	4-4-5-7	9		Fine Sand, some Silt, trace Gravel, Roots, Brown/Gray, Moist, Loose (SM)
5						Silt, some Sand, trace to some Gravel, Brown, Moist to Wet, Loose (ML)
6	4	SS	5-5-4-4	9		Silt, trace to some Clay, Brown/Gray, Wet, Loose/Medium Stiff (ML)(CL) Occasional Thin Clay Layers
7						
8	5	SS	4-4-4-5	8		
9		PA				
	6			100+		Weathered Shale, trace Silt, Dark Gray, Wet, Very Dense (GM-GP)
10						Run1
11						Dark Gray Fractured Shale
12	Run 1	DB				RQD = 18 percent
13						
14						
15						End of Boring at 14.6 Feet

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 12601
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Data are based on a 0.05000000074505806 deg grid spacing

Period (sec)	Centroid Sa (g)	
0.2	0.258	(Ss)
1.0	0.066	(S1)

Period (sec)	Maximum Sa (g)	
0.2	0.270	(Ss)
1.0	0.066	(S1)

Period (sec)	Minimum Sa (g)	
0.2	0.247	(Ss)
1.0	0.065	(S1)

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 12601
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class C

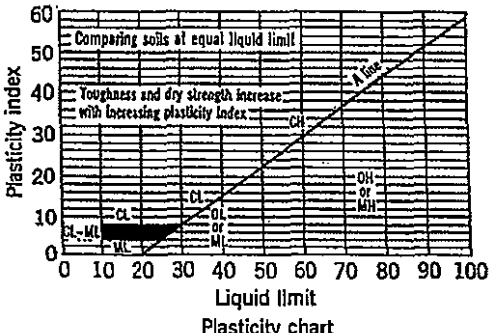
Period (sec)	Centroid Sa (g)	
0.2	0.310	(SMs, Fa = 1.200)
1.0	0.112	(SM1, Fv = 1.700)

Period (sec)	Maximum Sa (g)	
0.2	0.325	(SMs, Fa = 1.200)
1.0	0.113	(SM1, Fv = 1.700)

Period (sec)	Minimum Sa (g)

Table 3.5 Unified Soil Classification

Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)						Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria			
Coarse-grained soils More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3		
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*			
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics	Atterberg limits below "A" line, or *PI* less than 4		Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols	
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7			
	Sands More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3			
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*			
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5		Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols	
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7			
Fine-grained soils More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size											
	Silts and clays liquid limit less than 50		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)							
			None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses				
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays					
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions				
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts					
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)				
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity					
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils					



Plasticity chart for laboratory classification of fine grained soils

From Wagner, 1957.

[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.

[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):

After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Soil Characteristics Pertinent to Roads and Airfields

Major Divisions		Letter (1)	Name	Value as Subgrade When Not Subject to Frost Action	Value as Subbase When Not Subject to Frost Action	Value as Base When Not Subject to Frost Action	Potential Frost Action	Compressibility and Expansion	Drainage Characteristics	Compaction Equipment	Unit Dry Weight lb. per cu. ft.	Typical Design Values: CBR (2)	Typical Design Values: Subgrade Modulus k lb. per cu. in.
Coarse-Grained Soils	Gravel and Gravelly Soils	GW	Well-graded gravels or gravel-sand mixtures, little or no fines	Excellent	Excellent	Good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	125-140	40-80	300-500
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines	Good to excellent	Good	Fair to good	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller, steel-wheeled roller	110-140	30-60	300-500
		GM d	Silty gravels, gravel-sand-silt mixtures	Good to excellent	Good	Fair to good	Slight to medium	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	125-145	40-60	300-500
		GM u		Good	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	115-135	20-30	200-500
		GC	Clayey gravels, gravel-sand-clay mixtures	Good	Fair	Poor to not suitable	Slight to medium	Slight	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	130-145	20-40	200-500
	Sand and Sandy Soils	SW	Well-graded sands or gravelly sands, little or no fines	Good	Fair to good	Poor	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	110-130	20-40	200-400
		SP	Poorly graded sands or gravelly sands, little or no fines	Fair to good	Fair	Poor to not suitable	None to very slight	Almost none	Excellent	Crawler-type tractor, rubber-tired roller	105-135	10-40	150-400
		SM d	Silty sands, sand-silt mixtures	Fair to good	Fair to good	Poor	Slight to high	Very slight	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	120-135	15-40	150-400
		SM u		Fair	Poor to fair	Not suitable	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-130	10-20	100-300
		SC	Clayey sands, sand-clay mixtures	Poor to fair	Poor	Not suitable	Slight to high	Slight to medium	Poor to practically impervious	Rubber-tired roller, sheepsfoot roller	100-135	5-20	100-300
Fine-Grained Soils	Silts and Clays LL is less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Poor to fair	Not suitable	Not suitable	Medium to very high	Slight to medium	Fair to poor	Rubber-tired roller, sheepsfoot roller; close control of moisture	90-130	15 or less	100-200
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Poor to fair	Not suitable	Not suitable	Medium to high	Medium	Practically impervious	Rubber-tired roller, sheepsfoot roller	90-130	15 or less	50-150
		OL	Organic silts and organic silt-clays of low plasticity	Poor	Not suitable	Not suitable	Medium to high	Medium to high	Poor	Rubber-tired roller, sheepsfoot roller	90-105	5 or less	50-100
	Silts and Clays LL is Greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	Not suitable	Not suitable	Medium to very high	High	Fair to poor	Sheepsfoot roller, rubber-tired roller	80-105	10 or less	50-100
		CH	Inorganic clays of medium to high plasticity, organic silts	Poor to fair	Not suitable	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	90-115	15 or less	50-150
		OH	Organic clays of high plasticity, fat clays	Poor to very poor	Not suitable	Not suitable	Medium	High	Practically impervious	Sheepsfoot roller, rubber-tired roller	80-110	5 or less	25-100
Highly Organic Soils		Pt	Peat and other highly organic soils	Not suitable	Not suitable	Not suitable	Slight	Very high	Fair to poor	Compaction not practical	—	—	—

Note:

(1) Unit Dry Weights are for compacted soil at optimum moisture content for modified AASHO compaction effort. Division of GM and SM groups into subdivision of d and u are for roads and airfields only. Subdivision is basis of Atterberg limits; suffix d (e.g., GMd) will be used when the liquid limit (L.L.) is 25 or less and the plasticity index is 6 or less; the suffix u will be used otherwise.

(2) The maximum value that can be used in design of airfields is, in some cases, limited by gradation and plasticity requirements.

GENERAL QUALIFICATIONS

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope of the project and location described herein, and my description of the project represents my understanding of the significant aspects relevant to soil and foundation characteristics. In the event that any changes in the design or location of the proposed facilities, as outlined in this report, are planned, I should be informed so the changes can be reviewed and the conclusions of this report modified or approved in writing by myself.

It is recommended that all construction operations dealing with earthwork and foundations be inspected by an experienced soil engineer to assure that the design requirements are fulfilled in the actual construction. If you wish, I would welcome the opportunity to review the plans and specifications when they have been prepared so that I may have the opportunity of commenting on the effect of soil conditions on the design and specifications.

The analysis and recommendations submitted in this report are based upon the data obtained from the soil borings and/or test pits performed at the locations indicated on the location diagram and from any other information discussed in the report. This report does not reflect any variations which may occur between these boring and/or test pits. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is a well-known fact that variations in soil and rock conditions exist on most sites between boring locations and also such situations as groundwater conditions vary from time to time. The nature and extent of variations may may not become evident until the course of construction. If variations then appear evident, it will be necessary for a reevaluation of the recommendations of this report after performing on-site observations during the construction period and noting the characteristics of any variations.

SECTION 02080 - PIPED UTILITIES - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Sleeves.
4. Grout.
5. Piped utility demolition.
6. Metal supports and anchorages.

1.3 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Identification devices.

B. Samples of color, lettering style, and other graphic representation required for each identification material and device.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 2 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 2 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.

e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Available Manufacturers:

a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.

D. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.

2.5 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPED UTILITY DEMOLITION

A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 2 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 2 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.6 PIPING HANGERS AND SUPPORTS

A. Refer to Division 15 Section "Hangers and Supports for Piping and Equipment" for piping support inside buildings, tunnels and vaults.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 02080

SECTION 02221 - BUILDING DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Demolition and removal of buildings and structures.
2. Demolition and removal of site improvements adjacent to a building or structure to be demolished.
3. Disconnecting, capping or sealing, and removing site utilities.

B. Related Sections include the following:

1. Division 1 Section "Summary" for use of the premises and phasing requirements.
2. Division 1 Section "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
3. Division 1 Section "Photographic Documentation" for preconstruction photographs taken before building demolition.
4. Division 1 Section "Temporary Facilities and Controls" for temporary construction, protection facilities, and environmental-protection measures for building demolition operations.
5. Division 1 Section "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
6. Division 2 Section "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of building demolition.

1.3 DEFINITIONS

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

B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.

C. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or recycled.

1.4 MATERIALS OWNERSHIP

A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered during building demolition remain Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to Owner.

1.5 SUBMITTALS

A. Qualification Data: For demolition firm.

B. Proposed Environmental-Protection, Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

C. Schedule of Building Demolition Activities.

D. Inventory: After building demolition is complete, submit a list of items that have been removed and salvaged.

E. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before Work begins.

1.6 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

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

C. Standards: Comply with ANSI A10.6 and NFPA 241.

D. Predemolition Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

A. Building to be demolished will be vacated and their use discontinued before start of Work.

B. Owner assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

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

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

D. Storage or sale of removed items or materials on-site is not permitted.

1.8 COORDINATION

A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Survey existing conditions and correlate with requirements indicated to determine extent of building demolition required.

B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are the same as those indicated in Project Record Documents.

C. Inventory and record the condition of items to be removed and salvaged.

D. When unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure the nature and extent of the element. Promptly submit a written report to Engineer.

E. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.

F. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.2 PREPARATION

A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.

2. If utility services are required to be removed, relocated, or abandoned, before proceeding with building demolition provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of demolition.

C. Removed and Salvaged Items: Comply with the following:

1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area on-site.
5. Protect items from damage during transport and storage.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during demolition and cleaned and reinstalled in their original locations after demolition operations are complete.

C. Existing Utilities: Maintain utility services indicated to remain and protect them against damage during demolition operations.

1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to authorities having jurisdiction.

a. Provide at least 72 hours' notice to Owner if shutdown of service is required during changeover.

D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 1 Section "Temporary Facilities and Controls."

1. Protect existing site improvements, appurtenances, and landscaping to remain.
2. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
3. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

4. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
5. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
6. Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise from occupied portions of adjacent buildings.

3.4 DEMOLITION, GENERAL

A. General: Demolish indicated existing buildings and structures and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
2. Maintain adequate ventilation when using cutting torches.
3. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

3.5 EXPLOSIVE DEMOLITION

A. Explosives: Use of explosives is not permitted.

3.6 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

B. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Division 2 Section "Earthwork."

C. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.7 REPAIRS

A. General: Promptly repair damage to adjacent construction caused by building demolition operations.

B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

C. Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.9 CLEANING

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

END OF SECTION 02221

SECTION 02225 - CONTROLLED DENSITY FILL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies ready-mix Controlled Density Fill (CDF) for the following applications:

1. Beddings, encasements, and closures for tanks and piping.
2. General backfill applications for trenches and abutments.

B. Related Sections include the following:

1. Section 02300 – Earthwork
2. Section 03300 – Cast-In-Place-Concrete.

C. Definitions:

1. Ready-mix Controlled Density Fill (CDF) is used as an alternative to compacted soil and is also known as controlled low strength material, or flowable fill.

2. Controlled Density Fill may be either machine or hand tool excavatable depending on the chosen compressive strength for the project.

1.3 SUBMITTALS

A. Submit manufacturer's Stable-Air Generator Admixture product data, installation instructions, and recommendations for material use.

B. Test and Performance Data:

1. Controlled Density Fill shall have a compressive strength of 100 psi according to ASTM C39 at 28 days after placement. Submit complete mix design.
2. Controlled Density Fill shall have a minimal subsidence and bleed water which is measured as a Final Bleeding of less than 2.0% (retains 98.0% of original height after placement, approximately ¼" per foot of depth) as measured in Section 10 of ASTM C940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Pre-placed Aggregate Concrete in the Laboratory".
3. Controlled Density Fill shall have a unit weight of 90 – 125 pcf.

PART 2 - PRODUCTS AND MATERIALS

2.1 PRODUCTS

A. Air Entraining Admixture:

1. Grace Construction Products, “DARAFILL”

2. Masterbuilders Technologies, “RHEOCELL – RHEOFILL”

2.2 MATERIALS

A. Portland Cement: ASTM C150

B. Aggregate: ASTM C33

C. Fly Ash: ASTM C618, Class C or F

D. Water: Clean potable

2.3 MIXTURE

A. Mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place.

B. Provide mix with a fresh unit weight between 90 – 125 pcf and a compressive strength of 100 psi when measured 28 days after placement.

C. Controlled Density Fill shall have an in-place yield of 98% of the design yield.

D. Entrained air content: 20 - 30%.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions of substrates or other conditions under which the work is to be performed and notify the Engineer of circumstances detrimental to proper placement of the material.

3.2 PLACEMENT

A. Secure piping, conduits, and other items to be encased to prevent movement during placement of the Controlled Density Fill.

3.3 PLACEMENT

A. Protect Controlled Density Fill from traffic or overlay materials until sufficient strength has been achieved for further construction operations.

END OF SECTION 02225

SECTION 02230 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants and grass to remain.
2. Removing existing trees and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place and removing site utilities.
7. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 1 Section "Execution Requirements" for verifying utility locations and for recording field measurements.
3. Division 1 Section "Selective Demolition" for partial demolition of buildings or structures undergoing alterations.
4. Division 2 Section "Earthwork" for soil materials, excavating, backfilling, and site grading.
5. Division 2 Section "Erosion and Sedimentation Control" for providing erosion and sedimentation control during construction.
6. Division 2 Section "Lawns and Grasses", "Exterior Plants" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 1 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures in accordance with Division 2 Section "Erosion and Sedimentation Control" and New York State Standards and Specifications for Erosion and Sediment Control to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

B. Temporary erosion and sediment control measures shall be installed prior to site disturbance.

C. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

D. Pavement and sidewalks in all work areas shall be broom cleaned at the end of each workday.

E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.

1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies and Owner to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner and Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
4. Use only hand methods for grubbing within tree protection zone.
5. Chip removed tree branches and dispose of off site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within tree protection zones.
3. Dispose of excess topsoil as specified for waste material disposal.

4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 02230

SECTION 02240 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes construction dewatering.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
2. Division 2 Section "Excavation Support and Protection."
3. Division 2 Section "Earthwork" for excavating, backfilling, site grading and for site utilities.
4. Division 2 Section "Subdrainage" for permanent foundation wall, underfloor, and footing drainage.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

1.4 SUBMITTALS

A. Shop Drawings for Information: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.

1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
2. Include a written report outlining control procedures to be adopted if dewatering problems arise.

B. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 02240

SECTION 02260 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes temporary excavation support and protection systems.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
2. Division 2 Section "Dewatering" for dewatering excavations.
3. Division 2 Section "Earthwork" for excavating and backfilling and for existing utilities.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.4 SUBMITTALS

A. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.

1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For Installer and professional engineer.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.3 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Engineer.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

END OF SECTION 02260

SECTION 02276 - EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Furnish all labor, equipment and materials required to complete all work associated with providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work on the Drawings and specified herein.

B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Owner's Representative.

C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off site sedimentation be absolutely minimized.

D. All work under this Contract shall be done in conformance with and subject to the limitations of the New York Rules and Regulations for Erosion and Sedimentation Control, and the Storm Water Pollution Prevention Plan (SWPPP), which has been prepared for this project in accordance with the applicable portions of the New York Pollution Discharge Elimination System (NYPDES).

E. The following excerpts from the regulations are particularly important:

1. ...slopes left exposed will, within 21 working days of completion of any phase of grading, be planted or otherwise provided with ground cover, devices, or structures sufficient to restrain erosion...
2. ...a ground cover sufficient to restrain erosion must be planted or otherwise provided within 21 working days on that portion of the tract (disturbed area) upon which further active construction is not being undertaken...

F. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sedimentation control devices will be adjusted on several occasions to reflect the current phase of construction. Erosion and sedimentation control devices shall be established prior to or concurrent with the clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established immediately following completion of the clearing operation.

G. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation.

The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Drawings shall have the prior acceptance of the Owner's Representative.

H. Erosion and sedimentation controls applicable to this project shall include but not be limited to the following items of work:

1. Provide temporary sedimentation basins for the settling of water pumped from the excavations or intercepted by drainage ditches for keeping water out of the excavations or to protect existing structures. The Contractor shall remove trapped sediments from the basins as necessary to maintain their effectiveness or as indicated by the Owner's Representative. Sediment material removed from the basins shall be disposed off site by the Contractor at no additional cost to the Owner.
2. Temporary diversion ditches shall be constructed adjacent to disturbed areas as shown on the Drawings to collect surface runoff from disturbed areas and direct the runoff to the temporary sediment basins or to divert non-sediment laden runoff away from undisturbed areas and/or temporary sediment basins. All such temporary diversion ditches shall terminate with temporary sediment basins as shown on the Drawings, unless diverting non-sediment laden runoff.
3. Provide temporary sediment basins at locations shown on the Drawings and at other locations indicated by the Owner's Representative.
4. Erect silt fence at locations shown on the Drawings and at other locations indicated by the Owner's Representative.
5. Provide gravel and riprap filter berm basins at locations shown on the Drawings and at other locations indicated by the Owner's Representative.
6. Provide temporary or permanent ground cover adequate to restrain erosion on erodible slopes or other areas that will be left unworked for periods exceeding 21 calendar days.
7. Construct 50-foot minimum temporary gravel buffer construction entrances as specified herein or as shown on the Drawings from public or private roads to all paved access roads used by the Contractor. The Contractor shall maintain the gravel buffers for the Contract duration or until final pavement, where applicable, has been constructed.
8. Provide other types of erosion and sedimentation control devices at the locations shown on the Drawings, or as specified herein.

I. Related Sections include the following:

1. Division 2 Section "Earthwork" for soil materials, excavating, backfilling, and site grading.

1.3 SUBMITTALS

A. Prior to the start of the work, prepare and submit a plan for applying temporary and permanent erosion and siltation control measures. Construction work shall not commence until the schedule of work and the methods of operations have been reviewed and approved.

B. In accordance with the procedures and requirements set forth in the General Conditions Division 1 and Section 01330 - Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.
3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

1.4 QUALITY ASSURANCE

A. Codes and Standards

1. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

a. Local Erosion and Sedimentation Control Code & Requirements.

1.5 WARRANTEE

A. All restoration and re-vegetation work shall be subject to the one-year warrantee period of the Contract as specified in the General conditions herein.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials for use in erosion and sedimentation control devices shall be in accordance with the New York Erosion and Sediment Control Planning and Design Manual.

B. Silt Fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalies and acids in the pH range from 2 to 13, and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be Type FX-ll, ar manufactured by Carthage Mills, Geotex 91OSC as manufactured by Synthetic Industries, Inc., Amoco 2130 as manufactured by Amoco Fabrics & Fibers, Co., or equal.

C. Filter fabric for the silt fence shall have the following minimum properties:

	Value	Test Method
Grab Tensile Strength	100 lbs	ASTM D 4632
Grab Elongation	15%	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4533
Mullen Burst Strength	265 lbs	ASTM D 3786
Puncture Strength	58 lbs	ASTM D 3787
Retained Strength (500 hrs. accelerated UV exposure)	80%	ASTM D4355
Filtration Efficiency	75%	VTM-5 I
Flow Rate	10 gal/mm/ft2	ASTM D4491
Height	36 inches	

D. Posts for silt fence shall be steel and shall have the following properties:

ASTM Designation:	ASTM 702
Length:	5-Feet Long (T-Type)
Weight:	I .25#fFoot (mm.)
Area of Anchor Plate:	14 Sq. In.

Note: Five (T) Fasteners shall be furnished with each post.

E. Wire Fabric for the silt fence shall have the following properties:

Wire Fabric Designation:	832-12-10-12.5 Class 1 ASTM
Designation:	ASTM A116
Width:	32”
Number of Line Wires:	8
Stay Wire Spacing:	12”
Line and Stay Wires:	12.5 Ga.
Top and Bottom Wires:	10 Ga.
Wire Coating:	ASTM Class 1 Zinc Coating

2.2 STONE FOR EROSION CONTROL

A. The Contractor shall place stone for erosion control as shown on the Drawings, as specified herein and as specified in the NYSDOT Standard Specifications.

2.3 RIP RAP

A. The Contractor shall place riprap as shown on the Drawings, as specified in NYSDOT Standard specifications for plain riprap. The stone for riprap shall consist of field stone or rough unhewn quarry stone. The stone shall be sound, tough, dense, and resistant to the action of air and water. Neither the width nor thickness of individual stones shall be less than one-third their length.

2.4 TEMPORARY SEDIMENT BASINS

A. Temporary sediment basins shall be constructed as shown on the Contract Drawings and as specified herein. The temporary sediment basins shall be constructed and maintained in accordance with Part 1 of this Section to the satisfaction of the Owner’s Representative until a vegetative ground cover has been established. The cost of the temporary sediment basins shall include the excavation, grading, diversion ditches, stone for erosion control, washed stone, geotextile, etc. and all maintenance activities required.

2.5 TEMPORARY SOIL STABILIZER

A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as “TerraTack III”, “Curasol AE”, “Aerospray 70”, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved

amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

2.6 STRAW WITH NET TEMPORARY DITCH LINING

A. The Contractor shall place straw with net temporary ditch lining in ditches as shown on the Drawings. The blanket shall consist of clean wheat straw from agricultural crops made into a knitted straw blanket that is machine assembled. The straw shall be evenly distributed throughout the blanket. The blanket shall be covered with a photodegradable synthetic mesh attached to the straw with degradable thread.

B. The Contractor shall place the straw with net temporary liner where directed immediately after the ditch has been properly graded and prepared, fertilized, and seeded. The netting shall be on top with the straw in contact with the soil.

C. The Contractor will immediately repair or replaced any section of straw with net ditch lining, which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

D. Straw with net shall be North American Green S 150 matting, ECS High Velocity Straw Mat, Contech High Velocity Ero Mat, or approved equal with a minimum shear stress value of 1.60 lb/ft2.

2.7 CURLED WOOD MAT TEMPORARY DITCH LINING

A. The Contractor shall place curled wood mat temporary ditch lining in ditches as~ shown on the Drawings. The mat shall consist of machine-produced mat of curled wood excelsior with a majority of the fibers 6 inches or longer with consistent thickness and the fibers evenly distributed over the entire area of the blanket. The top of the mat shall be covered with a biodegradable synthetic mesh. The mesh shall be attached to the curled wood excelsior with photodegradable synthetic yarn.

B. The Contractor shall place the curled wood mat temporary liner where directed immediately after the ditch has been properly graded and prepared, fertilized, and seeded. The mesh shailbe on top with the wood fibers in contact with the soil.

C. The Contractor will immediately repair or replace any section of mat, which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

D. Curled wood mat shall be Excelsior High Impact, North American Green C 125, Contech Excelsior Erosion Blankets (Super Plus) or equal matting with a minimum shear stress value of 2.0 lb/ft2.

2.8 SYNTHETIC MAT PERMANENT DITCH LINING

A. The Contractor shall place synthetic mat permanent ditch lining in ditches as shown on the Drawings. The mat shall consist of entangled nylon, polypropylene or polyester monofilaments mechanically joined at their intersections forming a three dimensional structure. The mat shall

be crush-resistant, pliable, water-permeable, and highly resistant to chemical and environmental degradation.

B. The Contractor shall place the synthetic mat where directed immediately after the ditch has been properly graded and prepared.

C. After the mat has been placed, the area shall be properly fertilized and. seeded as specified allowing the fertilizer and seeds to drop through the net.

D. The Contractor will immediately repair or replace any section of mat which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.

E. Synthetic mat shall be Enkamat 7020 as manufactured by Akzo Industrial Systems Co., Synthetic Industries Landlock Erosion Mat TRM TI 060, Miramat 1800 as manufactured by Mirafi, or equal matting with a minimum shear stress value of 3.5 lb/ft2.

PART 3 - EXECUTION

3.1 EROSION AND SEDIMENTATION CONTROL DEVICES

A. The following erosion and sedimentation control devices shall be incorporated into the work. Other devices, as necessary and acceptable to the Owner's Representative shall be installed as required.

1. Temporary Sediment Basins shall be constructed at the locations shown on the Drawings, at the termination of all temporary diversion ditches diverting sediment laden runoff, and at other locations indicated by the Owner's Representative. Temporary sediment basins shall be constructed by excavating the appropriate size rectangular basin and constructing a rock-fill dam on the discharge end to form a sediment trap. Unless otherwise shown, temporary sediment basins shall be spaced to limit the maximum tributary drainage area to less than or equal to 5 acres.
2. Temporary Diversion Ditches shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Owner's Representative. Dimensions shall be as shown on the Drawings.
3. Silt Fence shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Owner's Representative.
4. Stone Filters shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Owner's Representative. Dimensions shall be as shown on the Drawings.
5. Stone Check Dams shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Owner's Representative. Dimensions shall be as shown on the Drawings.
6. Yard Inlet Erosion Control Measures shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Owner's Representative. Dimensions shall be as shown on the Drawings.
7. Drop Inlet Erosion Control Measures shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Owner's Representative.

3.2 INSTALLATION

A. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sedimentation control devices will be adjusted on several occasions to reflect the current phase of construction. Erosion and sedimentation control devices shall be established prior to or concurrent with the clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established immediately following completion of the clearing operation.

B. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off site sedimentation. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from construction areas. All deviations from the erosion and sedimentation control provisions shown on the Drawings shall have the prior acceptance of the Owner's Representative.

C. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency, and intent of the device. Maintenance shall include but not be limited to 1) the removal and satisfactory disposal of trapped sediments from basins or silt barriers and 2) replacement of filter fabrics used for silt fences. Sediments removed from erosion and sedimentation control devices shall be disposed of in locations that will not result in off site sedimentation as acceptable to the Owner's Representative.

D. The Contractor shall provide temporary or permanent ground cover adequate to restrain erosion on all disturbed areas that will be left unworked for periods exceeding 21 days.

E. The Contractor shall provide temporary sedimentation basins for the settling of water pumped from the excavations or intercepted by drainage ditches for keeping water out of the excavations or to protect existing structures. The Contractor shall remove trapped sediments from the basins as necessary to maintain their effectiveness or as indicated by the Owner's Representative. Sediment material removed from the basins shall be disposed off site by the Contractor at no additional cost to the Owner.

F. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Owner's Representative. The placed riprap shall form a properly graded, dense, neat layer of stone. The placed riprap shall have a minimum depth of 24 inches.

G. Stone for erosion control shall be dumped and placed in such manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above and to protect structures from damage when rock material is placed against the structures.

H. Silt fence shall be erected as shown on the Drawings and specified herein. Silt fence shall be erected and maintained to the satisfaction of the Owner's Representative until a vegetative ground cover has been established. Proper maintenance will include, but not be limited to, the periodic removal of trapped sediments and replacement of the filter fabric should it deteriorate

to a point that, in the opinion of the Owner's Representative, it will no longer provide an adequate run off filter. Replacement of the filter fabric, if required by the Owner's Representative, will be at the Contractor's expense.

1. Silt fence shall be erected around all catch basins, which are located downstream from any construction work. Should any catch basins be indicated to be relocated or modified, silt fence shall be utilized until work is completed on the catch basins. Upon completion of the modification, the area shall be rough graded, as shown on the Drawings, until the end of the project, at which time final grading shall occur.
2. Upon completion of the project, the Contractor shall remove all silt fence in areas where a stand of grass has been established and erosion is no longer evident. Removal of the remainder of the silt fence shall occur as other areas are established. Removal of any silt fence shall be permitted only with the prior approval of the Owner's Representative.

I. Owner's Representative may direct the Contractor to place Straw with Net, Curled Wood Mat Temporary Ditch Linings and Synthetic Mat Permanent Ditch Lining at other locations not shown on Drawings.

1. All temporary and permanent ditch linings shall be unrolled in the ditch in the direction of the flow of water. Temporary linings shall overlap the buried end of the downstream blanket by a minimum of 6 inches. Permanent linings shall overlap a minimum of 3 feet. All anchor trenches shall be a minimum of 12 inches deep. All mat shall be stapled as per manufacturer's specifications.

J. Additional Requirements

1. All storm sewer piping shall be blocked at the end of every working day until the inlet is constructed above grade.
2. All streets around the construction area shall be scraped as necessary to prevent accumulation of dirt and debris.
3. The Contractor shall provide adequate means to prevent any sediment from entering any storm drains (curb inlet filter box), ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of offsite areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed.
4. The Owner's Representative may direct the Contractor to place any additional sediment and erosion control devices at other locations not shown on the Drawings.

END OF SECTION 02276

SECTION 02300 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade and precast concrete structures.
4. Subbase course for concrete walks and pavements.
5. Subbase course for asphalt paving.
6. Excavating and backfilling for utility trenches, including permits and re-paving.
7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.3 UNIT PRICES

A. Unit prices for earthwork are included in Section 01270 "Unit Prices."

B. Quantity allowances for earthwork are included in Section 01210 "Allowances."

C. Rock Excavation Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. 24 inches outside of concrete forms other than at footings.
2. 12 inches outside of concrete forms at footings.
3. 6 inches outside of minimum required dimensions of concrete cast against grade.
4. 12 inches beneath bottom of concrete slabs-on-grade.
5. 6 inches beneath pipe in trenches, and 21 inches wider than pipe.
6. 24 inches from outside of precast concrete vault walls.

D. Authorized Additional Excavation Measurement: Volume of material excavated below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer, measured in original position. Unit prices for authorized additional excavation include replacement with approved materials.

E. Authorized Additional Subbase Material Measurement: Cubic yards of material filled below walks and pavements including excavation, placement, compaction and stabilization fabric as directed by Engineer, measured in original position.

F. Authorized Additional Crushed Stone Material Measurement: Cubic yards of material filled below walks and pavements including excavation, placement, compaction and stabilization fabric as directed by Engineer, measured in original position.

1.4 ALLOWANCES

A. Allowance No. 1 for the testing services included in Division 1 “Allowances” for compaction testing.

1.5 DEFINITIONS

A. Backfill: Soil material or controlled density fill material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179 (ratings are based on Caterpillar's "Model No. 320CL”).
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-

purpose bare bucket; measured according to SAE J-732 (ratings are based on Caterpillar's "Model No. 973C").

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Course placed between the subgrade and hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.6 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.
2. Controlled low-strength material, including design mixture.

B. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

C. Blasting Plan: For record purposes; approved by authorities having jurisdiction.

D. Seismic Survey Report: For record purposes; from seismic survey agency.

E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

1.7 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring during blasting operations.

1.8 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Contact utility-locator service for area where Project is located before excavating.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; well graded, free of rock or gravel larger than 1-1/2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: NYSDOT Item 304.12, Type 2 Subbase Course.

E. Controlled Fill: Naturally or artificially graded mixture of sand, natural or crushed stone or gravel conforming to NYSDOT Item 304.12, Type 2; free of debris, waste, frozen or organic materials and other deleterious matter.

F. Embedment Material:
1. Unpaved areas - Satisfactory soils.
2. Paved areas – Subbase material.

G. Stone Filling: NYSDOT Item 620.03 Light Stone Fill

H. Drainage Course: Subbase material.

I. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

J. Crushed Stone: NYSDOT Item 703-02, Coarse Aggregate, Crushed Stone, Size Designation #2.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; (with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep when used over non-metallic duct or pipe); colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

3.4 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

   a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding excavation limits specified.

B. Groundwater levels inside sheeting at the pump station locations shall be lowered to a minimum of 2 feet below the bottom of excavation.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate trenches 6 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

3.8 SUBGRADE INSPECTION

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with 10 ton roller to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under new foundations or wall footings by extending bottom elevation of new concrete foundation or footing to excavation bottom, without altering top elevation.

B. Fill unauthorized excavation under existing foundations or wall footings with Division 2 Section “Controlled Density Fill”.

C. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Removing concrete formwork.
   4. Removing trash and debris.
   5. Removing temporary shoring and bracing, and sheeting.

6. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Backfill of Structures: Place and compact controlled fill. Controlled fill shall extend away from the structure a distance equal to two-thirds the height of the fill being placed, or to sheeting, if installed.

D. Backfill areas excavated under footings and slabs, where shown on the drawings, with controlled density fill as specified in Division 2 Section "Controlled Density Fill".

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact initial backfill of embedment material to a height of 12 inches over the utility pipe or conduit, unless otherwise shown or specified.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

D. Place and compact final backfill final subgrade elevation.

E. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact as fill material in layers to required elevations. Use satisfactory soil material.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557, modified proctor:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBBASE COURSES

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:
1. Place subbase course under hot-mix asphalt pavement.
2. Shape subbase course to required crown elevations and cross-slope grades.
3. Place subbase course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557, modified proctor.

3.18 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade and precast concrete structures as follows:
   1. Place drainage course 6 inches or less in compacted thickness in a single layer.
   2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557, modified proctor.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency of the Owners choosing to perform field tests and inspections and to prepare test reports.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

   1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil, rock and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 02300

SECTION 02446 – HORIZONAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work of this section consists of furnishing and installing underground utilities using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring or guided horizontal boring. This work shall include all services, equipment, materials and labor for the complete and proper installation, testing, restoration of underground utilities, environmental protection and site restoration.

B. Related Sections:
   1. Division 2 Section "Wastewater Process Piping" for sewer piping.
   2. Division 2 Section "Earthwork" for site excavation, fill, and backfill

1.3 SUBMITTALS

A. Informational submittals:
   1. Presentation of similar experience in the last 3 years.
      a. Include, but not limited to, owner name, address, telephone number, contact person, date and duration of work, location, pipe information, and contents handled by pipeline.
      b. Supervisory field personnel and historical information of HDD experience.
   2. Working Drawings and written procedure describing in detail the proposed method and schedule to complete the work including, but not limited to:
      a. Size, capacity and arrangement of equipment.
      b. Location and size of drilling and receiving pits.
      c. Dewatering and methods of removing spoils material.
      d. Method of installing detection wire and pipe.
      e. Type, location and method of installing locator station.
      f. Method of fusion pipe segment and type of equipment.
      g. Type of cutting head.
      h. Method of monitoring and controlling line and grade.
   3. Detection of surface movement.
   4. Bentonite drilling mud for information only:
         1) Products information, material specifications, and handling procedures.
         2) Material safety data sheet and special precautions required.
         3) Method of mixing and application.

B. Product Data: For the following:

1. Detection wire
2. Locator station

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Contact utility-locator service for area where Project is located before excavating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 PIPING MATERIALS

A. Refer to Division 2 Section “Wastewater Process Piping” for sewer piping.

2.3 DRILLING FLUID

A. Bentonite drilling mud compatible with the environment.

B. Waste oil or environmentally non-compatible polymers cannot be part of composition.

2.4 DETECTION WIRE.

A. TW, THW, THWN, or HMWPE insulated copper, 10 gage or thicker wire.

2.5 LOCATOR STATION.

A. Underground, Flush Mounted:
1. Tube minimum 18 inches long with minimum inside diameter of 2-1/2-inches made of ABS plastic or other non-corrosive material.
2. Factory attached cast iron collar with ribs to prevent rotation when removing locking lid after locator station is set in concrete.

3. Tamper-proof cast iron locking lid shall withstand AASHTO H-20 traffic loads and contain a standard AWWA size cast-in pentagon bolt.
4. Mark locking lid “Sewer” to identify pipeline with a permanent identification.
5. Terminal block made of a high dielectric material.
   a. Terminal block furnished with two 3/16-inch (min.) threaded studs, nuts, and washers made of stainless steel or nickel plated brass.
6. Available manufacturers:
   a. C.P. Test Services, Inc., Model #TWABADJ18

PART 3 - EXECUTION

3.1 GENERAL

A. At least one of the HDD field supervisors listed in the informational submittal must be at site when HDD operations are in progress.

3.2 PREPARATION

A. Excavate pits following Division 2 Section "Earthwork.”

B. Provide equipment to guard against electrocution and an alarm system on drilling equipment capable of detecting electrical current as it approaches electric lines.

C. Test pit underground utilities crossing before HDD operation following.

3.3 OPERATION

A. General.
   1. Determine drilling length and equipment pull strength for type of soil encountered.
   2. Provide method to control line and grade.
      a. Provide and maintain instrumentation that accurately locates pilot hole.
      b. Drill pilot hole along path following Drawings to these tolerances:
         1) Vertical alignment plus or minus 0.5 foot. Vertical path of the pilot hole must not establish new high points not shown on Drawings.
         2) Horizontal alignment plus or minus 1.0 foot.
      c. Include electronic monitoring of the horizontal and vertical drilling head location. Obtain an accuracy range within 1 inch of actual position of the pipeline. Record position readings at a maximum of 10 foot intervals.
      d. At completion of pilot hole drilling, furnish Engineer tabulations of horizontal and vertical alignment.
   3. When water is encountered.
      a. Provide and maintain a dewatering system of sufficient capacity to remove water.
      b. Keep excavation free of water until backfill operation is in progress.
      c. Perform dewatering in such a manner that removal of soils particles are held to a minimum.
      d. Dewater into a sediment trap.

4. Maintain close observation to detect settlement or displacement of surface and adjacent facilities.
    a. Notify Engineer immediately if settlement or displacement is detected.
    b. Act to maintain safe conditions and prevent damage.

B. Drilling Operation.
1. Drilling Fluids.
    a. Maintain drilling fluid in bore hole to increase stability of the surrounding soil and reduce drag on pulled pipe.
    b. Transport and dispose of excess drilling fluid and other spoils at a disposal site following laws, ordinances, rules, and regulations of State and local jurisdiction.
    c. Minimize drilling fluid at locations other than entry and exit points. Immediately clean up any drilling fluids that inadvertently surface.
    d. Provide clean water for drilling,.
2. Pilot Hole Drilling.
    a. Angle entry hole so that curvature of pilot hole does not exceed allowable bending radius of HDPE pipe.
    b. Be able to make a turn of up to 90 degrees and maintain a curvature not to exceed allowable bending radius of HDPE pipe.
    c. Alignment Adjustment and Restarts.
        1) Follow pipeline alignment on Drawings within tolerances specified herein.
        2) Notify Engineer when forward motion of operation is stopped by an obstruction.
            a) Abandon in place with drilling fluid, unless Engineer directs otherwise.
            b) Upon Engineer’s approval, attempt a second installation at approved location.
    d. Exercise caution including, but not limited to, locating existing utilities

3.4 INSTALLATION

A. Installing HDPE Pipe.
1. Provide a swivel to reaming assembly and pull section of pipe to minimize torsional stress on pull section after drilling pilot hole.
2. Hold reaming diameter to 1.5 times the outside diameter of HDPE pipe being installed.
3. Protect pull section as it proceeds during pull back so that it moves freely and is not damaged.
4. Pull detection wire along with HDPE pipe. Extend wire into locator station at each end of HDPE pipe.
5. When connecting to adjacent pulled or non-pulled section of HDPE pipe, allow pull section of pipe to extend past termination point. Make tie-ins no sooner than 24 hours after pullback of HDPE pipe.
6. Test pit pipe installation to verify horizontal and vertical alignment at Engineer's direction.
    a. One test pit for every 500 feet along length of pipeline.
    b. Engineer may order additional test pit for each test pit that reveals pipeline installation is not in compliance with the Contract Documents at no additional cost to the Owner.
7. Replace portions of the pipeline not in compliance with the Contract Documents at Engineer’s direction and at no additional cost to the Owner.

3.5 FIELD QUALITY ASSURANCE

A. Perform field testing of HDPE pipe following Division 2 Section “Wastewater Process Piping".

END OF SECTION 02446

SECTION 02530 – WASTEWATER PROCESS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes buried gravity-flow (non-pressure) and force main (pressure) sanitary sewerage piping and wastewater process piping located outside the buildings and tunnels, with the following components:

1. Precast concrete manholes.
2. Inflow protection inserts

1.3 DEFINITIONS

A. PE: Polyethylene plastic.

B. PP: Polypropylene plastic.

C. PVC: Polyvinyl chloride plastic

1.4 SUBMITTALS

A. Product Data: For pipe, fittings and inflow protection inserts

B. Shop Drawings: For the following:

1. Manholes: Include plans, elevations, sections, details, and frames and covers.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions

1.6 PROJECT CONDITIONS

A. Interruption of Existing Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of service.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Linings and coatings, pipe and fittings:

1. Lining: AWWA C104 cement mortar lining.
2. Buried Piping, Exterior Coating: AWWA C151/C110 asphaltic coating

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, thickness class 53, with mechanical-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2. Pipe-Mechanical Joint Materials: Suitable for chemical and thermal conditions of piping system contents.

    a. Gaskets: AWWA C111, SBR rubber, gasket size as indicted.
    b. Mechanical Joint Bolts and Nuts: AWWA C111, tee head.
    c. Glands: Mechanical Joint Retaining Gland

        1) The joint restraint shall be incorporated in the restraining mechanism gland.
        2) Glands shall be manufactured of ductile iron conforming to ASTM A536, Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN.
        3) Dimensions of the glands shall be such that it can be used with the standardized mechanical joint bell and Type 304 stainless steel, tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153/A21.53.
        4) Torque limiting twist off nuts shall be of the same material and sizes as the tee-head bolts to ensure proper actuating of restraining devices.
        5) Available Manufacturer/Product: Ebaa Iron, Megalug.

C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, thickness class 53, with push-on-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

    a. Gaskets: AWWA C111, rubber.
2. Pipe-Push-on-Joint Materials: Suitable for chemical and thermal conditions of piping system contents.

    a. Gaskets: AWWA C111, Restraint type SBR rubber,
        1) Available Manufacturer/Product: US Pipe, Field Lok.

D. Flanged Joint, Ductile-Iron Pipe: AWWA C151, thickness class 53, 250 psi minimum working pressure, with ANSI B16.1 Class 125 Flanged joint.

1. Flanged Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern. ANSI B16.1 Class 125 Flange.
2. Flange Fillers: ANSI B16.1 Class 125 pattern, AWWA C210 interior coating.
3. Pipe-Flange Materials: Suitable for chemical and thermal conditions of piping system contents.

    a. Gaskets: AWWA C111, SBR rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
    b. Flange Bolts and Nuts: AWWA C115, ASME B18.2.1, carbon steel, unless otherwise indicated.

2.4 PE PIPE AND FITTINGS

A. PE Pipe: AWWA C906, DR17, IPS; heat fusion joints; with PE compound number required to give pressure rating not less than 100 psig.

2.5 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, PS115, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals, color: green.

2.6 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings, Elliptical: ASTM C 507, with bell-and-spigot ends for gasketed joints with ASTM C 443, rubber gaskets.

2.7 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Joining Materials:

    a. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
    b. Mueller, or approved equal compression fittings.

B. Hard Copper Tube: ASTM B 88, Types L tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Joining Materials:

    a. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
    b. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.8 PIPE COUPLINGS

A. Reducing or transition, metal, bolted, sleeve-type, reducing or transition coupling, for joining underground piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

1. Center-Sleeve Material: Ductile iron.
2. Gasket Material: Natural or synthetic rubber.
3. Metal Component Finish: Corrosion-resistant coating or material.

2.9 MANHOLES

A. Designed Precast Concrete Manholes: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.

1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
2. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
4. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12-inch intervals.
5. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
6. Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to exterior surfaces.
7. Manhole Frames and Covers: Neenah Foundry, Inc. Model R-1642 (24”) or Model R-1557 (30”) or equivalent for built-up manholes; Neenah Foundry, Inc. Model R-6078 (30”) or equivalent for cast-in-slab conditions. All lids to be heavy duty. Include indented top design with lettering cast into cover, using wording "SANITARY SEWER". Include countersunk stainless steel tamper-proof bolts in lid as locking device, where indicated on the drawings.

    a. Material: ASTM A 48/A 48M, Class 35 gray iron, unless otherwise indicated.

2.10 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.

4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

2. Benches: Concrete, sloped to drain into channel.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.11 INFLOW PROTECTION INSERTS

A. Available Manufacturers:
1. FRW Industries.

B. Size: To fit manhole frame and lids as installed.

C. Insert Body: Acrylonitrile Butadiene Styrene plastic that meets Federal Standard LP1183 and ASTM D256, D638, D790, D792, D785 D648. Thickness shall be between 3/32inches and 6/32 inches. A 1” wide polyester lifting strap shall be attached to the body by means of a 3/16 inch stainless steel rivet.

D. Gasket: Factory installed closed cell neoprene. The gasket adhesive and the gasket material shall be suitable for either wet or dry conditions of use.

E. Relief Valve: Medium density polyethylene body, designed to relieve pressure at 1 p.s.i. or less, leak down rate of not more than 10 gallons/24 hours, easily removable.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING APPLICATIONS

A. Buried Gravity-Flow, Nonpressure Sewer Piping: Includes headworks building influent and headworks building effluent sewer piping:

1. NPS 8 and larger: PVC sewer pipe and fittings, SDR 26, gaskets, and gasketed joints.
2. NPS 8 and larger: Ductile-iron, mechanical-joint pipe and fittings.
3. NPS 8 and larger: PE pipe, AWWA C906, DR17, IPS; heat fusion joints
4. Elliptical: Reinforced-Concrete sewer pipe and fittings, elliptical, bell and spigot.

B. Buried Force-Main, Pressure Piping: Includes existing building sewer force main extension, existing D.C. garbage facility force main extension, existing plant effluent line extension

1. NPS 3 and larger: Ductile-iron, mechanical-joint pipe; and ductile-iron, mechanical-joint fittings. Use mechanical joint retainer gland with all mechanical joints.

C. Underground Wastewater Process Piping: Use the following piping materials for each size range and type:

1. NPS 3 and larger: Ductile-iron, push-on-joint pipe; or ductile-iron, mechanical-joint pipe; and ductile-iron, mechanical-joint fittings. Use mechanical joint retainer gland with all mechanical joints. Includes types:

   a. Sewer Pipe.
   b. Supernatant Pipe.
   c. Primary Sludge Pipe.
   d. Secondary Sludge (WAS/RAS) Pipe.
   e. Thickened Sludge Pipe.
   f. Make-up Water Pipe.

2. NPS 2-1/2 and under: Soft Copper Tube: ASTM B 88, Type K tube, annealed temper with compression fittings. Includes types:

   a. Make-up Water Pipe.
   b. Effluent Water Pipe.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of wastewater process piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction on gravity sewers, unless fittings are indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure, piping according to the following:

1. Install piping pitched down in direction of flow, at slope indicated.
2. Install piping with 48-inch minimum cover.
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install RCP sewer pipe according to ASTM C 1479.

F. Install force-main, pressure piping according to the following:

1. Install piping with restrained joints at fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 48-inch minimum cover.
3. Install ductile-iron pressure piping according to AWWA C600.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 4 inches above finished surface elsewhere, unless otherwise indicated.

E. Install inflow protection inserts in all manholes located in paved areas.

F. At completion of work provide the Owner with locking keys to tamper-proof manhole lids.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.6 PIPING HANGERS AND SUPPORTS

A. Refer to Division 15 Section "Hangers and Supports" for piping support inside buildings, tunnels and vaults.

3.7 IDENTIFICATION

A. Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.8 PAINTING

A. Clean and prepare concrete manhole surfaces for field touch-up painting. Remove loose efflorescence, chalk, dust, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:
1. Precast Concrete Manholes: All exterior.

3.9 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove manhole and close open ends of remaining piping.
2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 2 Section "Earthwork."

3.10 FIELD QUALITY CONTROL

A. All pipe lines and structures shall be made as watertight as possible.

B. Sewers shall not be tested until at least 30 days after installation and backfill.

C. Inspect interior of piping and manholes to determine whether line displacement or other damage has occurred.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping or manholes.
d. Infiltration: Water leakage into piping or manholes.
e. Exfiltration: Water leakage from or around piping or manholes.

3. Replace defective piping or manholes using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

D. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Test completed piping systems according to requirements of authorities having jurisdiction and the requirements herein.
2. Schedule tests and inspections by authorities having jurisdiction with at least 48 hours' advance notice.
3. Submit separate report for each test.
4. Deflection Tests: Test PVC piping to insure passage of ball or cylinder of size not less than 92.5 percent of piping diameter.

   a. The test shall be conducted without the use of mechanical pulling devices.
   b. If deflection exceeds 7.5%, the failing pipe section shall be removed and replaced and the test repeated.

5. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following, if groundwater levels are below the invert of the sewer being tested:

   a. Test plastic gravity sewer piping according to ASTM F 1417
   b. Test RCP gravity sewer pipe according to ASTM C 924.

6. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following if groundwater levels are above the invert of the sewer being tested:

   a. Close openings in system and fill with water.
   b. The hydrostatic test shall be performed with a minimum positive head of 2 feet above the top of the crown of the pipe, or the existing groundwater levels, whichever is higher
   c. Purge air and refill with water.
   d. Disconnect water supply.
   e. Allowable leakage is maximum of 100 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.

7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.
   a. Test in accordance with AWWA C600.

8. Manholes: Perform air test according to ASTM C 1244.

E. Leaks and loss in test pressure constitute defects that must be repaired.

F. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous material.

END OF SECTION 02530

SECTION 02553 - FUEL GAS DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for propane fuel gas distribution outside the building:

1. Piping.
2. Valves.

1.3 DEFINITIONS

A. Point of Delivery: Piping outlet from service-meter assembly.

B. Natural Gas Piping: Piping that conveys natural gas from point of delivery to natural gas utilization devices inside the building.

C. PE: Polyethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. For Piping Containing Only Vapor:

a. Piping and Valves: 125 psig unless otherwise indicated.

2. For Piping Containing Liquid:

a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.
b. Piping Other Than Above: 250 psig unless otherwise indicated.
c. Valves and Fittings: 250 psig unless otherwise indicated.

3. Minimum Operating Pressure of Service Meter: 5 psig.

1.5 SUBMITTALS

A. Product Data: For the following:

1. PE pipe and fittings.
2. Valves.
3. Service regulators. Indicate pressure ratings and capacities.

B. Shop Drawings: For natural gas service piping. Include plans, elevations, sections, details, and attachments to other work.

C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with ANSI Z223.1 or NFPA 58 or AGA IFGC for materials, installation, testing, inspection, and purging.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store PE pipes and valves protected from direct sunlight.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

B. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B; Schedule 40, black.

1. Malleable-Iron Fittings: ASME B16.3, Class 150, standard pattern, with threads complying with ASME B1.20.1.
2. Steel Fittings: ASME B16.9, wrought-steel butt-welding type; and ASME B16.11, forged steel.
3. Steel Flanges and Flanged Fittings: ASME B16.5.
4. Unions: ASME B16.39, Class 150, black malleable iron; female pattern; brass-to-iron seat; ground joint.

C. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket type or ASTM D 3261, butt type with dimensions matching ASTM D 2513, SDR 11, PE pipe.

D. Transition Fittings: Manufactured pipe fitting with one PE pipe end for heat-fusion connection to PE pipe and with one ASTM A 53/A 53M, Schedule 40, steel pipe end for threaded connection to steel pipe.

E. Service-Line Risers: Manufactured PE pipe fitting with PE pipe inlet for heat-fusion connection to underground PE pipe; PE pipe riser section with protective-coated, anodeless, steel casing and threaded outlet for threaded connection to aboveground steel piping.

2.2 JOINING MATERIALS

A. Components, Tapes, Gaskets, and Bolts and Nuts: Suitable for natural gas and as recommended by piping manufacturer.

2.3 SHUTOFF VALVES

A. Shutoff Valves, General: Manual operation, suitable for propsnr gas service.

B. Ball Valves: Bronze body, with chrome-plated brass ball; lever handle; and complying with ASME B16.33, MSS SP-110, UL 842, or CSA listing. Include locking device.

2.4 CONCRETE BASES

A. Description: Precast concrete made of 3000-psi- minimum, 28-day compressive strength reinforced concrete; at least 4 inches thick and 4 inches larger in each dimension than supported item, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off gas to premises or piping section.

B. Inspect fuel gas piping according to fuel gas code to determine that natural gas utilization devices are turned off in piping section affected.

C. Comply with fuel gas code requirements for prevention of accidental ignition.

3.3 PIPING APPLICATIONS

A. Flanges, unions, and transition and special fittings with pressure ratings same as or higher than system pressure rating may be used, unless otherwise indicated.

B. Aboveground Piping:

1. NPS 2 and Smaller: Steel pipe, malleable-iron fittings, and threaded joints.

C. Underground Piping: PE pipe, PE fittings, and heat-fusion joints.

D. Underground-to-Aboveground Piping Connections: Service-line riser.

E. PE-to-Steel Piping Connections: Transition fitting.

3.4 VALVE APPLICATIONS

A. Drawings indicate types of shutoff valves to be used. If specific types are not indicated, the following requirements apply:

1. Aboveground, NPS 2 and Smaller: Ball valves.

3.5 PIPING INSTALLATION

A. Install underground, fuel gas distribution piping buried at least 36 inches below finished grade.

B. Install underground, PE, fuel gas distribution piping according to ASTM D 2774.

3.6 VALVE INSTALLATION

A. Install metal shutoff valves on aboveground, natural gas distribution piping.

3.7 JOINT CONSTRUCTION

A. Refer to Division 2 Section "Piped Utilities -- Basic Materials and Methods" for basic piping joint construction.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas distribution according to requirements of fuel gas code and utility.

B. Repair leaks and defective valves and specialties and retest system until no leaks exist.

C. Report results in writing.

D. Verify correct pressure settings for service regulators.

END OF SECTION 02553

SECTION 02667 - PROJECT WATER MAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water-distribution piping and specialties outside the building for the following:

1. Pipe and fittings for project water mains.
2. Valves, Hydrants and Services.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for excavation and backfill of Water Mains.
2. Division 2 Section "Testing and Disinfection of Water Mains" for quality control of Water Mains.

1.3 REFERENCES

A. AASHTO T180 – Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-in. Drop.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ASTM 8-62 - Bronze Parts Used in Pipe Valves.

E. ASTM B88 - Seamless Copper Water Tube.

F. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lb. Rammer and 12 inch Drop.

G. ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb. Rammer and 18 inch Drop.

H. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

I. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR □PR).

J. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

K. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

L. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

M. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil Aggregate Mixtures.

N. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.

O. ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR-PR) based on Controlled Outside Diameter.

P. AWS A5.8 - Brazing Filler Metal.

Q. AWWA C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

R. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other liquids.

S. AWWA C111 – Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.

T. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

U. AWWA C153 - Ductile-Iron Compact Fittings, 3 in. Through 12 in., for Water and Other Liquids.

V. AWWA C500 - Gate Valves, 3 through 48 in NPS, for Water and Sewage Systems.

W. AWWA C502 - Dry Barrel Fire Hydrants.

X. AWWA C504 - Rubber Seated Butterfly Valves.

Y. AWWA C508 – Swing-Check Valves for Waterworks Service, 2 in through 24 in NPS.

Z. AWWA C509 - Resilient Seated Gate Valves 3 in through 12 in NPS, for Water and Sewage Systems.

AA. AWWA C510 – Double Check Valve Backflow Prevention Assembly.

BB. AWWA C600 - Installation of Ductile-Iron Water Mains and Appurtenances.

CC. AWWA C606 - Grooved and Shouldered Type Joints.

DD. AWWA C700 – Cold Water Meters – Displacement Type.

EE. AWWA C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 through 12 inch, for Water.

FF. AWWA C901 - Polyethylene (PE) Pressure Pipe, Tubing, and Fittings, 1/2 inch through 3 inch, for Water.

GG. UL 246 - Hydrants for Fire - Protection Service.

1.4 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipefittings, valves and accessories.

1.5 SUBMITTALS FOR CLOSEOUT

A. As specified in Division 1 Section “Closeout Procedures”: Record Drawings, Operation and Maintenance Data and Spare Parts and Maintenance Products.

B. Manufacturer's Certificate: Certify that products meet or exceed all specified requirements.

C. Shop Drawings: Provide shop drawings containing catalog cuts of all products referenced in this section.

D. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with Dutchess County Department of Health requirements.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. All products shall be domestically produced within North America and in new condition.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall be responsible for delivery, storage, protection and handling of all products to site. Products lost or damaged by the Contractor shall be replaced at the sole cost of the Contractor.

B. Deliver and store hydrants and valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 WATER PIPE

A. Ductile Iron Pipe: AWWA C151/C104, cement lined: thickness class 52. Pipe shall be push-on (Tyton) or mechanical joint pipe as manufactured by U.S. Pipe and Foundry or approved equal. Mechanical joint pipe shall be provided in specific locations as indicated in the contract plans.

1. Fittings: Ductile iron, standard thickness, AWWA C110/C104, or Compact Fittings (AWWA C153).
2. Joints: AWWA C111, rubber gasket.

3. Joint Restraint: AWWA C111. Joint restraints shall be U.L. listed and Factory Mutual approved to withstand a minimum pressure of 200 psi. The joint restraints shall be provided for ductile iron push on or mechanical joint pipe with twist off indicators and shall be as manufactured by EBAA Iron Megalug or approved equal.
4. End Caps: Ductile iron, AWWA C110 as manufactured by U.S. Pipe and Foundry, Clow or approved equal.

B. Copper Tubing: ASTM B88, Type K, annealed:

1. Fittings: Mueller, or approved equal compression fittings.

2.2 GATE VALVES

A. Manufacturers: Mueller, or approved equal.

B. AWWA C509, Iron body, resilient seat, bronze trim, non-rising stem with square nut, single wedge, mechanical joint, control rod, valve extension box and two (2) valve keys.

2.3 FIRE HYDRANT

A. Manufacturer and Model: Mueller Centurion, or Approved Equal.

B. Hydrants shall comply with AWWA C502 standards and are to be approved by the Town of Poughkeepsie. Hydrant shall be of the compression type, with the main valve opening against water pressure.

C. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.

D. Hose and Streamer Connection: Match sizes with existing hydrants, in conformance with fire department requirements. Install with hydrant flag.

E. Finish: Primer and two coats of enamel in color matching existing hydrants.

2.4 BEDDING AND COVER MATERIALS

A. Bedding and Cover Materials: As specified in the contract plans and in Division 2 Section “Earthwork”.

2.5 ACCESSORIES

A. Services: Corporation stop, double strap services clamp and curb stop shall be as manufactured by Mueller or approved equal and shall conform to the contract plans.

B. Flushing Hydrant: Flushing Hydrant shall be an above ground unit with 2 ½ “ NST outlet, steel body with brass internals, automatic draining, multi-turn valve operation. Unit shall be Tru Flow TF200 or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to installation.

3.2 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

A. Excavate pipe trench in accordance with Division 2 Section “Earthwork”. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth; compact to 95 percent standard Proctor Density.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95 percent standard Proctor Density.

D. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Maintain separation of water main from sewer and other utilities in accordance with contract plans and Dutchess County Department of Health requirements.

B. Install pipe to indicated elevations, where noted, within tolerance of 5/8 inches.

C. Install ductile iron piping and fittings as per manufacturer's recommendation and in conformance to AWWA C600.

D. Install pipe to allow for expansion and contraction without stressing pipe or joints.

E. Provide joints and restraints at each elbow or change of direction of pipe main and for all fittings, valves and hydrants as indicated in the contract plans.

F. Establish elevations of buried piping to ensure not less than 5 ft of cover.

3.5 INSTALLATION – VALVES AND HYDRANTS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumped nozzle perpendicular to and facing roadway or existing building where roadway does not exist.

D. Set hydrants to grade, with nozzles at least 20 inches above ground.

E. Provide a drainage pit 36 inches square by 24 inches deep filled with crushed stone. Encase elbow of hydrant in crushed stone to 6 inches (150 mm) above drain opening. Do not connect drain opening to sewer.

F. Paint hydrants with one coat of primer and 2 coats of enamel in accordance with manufacturer's recommendations to match the existing color of installed hydrants.

3.6 DISINFECTION AND PRESSURE TESTING OF DOMESTIC WATER PIPING SYSTEM

A. Flush lines, pressure test and disinfect system in accordance with Division 2 Section "Testing and Disinfection of Water Mains".

3.7 SERVICES

A. Obtain listing of properties or buildings that are to receive services from the Engineer prior to installing any services.

B. Provide water services for parcels and buildings as indicated in the contract plans.

C. Verify location of each service to be installed and confirm location with each property owner.

D. Provide tap, corporation stop, type K copper tubing and curb stop at offset locations shown in the contract plans for each individual service. Install curb stop at property line or at the location as specified in the contract plans.

E. Mark and record the location of each curb stop installed.

F. Activate service and pressure test service line to visually check for leaks.

3.8 BACKFILL AND RESTORATION

A. Perform backfilling and restoration in conformance with Division 2 Section “Earthwork”.

3.9 FIELD QUALITY CONTROL

A. Provide testing as indicated in Division 1 Section “Quality Requirements”.

B. Compaction testing: as specified in Division 2 Section “Earthwork”.

END OF SECTION 02667

SECTION 02675 - TESTING AND DISINFECTION OF WATER MAINS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure Testing and Disinfection of potable water distribution and transmission system.

B. Testing and reporting results.

1.2 RELATED SECTIONS

A. Division 2 Section “Project Water Mains” for the installation of site water mains.

1.3 REFERENCES

A. AWWA B300 - Standard for Hypochlorites.

B. AWWA B301 - Standard for Liquid Chlorine.

C. AWWA B302 - Standard for Ammonium Sulfate.

D. AWWA C600 - Standard for Installation of Ductile Iron Water Main - Hydrostatic Testing.

E. AWWA C651 - Standards for Disinfecting Water Mains.

1.4 SUBMITTALS

A. Test Reports: Show results and specified requirements. Submit test report form and obtain Engineer’s approval prior to conducting any tests.

B. Certificate: Certify that pressure testing, Leakage and cleanliness of water distribution system meets or exceeds requirements of the Dutchess County Department Health.

1.5 PROJECT RECORD DOCUMENTS

A. Pressure Report:

1. Hydrostatic Test Pressure.
2. Dates and time for start and completion of pressure testing.
3. Pressure results at start and finish of each section tested.
4. Amount of Water Used during testing.
5. Signature of person performing tests and signature of witness.

B. Disinfection report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Initial and final disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
5. Date and time of flushing start and completion.
6. Disinfectant residual after flushing in ppm for each outlet tested.
7. Procedure for neutralizing disinfectant and for discharge of flushed water.
8. Signature of person performing tests and signature of witness.

C. Bacteriological report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and final disinfectant residuals in ppm for each outlet tested.
6. MFT Coliform bacteria test results for each outlet tested. (Other testing methods are not acceptable).
7. Certification that water conforms, or fails to conform, to bacterial standards of Dutchess County Department of Health.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651 for disinfection of the distribution system.

B. Perform Work in accordance with AWWA C600 for pressure testing of distribution main.

C. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years experience.

D. Testing Firm: Company specializing in testing potable water systems, approved by the State of New York.

E. Submit bacteriologist's signature and authority associated with testing.

1.7 REGULATORY REQUIREMENTS

A. Conform to Dutchess County Department of Health regulations as well as the contract plans for performing the work of this Section.

PART 2 - PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite; AWWA B301, Liquid Chlorine; AWWA B302, ammonium sulfate.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping system has been cleaned, inspected, and pressure tested. Perform initial pressure testing for a minimum of 1 hour and confirm that main test valves do not leak.

B. Provide and attach required equipment to perform the work of this Section.

C. Perform scheduling, pressure testing and disinfecting activity with start-up, testing, adjusting and balancing demonstration procedures, including coordination with related systems.

3.2 LEAK TESTING

A. Perform pressure testing at 50% above the normal operating pressure of the system and in no case less than 150 PSI for a duration of at least 2 hours. Pressure shall not vary by plus or minus five (5) psi.

B. Determine leakage in conformance with AWWA C600 standards, Repair or replace any section not meeting pressure testing requirements and retest until acceptable results are obtained at the sole expense of the Contractor.

C. The testing shall be performed in sections so as to allow these sections to be put into service if required before completion of the entire length.

3.3 DISINFECTION TESTING

A. Prior to disinfection, the water main shall be filled to eliminate air pockets and shall be flushed to remove particulates. A flushing velocity of at least 2.5 ft/sec shall be obtained in the water main.

B. Perform disinfection testing by injecting treatment disinfectant into piping system. Initial chlorine residual shall not be less than 25 mg/l.

C. Maintain disinfectant in system for 24 hours. At the end of testing, chlorine residual shall not be less than 10 mg/l.

D. Add neutralizing chemical for heavily chlorinated water, as required by Dutchess County Department of Health.

E. Flush, circulate, and clean until required cleanliness is achieved; use existing water supply.

F. Replace permanent system devices removed for disinfection.

G. Determine if testing meets the required disinfection and bacteriological standards. If test results fail to meet required standards, clean water main, redisinfect and perform testing until satisfactory results are obtained at the Contractor's sole expense. The Contractor shall pay for or provide any supply water required for retesting.

3.4 FIELD QUALITY CONTROL

A. Test samples in accordance with AWWA C651.

END OF SECTION 02675

SECTION 02720 - STORM SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:

1. Pipe
2. Precast concrete catchbasins.

1.3 DEFINITIONS

A. PE: Polyethylene plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silttight, unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Pipe

B. Shop Drawings: For the following:

1. Catch Basins: Include plans, elevations, sections, details, and frames, covers, and grates.

C. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.

D. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle catch basins according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

C. Corrugated, perforated PE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.

D. Available Manufacturers:

   a. Advanced Drainage Systems, Inc.

2.4 CATCH BASINS

A. Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.

1. Joint Sealants: ASTM C 990, bitumen or butyl rubber.
2. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match frame and grate dimensions.
3. Steps: ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 42 inches.
4. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum, unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING APPLICATIONS

A. Gravity-Flow, Nonpressure Storm Drainage Piping: Includes grit/ash pad drain pipe:

1. NPS 4 and NPS 36: Corrugated PE drainage pipe and fittings, soiltight couplings, and coupled joints.

B. Gravity-Flow, Nonpressure Storm Drainage Underdrain Piping at Footing Drains: Use the following pipe materials for each size range:

1. NPS 4 and NPS 36: Corrugated, perforated PE drainage pipe and fittings, soiltight couplings, and coupled joints.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install catch basins for changes in direction unless fittings are indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at slope and depths shown
   2. Install PE corrugated storm drainage piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

3.4 PIPE JOINT CONSTRUCTION

A. Basic pipe joint construction is specified in Division 2 Section "Piped Utilities - Basic Materials and Methods." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join corrugated PE piping according to CPPA 100 and the following:
      a. Use soiltight couplings for Type 2, soiltight joints.

3.5 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.6 IDENTIFICATION

A. Materials and their installation are specified in division 2 Section "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

   1. Use warning tape or detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.7 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Storm drainage shall not be tested until at least 30 days after installation and backfill.

   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Crushed, broken, cracked, or otherwise damaged piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

3.8 CLEANING

A. Clean interior of piping and catch basins of dirt and superfluous materials.

END OF SECTION 02720

SECTION 02741 - HOT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving,

   a. Provisions for paving over prepared subbase,
   b. Provisions for paving over reclaimed asphalt.

2. Pavement-marking paint.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Material certificates.

1.4 ALLOWANCES

A. Allowance No. 1 for the testing services included in Division 1 “Allowances” for compaction testing.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the New York State Department of Transportation (NYSDOT).

B. Regulatory Requirements: Comply with Standard Specifications, Construction and Materials of the NYSDOT for asphalt paving work.

C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.
2. Asphalt Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: NYSDOT Item 703-02.

B. Fine Aggregate: NYSDOT Item 703-01.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: NYSDOT Item 702-0700.

B. Tack Coat: NYSDOT Item 702-9001 or 702-9002, emulsified asphalt, diluted in water, of suitable grade and consistency for application.

2.3 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Binder Course: NYSDOT Type 3, Item 403.138902.
3. Surface Course: NYSDOT Type 6, Item 403.178902.

2.4 AUXILIARY MATERIALS

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with FS TT-P-115, Type I or AASHTO M 248, Type N.

1. Color: White.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. All surfaces abutting or projecting into asphalt pavement shall be saw-cut flush to provide a smooth, clean edge.

E. Areas directly adjacent to new asphalt pavement overlays shall be cold milled 1-1/2” deep x 24” wide to provide a smooth transition between new and existing asphalt surfaces.

3.2 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F.
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.3 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

   1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

   1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm. Continue rolling until roller marks are eliminated and course has attained 95 percent laboratory density.

E. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.4 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Binder Course: Plus or minus 1/2 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

   1. Binder Course: 1/4 inch.
   2. Surface Course: 1/8 inch.

3.5 PAVEMENT JOINT SEALING:

A. Pavement Sealing: All joints between existing and new pavements shall receive NYSDOT Item 702-07 Asphalt Filler, including road joints. Placement shall be in conformance with NYSDOT Regulations.

3.6 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency of the Owners choosing to perform field tests and inspections and to prepare test reports.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.8 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 02741

SECTION 02745 - PAVEMENT RECLAMATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the reclamation of the existing pavement with foam injection stabilizing, as indicated on the Contract Drawings. The work shall include but not be limited to all equipment necessary for reclamation and recycling, shaping, grading, compacting materials and testing as required to complete the work indicated on the contract drawings and the specifications.

B. Related Sections include the following:

1. Division 1 Section "Unit Prices" for unit-price authorized additional subbase material and additional crushed stone material.

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

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

B. Qualification Data: For Contractor.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Qualifications: Contractor shall have minimum of three (3) years experience in the reclamation of asphalt pavement, including at least three (3) years experience for the operators to be employed in the performance of this contract in operation of said machines supplied with at least two (2) years experience in the Foam Asphalt Process of a reclaimed pavement including at least two (2) years experience for the certified operators..

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit Insert type of work to be performed according to manufacturers' written instructions and warranty requirements.

PART 2 - PRODUCTS

2.1 LIQUID ASPHALT

A. Liquid Asphalt used to produce foamed asphalt shall meet all requirements of AASHTO MP-1: Standard Specification for Performance Graded Asphalt Binder, PF 58-28 (AC-10).

PART 3 - EXECUTION

3.1 EQUIPMENT

A. A.Equipment must be hydrostatically driven with pneumatic tires and must also be equipped with an automatic hydraulic driven liquid proportioning system (LPS) through a computerized meter mounted on the machine to insure proper application of any additives. The LPS shall be designed to handle a complete range of petroleum based additives and function to precisely add the selected quantity of additives to the in-place recycled pulverized materials within the limits of the specification.

B. For injecting metered quantities of cold atomized water into hot penetration grade asphalt emulsion to produce foamed asphalt, to maximize coating of the pulverized material, the Reclaimer shall be equipped with a Foamstab Mixer or approved equal. The Foamstab Mixer shall introduce controlled quantities of water and air through a stream of hot bitumen in specifically designed individual expansion chambers and nozzles to produce consistent foam.

C. The Reclaimer shall also be equipped with a computerized meter mounted on the machine to insure accurate control of all flows, and application of the foamed asphalt. The Foamstab Mixer or equal shall be capable of a full circulating system with an input and output line to the asphalt supply for maintaining the same level of heat temperature throughout the foam asphalt project.

D. The equipment must be capable of grinding to the depths required, and to the gradation specified.

3.2 RECLAMATION DEPTH

A. The existing pavement material shall be ground up to a depth of 12”, or as necessary to obtain the proposed cross section, and shall conform to the following gradation:

SIEVE SIZE	PERCENT PASSING
2”	98-100
1 ½”	95

Material gradation may vary due to local aggregates and conditions. When the largest aggregate in the pavement material being ground is smaller than a 2” stone, the maximum number of

passes allowed to achieve the gradation shall be two (2). For depths over 8" and up to 18", the maximum number of passes shall be four (4).

3.3 GRADING

A. The Reclamation Contractor shall be responsible for, and shall work with the General Contractor to provide, within 0.50 percent of the required grading of the reclaimed material to the line and grade, as well as cross slopes, as indicated on the Contract Drawings. The Reclamation Contractor will also be responsible for compaction, including optimum moisture for the reclaimed material, conforming to NYSDOT Section 203-3.12. The Reclamation Contractor will be responsible for dust control during the reclamation phase of the project.

B. Additional "Subbase Material" as per Section 02300 may be added to the reclaimed material prior to grading in order to provide the proper gradation to achieve compaction and density.

3.4 RECLAIMED BASE STABILIZATION

A. After the existing pavement has been reclaimed and rough graded to within 0.50 percent of the finished grade. The pavement area shall be re-ground to a minimum depth of 6" mixing foamed asphalt shall be blended with the newly reclaimed base.

B. The Reclamation Contractor shall determine the optimum foamed asphalt content required to be blended with the newly reclaimed base upon laboratory mix design testing. Mix design testing will be submitted to the Engineer.

C. The laboratory must be equipped with a foam lab. This foam lab shall be capable of producing foamed asphalt for use in the mix design testing that is the equivalent of that produced by the Foamstab Mixer in the Reclaimer.

D. Reclamation Contractor shall obtain a minimum of one sample per one thousand (1000) linear feet.

E. The mix design procedure shall be based upon modifications of AEMA's "Marshall Method for Emulsified Asphalt – Aggregate Cold Mix Design," to meet the requirements of foamed asphalt.

F. Preliminary Testing of the material shall be performed as follows:

1. Gradation of un-extracted material.
2. Optimum Moisture Content (ASTM D - 1557)
3. Asphalt Content (ASTM D2172)

G. Based upon the results of the preliminary testing, samples shall be prepared and tested in accordance with the design procedure. The selection of the optimum foamed asphalt content shall be based upon the following values:

1. The wet stability shall not be less than 2,000 lbs.
2. The flow shall not be less than 6 or more than 18.
3. The percent retained stability (dry vs. wet) shall be a minimum of 60%.

H. The moisture content of the reclaimed material at the time of the addition of the foamed asphalt shall be uniformly distributed through the reclaimed material and shall be at a level such that proper coating of the aggregates can be achieved.

I. The Reclamation Contractor must have equipment on hand to determine the moisture content and monitor such during the mixing operation.

J. The Reclamation Contractor shall provide a water truck when it is necessary to add water.

K. Compaction of the stabilized mixture shall be the responsibility of the Reclamation Contractor. The Reclamation Contractor shall supply as a minimum a 25-ton, vibratory, steel wheel roller, capable of compacting the material to 95% modified proctor.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. A sample of the reclaimed material will be collected for testing. A modified proctor ASTM D1557 will be performed to determine optimum moisture content and maximum dry density. The Contractor shall provide a Nuclear-Density meter and a certified operator to control the final in-place moisture and density of the stabilized material. The moisture content must be within 2% of optimum moisture determined by the mix design. The reclaimed material shall be compacted to 95% modified proctor. The meter shall be used to determine the optimum number of roller passes required to achieve an acceptable density. Field test reports shall be provided to the Engineer upon completion of the process.

C. The contractor will test for conformance to required cross slope and longitudinal grade at intervals determined by the engineer with methods acceptable to the Engineer. Deficiencies will be corrected before placing base course.

END OF SECTION 02745

SECTION 02751 - CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Curbs.
2. Walkways.

B. Related Sections include the following:

1. Division 1 Section "Unit Prices" for unit-price concrete walkway, unit-price concrete curbs, authorized additional excavation provisions and authorized additional subbase material.
2. Division 2 Section "Earthwork" for subgrade preparation, grading, and subbase course.

1.3 UNIT PRICES

A. Unit prices for cement concrete pavements are included in Division 1 Section "Unit Prices."

B. Concrete Walkway Replacement Measurement: Square feet of concrete, measured in place. Unit measurement shall include price of demolition of existing concrete walkways, repair of existing subgrade and subbase, and construction of new concrete walkway in accordance with these specifications.

1. Includes only the replacement of existing Concrete Walkway with new Concrete Walkway.
2. All Concrete Walkways labeled as New are part of Item #1 in Base Bid.

C. Concrete Curbs Replacement Measurement: Linear Feet of concrete, measured in place. Unit measurement shall include price of demolition of existing concrete curbs, repair of existing subgrade and subbase, and construction of new concrete curb in accordance with these specifications.

1. Includes only the replacement of existing Concrete Curbs with new Concrete Curbs.
2. All Concrete Curbs labeled as New are part of Item #1 in Base Bid.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.5 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Bonding agent or epoxy adhesive.
6. Joint fillers.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

D. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

E. Deformed-Steel Wire: ASTM A 496.

F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

1. Available Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edeco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, ChemRex Inc.; Confilm.
k. Meadows, W. R., Inc.; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation; Finishing Aid.
p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

1. Available Products:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoko; Aqua Resin Cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
f. Euclid Chemical Company (The); Kurez DR VOX.

g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
j. Meadows, W. R., Inc.; 1100 Clear.
k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
l. Symons Corporation; Resi-Chem Clear.
m. Tamms Industries Inc.; Horncure WB 30.
n. Unitex; Hydro Cure 309.
o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 3000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
3. Slump Limit: 5 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use admixtues in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.

C. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness.

D. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.

1. Remove and replace concrete that has been placed for more than 15 minutes without being covered by top layer, or use bonding agent if approved by Engineer.

J. Screed pavement surfaces with a straightedge and strike off.

K. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

L. Cold-Weather Placement: Comply with ACI 306.1.

M. Hot-Weather Placement: Comply with ACI 301.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing

operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 02751

SECTION 02832 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes single- depth segmental retaining walls with soil reinforcement.

B. Related Sections:

1. Division 2 Section "Earthwork" for excavation for segmental retaining walls.

1.3 PERFORMANCE REQUIREMENTS

A. Basis of Design: Provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.

1.4 SUBMITTALS

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

B. Plans, elevations, sections, details, and structural analysis data signed and sealed by the qualified New York State registered professional engineer responsible for their preparation.

C. Samples for Initial Selection: For concrete units.

D. Samples for Verification: For each color and texture of concrete unit required. Submit sections of units not less than 3 inches square.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

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

   a. Allan Block Corporation.
   b. Anchor Wall Systems, Inc.
   c. GeoWestern, Inc.
   d. ICD Corporation.
   e. Keystone Retaining Wall Systems, Inc.; a Contech company.
   f. Risi Stone Systems; a division of Rothbury International.
   g. Rockwood Retaining Walls, Inc.
   h. Tensar Earth Technologies, Inc.
   i. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.

2. Provide units that comply with requirements for freeze-thaw durability.
3. Provide units that interlock with courses above and below by means of integral lugs or lips.

B. Color: As selected by Engineer from manufacturer's full range.

C. Shape and Texture: Provide units of basic shape and dimensions indicated with machine-split textured exposed faces.

D. Batter: Provide units that offset from course below to provide at least 1:8 batter.

E. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.

F. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

2.2 INSTALLATION MATERIALS

A. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

C. Leveling Course: Provide leveling course in accordance with the written Manufacturer's instruction.

D. Drainage Fill: Comply with requirements in Division 2 Section "Earthwork" for drainage fill material."

E. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 sieve, 0 to 60 percent passing No. 40 sieve, 0 to 35 percent passing No. 200 sieve, and with fine fraction having a plasticity index of less than 20.

F. Nonreinforced-Soil Fill: Comply with requirements in Division 2 Section "Earthwork" for satisfactory soils.

G. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd..

H. Soil Reinforcement: Product specifically manufactured for use as soil reinforcement and as follows:

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

a. Colbond Inc.
b. Huesker, Inc.
c. Luckenhaus Technical Textiles, Inc.
d. Mirafi Construction Products; Ten Cate Nicolon.
e. Propex Fabrics Inc.; Civil Engineering Fabrics.
f. Strata Systems, Inc.
g. Synteen Technical Fabrics, Inc.
h. Tenax Corporation; Subsidiary of Tenax Group.
i. Tensar Earth Technologies, Inc.

j. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.
k. Webtec, Inc.

2. Product Type: Knitted or woven geogrid made from polyester yarns with a protective coating.

2.3 SOURCE QUALITY CONTROL

A. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:

1. Weight.
2. Roll size.
3. Grab or single-rib strength.
4. Aperture opening.
5. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.

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

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in running bond.
2. Form corners and ends by using special units.

B. Leveling Base: Place and compact base material to Manufacturer’s recommended thickness and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.

E. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Division 2 Section "Earthwork," NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

    a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Division 2 Section "Earthwork."

D. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches wide behind drainage geotextile to within 12 inches of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.

G. Place impervious fill over top edge of drainage fill layer.

H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.

I. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8

inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.

1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
2. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
3. Do not dump fill material directly from trucks onto geosynthetics.
4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

3.5 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Engineer approves methods and results.
2. Segmental retaining walls that do not match approved Samples.
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 02832

SECTION 02921 - SEEDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Seeding preparation.
2. Seeding.
3. Mulching.

1.3 SUBMITTALS

A. Product Data: Hydro Mulch: Manufacturer’s specifications and application rate.

B. Sample: One pound of seed in vendor's unopened package with label and seed analysis.

1.4 QUALITY ASSURANCE

A. Field Examples: Seed samples will be taken by the Owner's Representative 30 days before sowing is tested. Test analysis will indicate species, purity, percent of germination, and weed content. Results will be sent directly to the Owner for acceptance or rejection based on these tests. The Contractor shall pay all expenses incurred for testing.

1.5 DELIVERY STORAGE AND HANDLING

A. Deliver fertilizer in manufacturer's standard size bags or cartons showing weight, analysis, and the name of the manufacturer. Store as approved by Owner's Representative.

B. Store all seed at the site in a cool dry place as approved by the Owner's Representative. Replace any seed damaged during storage.

C. Deliver seeds, 30 days in advance of anticipated use, in vendor's unopened packages bearing labels showing vendor's name and seed analysis by weight.

1.6 SCHEDULING

A. Time For Seeding: Sow grass seed between March 15th and May 15th or between August 15th and October 1st, except as otherwise approved in writing by the Owner.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Fertilizer: Commercial (5-10-5) inorganic, or organic, containing not less than 5 percent nitrogen, 10 percent available phosphoric acid and 5 percent water soluble potash.

B. Other fertilizers with a 1-2-1 ratio such as 10-20-10 or 6-12-6 may be substituted for above.

2.2 SEED

A. Furnish fresh, clean, new-crop seed mixed in the proportions specified for species and variety, and conforming to Federal and State Standards.

B. Acceptable material in a seed mixture other than pure live seed consists of nonviable seed, chaff, hulls, live seed of crop plants and inert matter. The percentage of weed seed shall not exceed 0.1 percent by weight.

C. All seed will be rejected if the label or test analysis indicates any of the following contaminates: Timothy, Orchard Grass, Sheep Fescue, Meadow Fescue, Canada Blue Grass, Alta Fescue, Kentucky 31 Fescue, and Bent Grass.

D. Provide the following seed mixture:

STANDARD MIXTURE			
AMOUNT BY WEIGHT IN MIXTURE	SPECIES OR VARIETY	PERCENTAGE	
		PURITY	GERMINATION
55 PERCENT (MIN)	KENTUCKY BLUEGRASS BLEND *	95 PERCENT	80 PERCENT
25 PERCENT (MIN)	RED FESCUE	97 PERCENT	80 PERCENT
20 PERCENT (MAX)	PERENNIAL RYE **	98 PERCENT	85 PERCENT
100 PERCENT			

*Approximately equal proportions of 2 or more improved Bluegrass varieties as listed in the Cornell Recommendations for Turfgrass.
**One or more of the improved Ryegrass varieties as listed in the Cornell Recommendations for Turfgrass.

2.3 MULCH

A. Dry Application, Straw: Stalks of oats, wheat, rye or other approved crops which are free of noxious weed seeds. Weight shall be based on a 15 percent moisture content.

B. Hydro Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch. Acceptable Product: Conwed Hydro Mulch, Conwed Fibers, 231 4th Street SW, Hickory, NC.

C. Jute Mesh: Heavy jute erosion cloth in rolls 225'-0" long by 48 inches wide as supplied by Jute Products, Inc., South 5th Street, Brooklyn, NY.

1. Wire Staples: Twelve inch lengths of No. 11 gage wire bent to form a "U", or other wire staples as approved by the Owner's Representative.

PART 3 - EXECUTION

3.1 PREPARATION

A. Seed Bed: Scarify soil to a depth of 2 inches in compacted areas. Smooth out unsightly variations, bumps, ridges, and depressions which will hold water. Remove stones, litter, or other objectionable material.

1. Obtain written approval of seed bed from the Owner's Representative before commencing seeding operations.

3.2 FERTILIZING

A. Apply 5-10-5 fertilizer evenly at the rate of 40 pounds per 1000 sq ft or 2 pounds of nitrogen per 1000 sq ft.

3.3 SEEDING

A. Assume all risks when seed is sowed before approval of seed analysis.

B. Do not seed when the wind velocity exceeds 5 miles per hour.

C. Application Rate:

1. Standard Mixture: 3 pounds per 1000 sq ft.
2. Special Mixture: 5 pounds per 1000 sq ft.

D. Dry Application: Sow seed evenly by hand or seed spreader on dry or moderately dry soil.

E. Hydroseeding:

1. Apply seeding materials with an approved hydro-seeder.
2. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch, and seed to obtain the specified application rate. Add seed to the tank after the fertilizer and mulch have been added. Maintain constant agitation to keep contents in homogeneous suspension. Prolonged delays in application or agitation that may be injurious to the seed will be the basis of rejection of material remaining in tank.
3. Distribute uniformly a slurry mixture of water, seed, fertilizer, and mulch at a minimum rate of 57 gallons per 1000 sq ft (2500 gallons per acre). The Owner's Representative

may order the amount of water increased if distribution of seeding materials is not uniform.

3.4 MULCHING

A. Dry Application: Within 3 days after seeding, cover the seeded areas with a uniform blanket of straw mulch at the rate of 100 pounds per 1000 sq ft of seeded area.

B. Hydro Application: Apply approved mulch in accordance with the manufacturer's written instructions and recommended rates of application.

C. Dry Application, Jute Mesh: Within 3 days after seeding, cover sloped areas with a uniform blanket of jute mesh. Securely fasten jute mesh to slope with wire staples spaced 2 feet on center. Do not apply straw mulch over jute mesh.

3.5 LAWN ESTABLISHMENT

A. Maintain the grass at heights between 1-1/2 inches and 2-1/2 inches and include a minimum of 3 mowings.

B. Water and protect all seeded areas until final acceptance of the lawn. Contractor shall water all seeded areas once per week to provide a minimum coverage of ¾” of water over the entire area.

3.6 FINAL ACCEPTANCE

A. Final acceptance of lawn areas will be granted when a uniform stand of acceptable grass is obtained, with a minimum of 95 percent coverage. Portions of the lawn areas may be accepted at various times at the discretion of the Owner's Representative.

B. Unacceptable lawn areas, dry application: Reseed as specified and fertilized at one-half the specified rate.

C. Unacceptable lawn areas, hydro application: Reseed, fertilize, and mulch at one-half the specified rate, use full water rate.

D. Once accepted, the Owner will assume all maintenance responsibilities.

END OF SECTION 02921

SECTION 03050 - INTEGRAL CONCRETE WATERPROOFING ADMIXTURE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Furnish all labor, materials, tools and equipment as necessary to perform incorporation of Liquid Integral Waterproofing Admixture for concrete mix. Admixture shall be added to the wet concrete mix at the batching plant or to the ready-mix-truck at job site per manufacturer's instructions.

B. The work of this section applies to all concrete for the project that will retain waste water.

C. Related Sections:

1. See Division 3: "Cast-in-Place Concrete"

1.2 REFERENCES

A. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.

B. ASTM C 348 - Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.

C. ACI 308 - Standard for Curing of Concrete.

D. COE CRD-C 48 - Method of Test for Water Permeability of Concrete; U.S. Army Corps of Engineers.

E. NSF 61 – Drinking Water System Components.

1.3 SUBMITTALS

A. General: Submit manufacturer's certification that proposed materials, details and systems as indicated and specified fully comply with manufacturer's details and specifications. If any portion of the Contract Documents do not conform to manufacturer's standard recommendations, submit notification of portions of design that are at variance with manufacturer's specifications.

B. Compatibility: Submit manufacturer's certification that proposed material is compatible with concrete mix design.

C. Product Data: Submit manufacturer's product data, installation instructions and MSDS for product.

D. Certification: Ad mixture will comply with NSF 61.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Company specializing in manufacturing concrete waterproofing products with minimum 5 years documented experience.

2. Capable of providing field service representation during construction and approving application method.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and store in a dry area at minimum 68°F (20°C). Handle and protect from freezing and contamination in accordance with manufacturer’s instructions.

B. Deliver materials in manufacturer's unopened containers, fully identified with brand, type, grade, class and all other qualifying information. Provide Material Safety Data Sheet.

1.6 SYSTEM REQUIREMENTS

A. Provide materials and accessories in timely manner so as not to delay Work.

1.7 PRE-INSTALLATION CONFERENCE

A. Convene pre-installation conference at the Contractor's direction prior to commencing work to review methods and sequence of installation. The meeting shall include the Engineer, Contractor and/or Subcontractor, Manufacturer's Representative.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. Manufacturers:

1. AQUAFIN, Inc. P.O. Box 1440, Columbia, MD, Phone (800) 394-1410 or (410) 964-1410, Fax (410) 964-1526; e-mail info@aquafin.net.

2. Xypex Chemical Corporation, 13731 Mayfield Place, Richmond, BC V6V 2G9. ASD. Tel: (800) 961-4477 or (604) 270-0451; e-mail info@xypex.com http://www.xypex.com.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Assure that concrete mix design and proposed material are in compliance with manufacturer's recommendations.

B. Assure that test batching and material testing if recommended by manufacturer has been carried out prior to starting concrete work.

C. Comply with manufacturer's product data and installation instructions.

3.2 INSTALLATION

A. Stir integral waterproofing admixture in container provided prior to use, to assure that the mixture is homogeneous.

B. At batching plant, comply with manufacturer's instructions.

C. Ready-mix truck at job site, comply with manufacturer's instructions.

D. Install concrete as per project specifications, Division 3 Sections for concrete installation.

END OF SECTION

SECTION 03251 - JOINTS FOR CONCRETE

PART 1 - GENERAL

1.1 WORK SPECIFIED

A. All labor, materials, services and equipment necessary for furnishing and installing all expansion joints, construction joints and control joints.

1.2 WORK SPECIFIED UNDER OTHER SECTIONS

A. Reinforced Concrete

B. Concrete Formwork

C. Concrete Reinforcement

D. Sealants

E. Concrete

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

B. Corps of Engineers (CRD)

1.4 SUBMITTALS

A. Furnish manufacturer's certification or test results identifying physical characteristics.

B. Submit two (2) samples of each size and type of waterstop required.

1. Minimum 4 inches in length.

C. On the concrete reinforcement shop drawings clearly show in detail the locations of all joints in concrete.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. W.R. Grace & Company

B. Sonneborn - Contech, Inc.

C. B.F. Goodrich Company

D. Vulcan Metal Products, Inc.

E. Kirkhill Rubber Company

2.2 INTEGRAL JOINT MATERIALS

A. Polyvinylchloride (PVC) Waterstops

1. PVC material shall be compounded from virgin PVC resins and shall contain no reclaimed, reground or reworked materials. The material shall meet the following physical property requirements:

Property	Method of Test	Requirement
Tensile Strength (psi)	ASTM D412	1400 min.
Ultimate Elongation (%)	ASTM D142	280 min.
Hardness, Type A Durometer	ASTM D2240	65-88
Stiffness in Flexure (psi)	ASTM D747	750 min.
Specific Gravity	ASTM D792	1.38 max.
Water Absorption in 48 hrs. (%)	ASTM D570	0.5 max.
Low Temperature Brittleness	ASTM D746	No sign of failure @ 35°F
Accelerated Aging:	CRD-C-572:	
Tensile Strength (psi)		1500 min.
Elongation (%)		300 min.
Effect of Alkali in 7 Days:	CRD-C-572:	
Weight Change (%)		-.10 to +.25
Hardness, Type A Durometer		0.5 max.
Tensile Strength Change (%)		-15 max.

2. Dimensions:

a. Expansion Joints: 9 inches long by 3/8-inch web with a 3/4-inch diameter center bulb.
b. Construction and Control Joints: 6 inches long by 3/8-inch web with a 3-inch diameter center bulb.

2.3 SELF-EXPANDING BUTYL STRIP WATERSTOPS

A. Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

B. Available Products:
   1. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
   2. Concrete Sealants Inc.; Conseal CS-231.
   3. Greenstreak; Swellstop.
   4. Henry Company, Sealants Division; Hydro-Flex.
   5. JP Specialties, Inc.; Earthshield Type 20.
   6. Progress Unlimited, Inc.; Superstop.
   7. TCMiraDRI; Mirastop.

PART 3 - EXECUTION

3.1 JOINT PREPARATION

A. The joint surface of concrete previously placed shall be clean, moist, true to level and reasonably rough, with some coarse aggregate exposed. All laitance and loose mortar shall be removed.

B. The surface of the joint shall be prepared prior to pouring. The joint shall be cleaned by wire brushing if necessary.

C. Protect the joint until concreting is resumed.

D. Hardened concrete shall be saturated for a period of six (6) hours and all excess moisture and all loose or foreign material shall be removed before new concrete is placed at joint.

E. Precede new concrete by about 2-inch of soft mortar of the same proportions as that in the concrete. When accessible, this shall be rubbed into the surfaces of the joint.

F. In column forms and other deep narrow forms, the concrete placement shall be started with an oversanded mix of 5/8-inch maximum aggregate with an extra sack of cement per cubic yard and with a 5-inch slump. This mix shall be placed several inches deep on the construction joint. Do not use a mortar layer.

G. Waterstops shall be placed continuous around corners and intersections. Splices shall be made in accordance with the manufacturer's recommendations.

3.2 INSTALLATION

A. Expansion Joints

   1. Discontinue reinforcing steel, corner protection angles, metal frames, and other fixed items embedded or bonded to concrete.
   2. Place parallel concrete reinforcement 2 inches on each side of joint.
   3. Provide slightly rounded or 3/4-inch chamfer, as shown on the contract drawings. Finish all edges neatly around the joint.

B. Construction Joints

1. Generally, the location of construction joints are shown on the contract drawings. Where joints are not shown, it shall be the contractor's responsibility to provide construction joints in locations suitable to operations and in locations that are in conformance with good concrete construction practice and as specified herein.
2. All horizontal construction joints shall have steel waterstops except as directed by the engineer, in writing.
3. To minimize shrinkage effects, do not pour long continuous walls or floor slabs at one time. The following tables give maximum pour lengths:
   a. Rectangular slab* pours shall conform to this table:

Short Side "S"	Long Side "L"
20 ft.	L must be 4x"S"ft.
20-30 ft.	L must be 80 ft.
30-40 ft.	L must be 70 ft.
40-60 ft.	L must be 60 ft.

   b. Circular slab* pours shall have a maximum surface area of less than 3600 square feet.

      1) *If pour exceeds the dimensions given in the tables, the slab shall be poured in alternating patterns conforming to the tables.

   c. Wall pours* shall be limited to 50 feet in horizontal dimension. Horizontal construction joints in walls are not permitted except as detailed on the contract drawings or as approved by the engineer.

      1) *If the walls exceed 50 feet, pour the wall in an alternating pattern.

4. Concrete reinforcement shall be continuous through all construction joints. Reinforcement shall be kept clean.
5. Provide additional reinforcing bars, No. 4 at 12 inches by 4 foot long centered in each vertical construction joint.
6. Provide keyways and waterstops as shown on the contract drawings.

C. Control Joints

1. Locate and construct control joints as shown on the contract drawings.

   a. Wall control joints shall be made at 15 foot intervals in long uninterrupted walls greater than 45 feet in length.
   b. Slab control joints shall be made using a pre-molded joint filler or by sawcutting. Sawcutting shall be done after the surface is firm enough not to be damaged by the cutting blade.

D. Joints Connecting Old and New Work

1. Construct as shown on the contract drawings.

2. Thoroughly clean and roughen existing surfaces before application of the bonding agent.
3. Make all joints watertight.

END OF SECTION 03251

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Equipment Pads and Bases.
5. Pipe Bases.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for drainage fill under slabs-on-grade.
2. Division 2 Section "Cement Concrete Pavement" for concrete pavement and walks.
3. Division 3 Section “Integral Concrete Waterproofing Admixture.”

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices for cast-in-place specified in Section 01270 "Unit Prices."

B. Quantity allowances for cast-in-place are included in Section 01210 "Allowances."

C. Authorized Additional Slab-on-Grade Concrete Measurement: Cubic yards of concrete, measured in place. Includes all Slab-on-Grade Concrete that is not indicated in the Contract.

D. Authorized Additional Concrete Steel Reinforcement Measurement: Pounds of steel reinforcement, measured in place. Includes all Concrete Steel Reinforcement that is not indicated in the Contract.

1.4 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.5 SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

E. Samples: For waterstops and vapor retarder.

F. Welding certificates.

G. Qualification Data: For Installer, manufacturer, and testing agency.

H. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

I. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

K. Field quality-control test and inspection reports.

L. Minutes of preinstallation conference.

1.6 ALLOWANCES

A. Allowance No. 1 for the testing services included in Division 1 “Allowances” for concrete testing.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or Type II, gray. Supplement with the following:

a. Fly Ash: ASTM C 618, Class C.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

2. Blended Hydraulic Cement: ASTM C 595, Type I (PM), pozzolan-modified portland cement.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

1. Available Products:

a. Boral Material Technologies, Inc.; Boral BCN.
b. Euclid Chemical Company (The); Eucon CIA.
c. Grace Construction Products, W. R. Grace & Co.; DCI.
d. Master Builders, Inc.; Rheocrete CNI.
e. Sika Corporation; Sika CNI.

D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Available Products:

a. Axim Concrete Technologies; Catexol 1000CI.
b. Boral Material Technologies, Inc.; Boral BCN2.
c. Cortec Corporation; MCI 2000.
d. Grace Construction Products, W. R. Grace & Co.; DCI-S.
e. Master Builders, Inc.; Rheocrete 222+.
f. Sika Corporation; FerroGard-901.

2.7 WATERSTOPS

A. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

1. Available Products:

a. JP Specialties, Inc.; Earth Shield TPE-Rubber.
b. Vinylex Corp.; PetroStop.
c. WESTEC Barrier Technologies, Inc.; 600 Series TPE-R.

2. Profile: Flat, dumbbell with center bulb.
3. Dimensions: 6 inches by 3/16 inch thick; nontapered.

2.8 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Available Products:

a. Fortifiber Corporation; Moistop Ultra A.
b. Raven Industries Inc.; Vapor Block 15.

c. Reef Industries, Inc.; Griffolyn Type-65G.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

C. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

D. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Available Products:

a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edoco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.

E. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

F. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

G. Water: Potable.

2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.0217-inch- thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 50 percent.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixtureimension, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

B. Foundation Walls: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45
3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

C. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 520 lb/cu.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
6. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A**,** 1/8 inch for smooth-formed finished surfaces.
2. Class B**,** 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.

1. Place and compact a 1/2-inch- thick layer of fine-graded granular material over granular fill.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls to accommodate efficient placement and forming (approval by Engineer is required). Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to view.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to all floors and slabs.

a. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.

C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

D. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
3. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including walls, underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure

after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.16 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M.

a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Engineer.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION 03300

SECTION 03930 - CONCRETE REHABILITATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Removal of deteriorated concrete and subsequent patching and rebuilding.
2. Epoxy crack injection.
3. Steel structural reinforcement.
4. Expansion Joint Repair

1.3 UNIT PRICES

A. Unit prices for Concrete Rehabilitation are included in Division 1 Section "Unit Prices."

B. Unit prices include costs of field quality control testing required by the Work for which the unit price applies.

C. Authorized Concrete Repair Measurement: Cubic feet of concrete, measured in place.

1. Concrete Repair: Includes existing concrete removal and patching or rebuilding. Work will be paid for by the cubic foot computed on the basis of rectangular solid shapes approximating the actual shape of concrete removed and replaced with average depths, widths, and lengths, measured to the nearest inch.

2. Reinforcing bar replacement will be paid for separately by the pound of replacement steel with welded and mechanical splices paid for by the unit.

D. Epoxy Crack Injection Measurement: Linear feet of crack injected, measured after crack preparation.

E. Concrete Expansion Joint Repair Measurement: Linear feet of existing expansion joints that are repaired, measured after joint preparation.

1.4 SUBMITTALS

A. Product Data: Include material descriptions, chemical composition, physical properties, test data, and mixing and application instructions.

1. Include Material Safety Data Sheets, if applicable.

B. Shop Drawings: For formwork and temporary shoring and supports, prepared by or under the supervision of a qualified professional engineer. Design and engineering of formwork and temporary shoring and supports are Contractor's responsibility. Indicate proposed schedule and sequence for removal of formwork and temporary shoring and supports.

C. Samples: Cured samples of patching materials.

D. Product Certificates: Signed by manufacturers certifying that products furnished comply with requirements and are recommended by manufacturer for uses indicated.

E. Qualification Data: For installers, professional engineer and manufacturers to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1. For products required to be installed by workers approved by product manufacturers, include letters of acceptance by product manufacturers certifying that installers are approved to apply their products.

F. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of bonding agents, patching mortars and epoxy adhesives with requirements indicated.

G. Rehabilitation program for each phase of the rehabilitation process, including protection of surrounding materials and Project site during operations. Describe in detail the materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

1. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request complying with Division 1 Section "Product Requirements" and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: In addition to other requirements in Division 1 Section "Quality Requirements," retain installers that employ workers trained and approved by manufacturer to apply concrete patching and rebuilding materials, epoxy crack injection materials and polymer sealers.

B. Manufacturer Qualifications: In addition to other requirements in Division 1 Section "Quality Requirements," manufacturers shall have factory-trained representatives who are available for consultation and Project site inspection at no additional cost.

C. Source Limitations: Obtain each of the following through one source from a single manufacturer:

1. Concrete patching and rebuilding materials.
2. Epoxy crack injection materials.

D. Mockups: Build mockups for concrete removal and patching, floor joint repair, epoxy crack injection, and polymer sealers to demonstrate qualities of materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.

B. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.

C. Store cementitious materials off the ground, under cover, and in a dry location.

D. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

1.7 PROJECT CONDITIONS

A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40° F within 8 hours.
2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60° F within 8 hours.
3. Use only Class C epoxies when substrate temperatures are above 60° F.

B. Cold-Weather Requirements for Cementitious Materials: Do not apply unless air temperature is between 40° and 90° F and will remain so for at least 48 hours after completion of Work.

C. Cold-Weather Requirements for Cementitious Materials: Comply with the following procedures:

1. When air temperature is below 40° F, heat patching material ingredients and existing concrete to produce temperatures between 40° and 90° F.
2. When mean daily air temperature is between 25°and40° F, cover completed Work with weather-resistant insulating blankets for 48 hours after repair.
3. When mean daily air temperature is below 25° F, provide enclosure and heat to maintain temperatures above 32° F within the enclosure for 48 hours after repair.

D. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90° F and above.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

B. Products: Subject to compliance with requirements, provide one of the following:

1. Epoxy Bonding Agent:

a. Dayton Superior Corporation; Sure-Anchor Epoxy (J-50).
b. Euclid Chemical Company; EUCO #352 EPOXY SYSTEM.
c. Fosroc International Limited; Nitobond 881-11.
d. Kaufman Products, Inc.; SurePoxy HM EPL.
e. Master Builders, Inc.; CONCRESIVE LIQUID LPL.
f. Sika Corporation; Sikadur 31 Hi-Mod Gel.
g. Sonneborn, Div. of ChemRex, Inc.; Epogel.
h. Sto Corp., Concrete Restoration Division; Sto Epoxy Adhesive.
i. Unitex; Pro-Poxy 204.

2. Latex Bonding Agent, Type II:

a. Dayton Superior Corporation; Day-Chem Ad Bond (J-40).
b. Euclid Chemical Company; FLEX-CON.
c. Kaufman Products, Inc.; SureBond.
d. Sonneborn, Div. of ChemRex, Inc.; Acrylic Additive.

3. Latex Bonding Agent, Type I:

a. Euclid Chemical Company; EUCO WELD.
b. Kaufman Products, Inc.; SureWeld.
c. Sika Corporation; SikaLatex.

4. Cementitious Patching Mortar:

a. Fosroc International Limited; Renderoc LA.
b. Kaufman Products, Inc.; HiCap.
c. Master Builders, Inc.; EMACO S66 CI.
d. Sika Corporation; SikaRepair 223.
e. Sto Corp., Concrete Restoration Division; Sto Full-Depth Repair Mortar.

5. Epoxy Crack Injection Adhesive:

a. Dayton Superior Corporation; Sure-Inject (J-56).
b. Sika Corporation; Sikadur 35 Hi-Mod LV.
c. Sonneborn, Div. of ChemRex, Inc.; EpoFil.

2.2 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

B. Epoxy Bonding Agent: ASTM C 881, Type II.

1. Thin Film Open Time: Not less than two hours.

C. Latex Bonding Agent: ASTM C 1059, Type II.

D. Mortar Scrub-Coat: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 sieve.

2.3 PATCHING MORTAR

A. Patching Mortar: Unless otherwise indicated, use one of the following:

1. Job-Mixed Patching Mortar: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 2-1/2 parts fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 sieve.
2. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.
3. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains a latex additive as either a dry powder or a separate liquid that is added during mixing.
4. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains silica fume complying with ASTM C 1240 and a latex additive as either a dry powder or a separate liquid that is added during mixing.
5. Epoxy-Modified, Cementitious Patching Mortar: Mixture of water-insensitive epoxy adhesive, portland cement, and graded aggregates.

B. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified above.

C. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.

2.4 CONCRETE

A. Concrete Materials and Admixtures: Comply with Division 3 Concrete.

B. Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 3 Concrete.

C. Form-Facing Materials: Comply with Division 3 Concrete.

D. Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 100 percent passing a 1-1/2-inch sieve, 95 to 100 percent passing a 1-inch sieve, 40 to 80 percent passing a 3/4-inch sieve, 0 to 15 percent passing a 1/2-inch sieve, and 0 to 2 percent passing a 3/8-inch sieve.

E. Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 sieve, 95 to 100 percent passing a No. 16 sieve, 55 to 80 percent passing a No. 30 sieve, 30 to 55 percent passing a No. 50 sieve, 10 to 30 percent passing a No. 100 sieve, 0 to 10 percent passing a No. 200 sieve, and having a fineness modulus of 1.30 to 2.10.

F. Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.

G. Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.

H. Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

2.5 ELASTOMERIC EXPANSION JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Multicomponent Nonsag Immersible Polysulfide Sealant:

1. Available Products: PolySpec Corp.; Thiokol 2235M HP with PolySpec Corp.; Thiokol 415 Primer for Polysufide sealants.
2. Type and Grade: M (multicomponent) and NS (nonsag).

2.6 MISCELLANEOUS MATERIALS

A. Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of at least 80 per ASTM D 2240.

B. Epoxy Crack Injection Adhesive: ASTM C 881, Type I.

C. Epoxy Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.

D. Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

2.7 MIXES

A. Mix products in clean containers according to manufacturer's written instructions.

1. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
2. Do not add water, thinners, or additives unless recommended by manufacturer.
3. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.

4. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.

B. Mortar Scrub-Coat: Mix with enough water to provide a consistency of thick cream.

C. Dry-Pack Mortar: Mix with just enough liquid to form a damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

D. Concrete: Comply with Division 3 Concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Notify Architect seven days in advance of dates when areas of delaminated concrete and reinforcing bars will be located.

B. Locate areas of delamination using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries of delaminated areas as directed by Engineer.

C. Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

3.2 PREPARATION

A. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.

1. Erect temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles that must remain in operation during course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch exterior-grade plywood supported at 16 inches o.c. and covered with asphalt roll roofing.
2. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
3. Neutralize and collect alkaline and acid wastes for disposal off Owner's property.
4. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

B. Shoring: Install temporary supports before beginning concrete removal.

C. Concrete Removal: Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcing. Remove loose and deteriorated concrete by breaking up and dislodging from reinforcing.

1. Remove concrete between cuts to a depth of at least 1/2 inch.

2. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar to provide at least a 3/4-inch clearance.
3. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound concrete is completely removed.
4. Provide fractured aggregate surfaces with a profile of at least 1/8 inch that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level.
5. Thoroughly clean removal areas of loose concrete, dust, and debris.

D. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by abrasive blast cleaning until only tightly bonded light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace as directed by Engineer. Remove additional concrete as necessary to provide at least a 3/4-inch clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318, by lapping, welding, or using mechanical couplings.

E. Concrete Expansion Joint Repair Preparation: Remove existing expansion joint of joint sealant, dust, laitance, grease, oils, curing compounds, form release agents and foreign particles by mechanical means. The joint and adjacent substrate must be clean, sound and free of surface contaminants. It may be dry or damp, but free of standing water. Blow joint free of dust using compressed air line equipped with an oil trap.

1. Elastomeric Tubing Sealant Backings: Provide neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F, where existing expansion joint filler is missing or beyond repair.

3.3 APPLICATION

A. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply patching mortar or concrete while epoxy is still tacky. If bonding agent dries, recoat before placing patching mortar or concrete.

B. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. If bonding agent dries, recoat before placing patching mortar or concrete.

C. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.

D. Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.

E. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:

1. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
2. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
3. For vertical patching, place material in lifts of not more than 1 inch nor less than 1/4 inch. Do not feather edge.
4. For overhead patching, place material in lifts of not more than 1 inch nor less than 1/4 inch. Do not feather edge.
5. After each lift is placed, consolidate material and screed surface.
6. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.
7. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth surface with a wood or sponge float.
8. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

F. Dry-Pack Mortar: Use for deep cavities. Place according to manufacturer's written instructions and as follows:

1. Provide forms where necessary to confine patch to required shape.
2. Wet substrate and forms thoroughly and then remove standing water.
3. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
4. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
5. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.

G. Concrete: Place according to Division 3 Concrete and as follows:

1. Apply epoxy bonding agent to reinforcing and concrete substrate.
2. Use vibrators to consolidate concrete as it is placed.
3. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
4. Place concrete by form and pump method.

    a. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
    b. Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi.

5. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.

6. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

H. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:

1. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
2. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
3. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch thick by 1 inch wider than crack.
4. Inject cracks wider than 0.003 inch to a depth of 8 inches or to a width of less than 0.003 inch, whichever is less.
5. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
6. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

I. Concrete Expansion Joint Repair:

1. Prime surface with Primer.
2. Where required install sealant backing into the joint; the backer rod should be compressed 25%, the joint depth shall be one half the joint width.
3. Apply sealant with conventional caulking equipment. Fill joint completely.
4. Immediately after application, dry tool the sealant using a tooling stick. Use light pressure to ensure positive and complete contact of the sealant to the joint surfaces. Tooling the bead in a concave shape achieves the desired hourglass shape of the finished bead.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to sample materials and perform tests specified in Division 3 and as follows:

1. Patching Mortar, Packaged Mixes: Five (5) percent randomly selected samples tested according to ASTM C 928.
2. Patching Mortar, Field Mixed: Five (5) percent randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.
3. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.

   a. Testing Frequency: 1 sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than 1 sample for each day's work.

4. Epoxy Joint Filler: Core drilled samples to verify proper installation.

   a. Testing Frequency: One sample for each 100 feet (30 m) of joint filled.
   b. Where samples are taken, fill holes with epoxy joint filler.

5. Epoxy Crack Injection: Core drilled samples to verify proper installation.

   a. Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet (30 m) of crack injected.
   b. Where samples are taken, fill holes with epoxy mortar.

END OF SECTION 03930

SECTION 04810 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units (CMUs).
2. Decorative cultured masonry.
3. Pre-faced concrete masonry units.
4. Concrete brick.
5. Face brick.
6. Building (common) brick.
7. Hollow brick.
8. Mortar and grout.
9. Reinforcing steel.
10. Masonry joint reinforcement.
11. Ties and anchors.
12. Embedded flashing.
13. Miscellaneous masonry accessories.
14. Masonry-cell insulation.
15. Cavity-wall insulation.

B. Products furnished, but not installed, under this Section include the following:

1. Dovetail slots for masonry anchors, installed under Division 3 Section "Cast-in-Place Concrete."

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths (f'_m) at 28 days.

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

C. Determine net-area compressive strength (f'_m) of masonry by testing masonry prisms according to ASTM C 1314.

1.5 SUBMITTALS

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

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
3. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection: For the following:

1. Decorative concrete masonry units, in the form of small-scale units.
2. Face brick, in the form of straps of five or more bricks.
3. Colored mortar.
4. Weep holes/vents.

D. Samples for Verification: For each type and color of the following:

1. Decorative concrete masonry units.
2. Face brick, in the form of straps of five or more bricks.
3. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
4. Stone trim.
5. Weep holes/vents.
6. Accessories embedded in masonry.

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

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Engineer and approved in writing.

F. Qualification Data: For testing agency.

G. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.
b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
d. For surface-coated brick, include material test report for durability of surface appearance after 50-cycles of freezing and thawing per ASTM C 67.
e. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

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

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

1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

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

J. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.6 ALLOWANCES

A. Allowance No. 1 for the testing services included in Division 1 “Allowances” for mortar testing.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 1 Section "Quality Requirements" for mockups.

1. Build sample panels for typical exterior and interior walls in sizes approximately 60 inches long by 48 inches high by full thickness.
2. Clean one-half of exposed faces of panels with masonry cleaner indicated.
3. Protect approved sample panels from the elements with weather-resistant membrane.
4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Engineer in writing.

a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Engineer in writing.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

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

1.9 PROJECT CONDITIONS

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

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen 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.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature 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: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not uses units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

A. Shapes: Provide shapes indicated and as follows:

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

B. Integral Water Repellent: Provide units made with integral water repellent.

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 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.

a. Available Products:

1) Addiment Incorporated; Block Plus W-10.
2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block.
3) Master Builders, Inc.; Rheopel.

C. Concrete Masonry Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi See Editing Instruction No. 4 in the Evaluations before selecting weight classification in subparagraph below. Select one of three weights or delete subparagraph for Contractor's option. Select last option for default requirement if more than one weight is used.
2. Weight Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by the owner.

D. Decorative Cultured Masonry: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.

2. Weight Classification: Normal weight.
3. Size (Width):
4. Pattern and Texture:

    a. Standard pattern, split-face finish.

5. Colors: As selected by Owner from manufacturer's full range.

E. Veneer Brick: ASJM C 1088, Grade SW, Type TBS.

1. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
2. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
3. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet.
4. Size (Actual Dimensions): 1/2 inches wide by 2-1/4 inches high by 7-1/2 inches long.

2.4 MORTAR AND GROUT MATERIALS

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

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

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.

D. Masonry Cement: ASTM C 91.

1. Available Products:
    a. Holcim (US) Inc.; Mortamix Masonry Cement.
    b. Lafarge North America Inc.; Magnolia Masonry Cement.
    c. Lehigh Cement Company; Lehigh Masonry Cement.

E. Mortar Cement: ASTM C 1329.

1. Available Products:

    a. Lafarge North America Inc.; Lafarge Mortar Cement.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Available Products:

    a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
    b. Davis Colors; True Tone Mortar Colors.

c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

G. Colored Cement Product: Packaged blend made from portland cement and lime masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
2. Pigments shall not exceed 10 percent of portland cement by weight.
3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
4. Available Products:

a. Colored Portland Cement-Lime Mix:
1) Lafarge North America Inc.; Eaglebond.
2) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

b. Colored Masonry Cement:
1) Lafarge North America Inc.
2) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.
3) National Cement Company, Inc.; Coosa Masonry Cement.

c. Colored Mortar Cement:

1) Lafarge North America Inc.; Magnolia Superbond Mortar Cement.

H. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C 404.

J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Available Products:

a. Addiment Incorporated; Mortar Kick.
b. Euclid Chemical Company (The); Accelguard 80.
c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
d. Sonneborn, Div. of ChemRex; Trimix-NCA.

K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.

1. Available Products:

    a. Addiment Incorporated; Mortar Tite.
    b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
    c. Master Builders, Inc.; Color Cure Mortar Admix.

L. Water: Potable.

2.5 REINFORCEMENT

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

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

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
4. Wire Size for Cross Rods: W2.8 or 0.188-inch diameter.
5. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet.

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

D. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- diameter, hot-dip galvanized carbon steel continuous wire.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.

B. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from steel sheet, galvanized after fabrication not less than 0.053 inch Ties made from galvanized steel sheet may be used in interior walls, unless otherwise indicated.

C. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

D. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
2. Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls, unless otherwise indicated.

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

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated**.**
2. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.188-inch- diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls, unless otherwise indicated.
3. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch- thick, steel sheet, galvanized after fabrication.
4. Tie Section for Concrete: Corrugated metal ties with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch of masonry face.

F. Partition Top anchors: 0.097-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins, unless otherwise indicated.

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

H. Stone Anchors: Fabricate dowels, cramps, and other stone anchors from stainless steel.

I. Adjustable Masonry-Veneer Anchors

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

2.7 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

C. Postinstalled Anchors: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).
2. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors.

2.8 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing**,** complying with SMACNA's "Architectural Sheet Metal Manual And Division 7 Section "Sheet Metal Flashing and Trim" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. weight or 0.0135 inch thick for fully concealed flashing; 16-oz./sq. ft. weight or 0.0216 inch thick elsewhere.
3. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
4. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.

    a. Available Products:

        1) Cheney Flashing Company; Cheney Flashing (Dovetail).
        2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.

5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
6. Fabricate through-wall flashing with drip edge**,** unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
7. Fabricate through-wall flashing with sealant stop**,** unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
8. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
9. Metal Drip Edges: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

10. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
11. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

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

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

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

D. Weep/Vent Products: Use the following, unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity between wythes. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch OD by 4 inches long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Available Products:

        1) Advanced Building Products Inc.; Mortar Maze weep vent.
        2) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
        3) Heckmann Building Products Inc.; No. 85 Cell Vent.
        4) Hohmann & Barnard, Inc.; Quadro-Vent.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Provide one of the following configurations:

    a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
    b. Strips, not less than 3/4 inch thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
    c. Sheets or strips full depth of cavity and installed to full height of cavity.

d. Sheets or strips not less than 3/4 inch thick and installed to full height of cavity with additional strips 4 inches high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

2. Available Products:

a. Advanced Building Products Inc.; Mortar Break.
b. Archovations, Inc.; CavClear Masonry Mat.
c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
d. Mortar Net USA, Ltd.; Mortar Net.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

1. Available Products:

a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.10 MASONRY-CELL INSULATION

A. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

1. Available Products:

a. Concrete Block Insulating Systems; Korfil.
b. Shelter Enterprises Inc.; Omni Core.

2.11 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Available Manufacturers:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.12 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement**,** mortar cement**,** and lime.
3. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement**,** mortar cement**,** and lime.
4. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

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

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type S.
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
5. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
3. Mix to match Engineer's sample.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

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

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

2.13 SOURCE QUALITY CONTROL

A. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

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

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

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

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

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

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern indicated on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

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

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

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

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

H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

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

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c., unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:

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

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

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

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

3.5 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to 1 story in height, but not more than 20 feet.

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.6 MASONRY JOINT REINFORCEMENT

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

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

    a. Reinforcement above is in addition to continuous reinforcement.

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

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

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

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

3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1/2 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

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

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

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

C. Form expansion joints in brick made from clay or shale as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants," but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.9 LINTELS

A. Provide lintels where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel.

B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install flashing as follows, unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and 1-1/2 inches into the inner wythe. Delete first subparagraph below if no masonry veneer over sheathing and studs.
4. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
5. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
6. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 7 Section "Joint Sealants" for application indicated.
7. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 7 Section "Joint Sealants" for application indicated.
8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

B. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products or open head joints to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches o.c., unless otherwise indicated.
4. Space weep holes formed from plastic tubing 16 inches o.c.
5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.11 REINFORCED UNIT MASONRY INSTALLATION

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

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

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

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

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.12 FIELD QUALITY CONTROL

A. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.

B. Mortar Test (Property Specification): For each mix provided, per ASTM C 780.

C. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

D. Prism Test: For each type of construction provided, per ASTM C 1314 at 7 days and at 28 days.

3.13 PARGING

A. Parge masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
8. Clean stone trim to comply with stone supplier's written instructions.
9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.15 MASONRY WASTE DISPOSAL

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

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 2 Section "Earthwork."
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04810

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Structural steel.
2. Grout.

B. Related Sections include the following:

1. Division 1 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 9 Section "Painting" for surface preparation and priming.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.4 SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Welding certificates.

D. Qualification Data: For Installer, fabricator, professional engineer, testing agency.

E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:

1. Structural steel including chemical and physical properties.
2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
3. Direct-tension indicators.
4. Tension-control, high-strength bolt-nut-washer assemblies.
5. Shear stud connectors.
6. Shop primers.
7. Nonshrink grout.

F. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1, P2 & P3 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

E. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design
4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
5. AISC's "Specification for Allowable Stress Design of Single-Angle Members
6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 COORDINATION

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 572/A 572M, Grade 50

B. Channels, Angles, Shapes: ASTM A 572/A 572M, Grade 50

C. Plate and Bar: ASTM A 572/A 572M, Grade 50

D. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

1. Finish: Plain.
2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.

a. Finish: Plain.

B. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable

1. Configuration: Hooked
2. Nuts: ASTM A 563 heavy hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436 hardened carbon steel.
5. Finish: Plain

C. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.

1. Nuts: ASTM A 563 heavy hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436 hardened carbon steel.
4. Finish: Plain.

D. Threaded Rods: A 572/A 572M, Grade 50

1. Nuts: ASTM A 563 heavy hex carbon steel.
2. Washers: ASTM F 436 hardened carbon steel.
3. Finish: Plain

E. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

F. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 PRIMER

A. Primer: SSPC-Paint 25, Type I, iron oxide, zinc oxide, raw linseed oil, and alkyd.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.

1. Camber structural-steel members where indicated.
2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
3. Mark and match-mark materials for field assembly.
4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

C. Bolt Holes: Cut, drill, punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning.

F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances

   a. Grind butt welds flush.
   b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials.
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Apply a 1-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.8 SOURCE QUALITY CONTROL

A. Correct deficiencies in Work that inspections indicate does not comply with the Contract Documents.

B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges."

B. Base and Bearing Plates: Clean concrete and masonry-bearing surfaces of bond reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

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1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of base plate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.

a. Grind butt welds flush.

b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

A. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

B. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

C. Correct deficiencies in Work that inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION 05120

SECTION 05500 - MISCELLANEOUS METAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Specified

1. All miscellaneous metal items not specifically described in other sections of these specifications or shown on the drawings but required for a complete and operable facility.

1.2 SUBMITTALS

A. Shop Drawings

1. After the contract has been awarded and before any miscellaneous metal is delivered to the job site, shop drawings showing all locations, markings, quantities, materials, sizes and shapes including all methods of connection, anchoring, fastening, bracing, and attachment to the work of other trades shall be submitted to the Engineer for review.

1.3 FIELD MEASUREMENTS

A. All measurements shall be verified in the field for all work fabricated to fit field conditions. Adjoining work shall be examined before work is started. Necessary corrective work shall be done to adjoining work to insure a proper fit.

1.4 QUALITY ASSURANCE

A. Installer's Qualifications

1. Mechanics engaged in the work of this section shall be regularly involved with the installation of materials specified herein.

B. Use only certified welders.

C. Codes and Standards

1. American Institute of Steel Construction (AISC)
2. American Welding Society (AWS)
3. American Society of Testing Materials (ASTM)

D. Compliance with Industry Standards

1.5 PRODUCT HANDLING

A. Protection

1. Use all means necessary to protect miscellaneous metal before, during and after installation and to protect installed work and materials from other trades.

B. Cleaning

1. All aluminum shall be thoroughly cleaned with plain water, a petroleum product such as white gasoline or kerosene, or an approved commercial cleaner.
2. No abrasive cleaning agent may be used.
3. Any work that has been damaged, discolored, defaced or does not comply with these specifications will not be accepted by the Engineer.

C. Replacement

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the Owner.

PART 2 - MATERIALS

2.1 MATERIALS

A. All materials and products shall meet the latest edition of the following standards:

1. Structural Steel: ASTM A-36
2. Miscellaneous Steel: Mild Steel
3. Bolts and Nuts: ASTM A-307
4. High Strength Bolts: ASTM A-325
5. Stainless Steel Bolts: ASTM A-193
6. Pipe Steel: ASTM A-53, Grade A Sch. 40 unless otherwise shown or specified.
7. Aluminum Structural Shapes: ASTM-B-308, Alloy 6061-T6
8. Aluminum Extrusions: ASTM-B-221, Alloy 6063-T6
9. Aluminum Plates and Sheets: ASTM-B-209, Alloy 6061-T6
10. Welding Rods: AWS Specifications for Arc Welding
11. Stainless Steel Bar & Shapes: ASTM A-276, Type 304, Condition A
12. Stainless Steel Plate, Sheet and Shape: ASTM A-167, Type 304
13. Stainless Steel Tubing: ASTM A-554, Type 304.

B. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-3.

1. Size of Channels: 1-5/8 by 1-5/8 inches.
2. Material: Galvanized steel complying with ASTM A 653/A 653M, structural steel, Grade 33, with G90 (Z275) coating; 0.108-inch nominal thickness.

2.2 FRAMES OF STRUCTURAL SHAPES

A. Provide frames of aluminum structural shapes for floor, wall, and stair opening where shown on drawings.

B. All corners shall be mitered, welded and ground smooth.

C. Frames embedded in concrete slabs shall be provided with 1/2" x 1" x 8" strap anchors at 18" on center.

D. Frames fastened to concrete or masonry walls shall be provided with 1/2" x 2" x 2'0" strap anchors. Ends shall be turned up 2 inches and welded to the jamb at 2'0" on center on block coursing, unless shown otherwise on the drawings.

E. Temporary spreaders shall be provided at the sill, and left in place until frames are set and anchored.

F. Angle frames shall be cut where required for stop plates or plank grooves.

2.3 FASTENERS

A. Anchor Bolts:

1. Anchor bolts for miscellaneous framing and architectural elements attachments shall conform to ASTM A36 or ASTM A307 Grade A except where stainless steel or other approved anchor bolts are shown on the Contract Drawings. Anchor bolts shall be of the size and configuration shown on the Contract Drawings and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.
2. Anchor bolts for equipment attachment shall be of stainless steel Type 316 with nitronic 60 stainless steel nuts and locknuts.
3. All underwater anchor bolts shall be Type 316 stainless steel with nitronic 60 stainless steel nuts.
4. Where anchor bolts are used to anchor galvanized steel or are otherwise specified to be galvanized, they shall be hot-dip galvanized in accordance with ASTM A307.
5. Pipe sleeves around anchor bolts shall be of the size and configuration shown on the Contract Drawings.

B. Bolts:

1. Bolts, nuts and washers for miscellaneous framing and for attachment of architectural elements shall conform to ASTM A325, Type 1, nuts shall conform to ASTM A563, galvanizing shall be by the hot-dip process.

    a. Nuts shall meet the requirements of either ASTM A563 for Grade DH, or ASTM A194 for Grade 2H.
    b. Flat circular washers and square or rectangular beveled washers shall conform to the requirements of ASTM F436.
    c. Bolt dimensions shall conform to the requirements for regular semi-finished hexagon bolts, ANSI B18.2.1, unless otherwise specified.
    d. Nut dimensions shall conform to requirements for heavy hexagon semi-finished nuts ANSI/ASME B18.2.2. Washers shall be flat and smooth and their dimensions shall conform with the requirements for heavy plain washers, ANSI B18.22.1.

2. Where bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized.

C. Stainless Steel Bolts:

1. Stainless steel bolts shall conform to ASTM F593. All underwater fasteners shall be Type 316 stainless steel. Unless otherwise specified, fasteners for aluminum members shall be Type 304 stainless steel. Fasteners for stainless steel members shall be of matching grade.
2. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts and shall have a raised letter or symbol indicating the manufacturer.

D. Concrete Anchors: Concrete anchors shall be one of the types listed below or as indicated on the Contract Drawings. Unless otherwise noted, all concrete anchors which are submerged, or which are subject to vibration from equipment such as pumps and generators, shall be injected, adhesive anchors. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by a commercial testing laboratory. There are two categories used:

1. Concrete anchors shall be of Stainless Steel Type 304 unless noted otherwise. Concrete anchors for stainless steel attachments shall be of matching grade.
2. Expansion anchors shall be wedge, sleeve, or drop-in mechanical anchors.

    a. Expansion anchors shall be Kwik Bolt II by Hilti or Trubolt Wedge Anchor by ITW Ramset/Redhead or Power-Stud by Powers/Rawl and shall be embedded to the depths shown on the Contract Drawings. If no embedment depth is given, the standard embedment depth as recommended by the manufacturer shall be used.
    b. Sleeve or drop-in anchors shall be as manufactured by Hilti, ITW Ramset/Red Head or Powers/Rawl.

3. Adhesive anchors shall be two-part injection type.

    a. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt (see Table 1) unless noted otherwise on the Contract Drawings. The adhesive system shall be "Epcon System Ceramic 6" as manufactured by ITW Ramset/Redhead, "HIT HY-150 Injection Adhesive Anchor System" as manufactured by Hilti or Powerfast by Powers/Rawl.

4. Where anchor pipe is not indicated on the Contract Drawings, the wedge expansion anchor shall be used.
5. All underwater concrete anchors shall be Type 316 stainless steel and shall have nitronic 60 stainless steel nuts.

6. Minimum Allowable Tensile Capacity (Kips) for Standard Manufacturer Embedment:

Minimum Allowable Tensile Capacity (Kips) for Standard Manufacturer Embedment		
Size	Concrete Anchors Wedge Type	Concrete Anchors with Injection Adhesive System
3/8"	1.3	2.1
1/2"	2.4	3.8
5/8"	3.3	5.9
3/4"	4.8	8.4
7/8"	5.6	11.0
1"	7.1	15.0

2.4 CHAIN

A. Stainless steel welded link type, 13 links per foot, 3/16-inch wire, with post loop at one end, chain snap and post loop at opposite end.

2.5 ALUMINUM GRATING

A. Aluminum grating shall be rectangular bar (thickness as indicated on drawings) with 3/16 bearing bars, and shall be Type 6063 aluminum. Grating pattern shall be provided with 4” x 1 ½” openings.

B. Integral arrow type full length anchors or strap anchor at 1 foot o.c. shall be provided for all grating.

C. Grating in contact with dissimilar metals shall be back painted.

D. Grating shall be installed with the stainless steel anchorage system in accordance with the manufacturer's recommendations.

E. All grating shall be set flush with the top of concrete surface.

2.6 OTHER MATERIALS

A. All materials not specifically described, but required for a complete and proper installation of miscellaneous metal, shall be new, free from rust, best of quality of the respective kinds, and subject to the approval of the Engineer.

2.7 SURFACE CONDITIONS

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of other trades and verify that all work is complete to the point where fabrication and installation of work covered under this section may commence.
2. Make all required field measurements to insure proper and adequate fit of all miscellaneous metal.

B. Discrepancies

1. In the event of discrepancies, immediately notify the Engineer.
2. Do not proceed with fabrication and installation until areas of discrepancies have been fully resolved.

2.8 FABRICATION

A. All metal work shall have smooth finish surfaces, welded joints shall be continuous, unless otherwise noted. The face of welds shall be dressed flush and smooth.

B. Where possible, welding will occur on the unexposed side. Exposed joints shall be made where least conspicuous.

C. Connection and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected.

D. Connections to aluminum shall be aluminum or stainless steel unless otherwise noted. All bolts used for aluminum shall be stainless steel.

E. Connections to cast iron and steel shall be steel unless otherwise noted.

F. Fastenings shall be concealed where practicable. All exterior connections and accessories shall be stainless steel unless otherwise noted.

G. Joints exposed to weather shall be formed to exclude water.

H. All supporting members, and other items required to connect the work rigidly and properly to structural materials shall be provided.

I. All aluminum shall be true to detail, clean, straight, and have smooth surfaces of uniform color and texture.

J. Fabricate all miscellaneous metal in strict accordance with approved shop drawing and reference standards. All work shall be free from defects impairing strength or durability.

2.9 SHOP FINISHES

A. All ferrous metals shall be clean and given one shop coat of primer compatible with the finish paint.

B. Anchors built into masonry shall be given a coating of asphalt paint unless specified as galvanized or stainless steel.

C. Metal work to be encased in concrete shall be left unpainted unless noted otherwise.

D. Metals specified as hot dip galvanized or zinc coated shall not be shop primed.

E. Unpainted castings shall be clean and coated with cold tar pitch varnish, shop paint at piece marks shall not be omitted.

F. Aluminum in contact with masonry, concrete or dissimilar metals shall be backpainted with bituminous paint before installation.

G. Exposed aluminum surfaces shall be free from die mark, scratches, welding discolorations and other surface blemishes. Aluminum surfaces shall receive an anodic oxide treatment in accordance with AA-MO-C22-A41 Aluminum Association Standard Finishes, unless otherwise specified.

H. A coating of methacrylate lacquer shall be applied to aluminum before factory shipment.

PART 3 - EXECUTION

3.1 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

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

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.2 FIELD PAINTING

A. Field abrasion, welds and other places where shop coating has been removed shall be field painted with the same paint that was used for the shop coat.

END OF SECTION 05500

SECTION 05511 - METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Industrial-type stairs with steel grating treads.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft..
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 1/4 inch, whichever is less.

B. Seismic Performance: Provide metal stairs capable of withstanding the effects of earthquake motions determined according to “The New York State Building Code”**.**

1.4 SUBMITTALS

A. Product Data: For metal stairs and the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.

2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: For products involving selection of color, texture, or design.

D. Welding certificates.

E. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Industrial-Type Stairs: Industrial class.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 METALS, GENERAL

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

2.3 FERROUS METALS

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

B. Steel Tubing: ASTM A 500 (cold formed).

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

D. Steel Bars for Grating Treads: ASTM A 36/A 36M.

E. Wire Rod for Grating Crossbars: ASTM A 510.

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts.

D. Machine Screws: ASME B18.6.3.

E. Lag Bolts: ASME B18.2.1.

F. Plain Washers: Round, ASME B18.22.1.

G. Lock Washers: Helical, spring type, ASME B18.21.1.

2.5 MISCELLANEOUS MATERIALS

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

B. Shop Primers: Provide primers that comply with Division 9 painting Sections.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.

1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Available Products:

a. Carboline Company; Carbozinc 621.
b. ICI Devoe Coatings; Catha-Coat 313.
c. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.
d. Moore, Benjamin, & Co.; Epoxy Zinc-Rich Primer CM18/19.
e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
g. Tnemec Company, Inc.; Tneme-Zinc 90-97.

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

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

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

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

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

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

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

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

G. Fabricate joints in a manner to exclude water. Provide weep holes where water may accumulate.

2.7 STEEL-FRAMED STAIRS

A. Available Manufacturers:

1. Alfab, Inc.
2. American Stair, Inc.
3. Sharon Companies Ltd. (The).

B. Stair Framing:

1. Fabricate stringers of steel channels.

   a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel channel headers and miscellaneous framing members as needed to comply with performance requirements].

3. Weld stringers to headers; weld framing members to stringers and headers.
4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded steel grating based upon size required by loading.
2. Surface: Serrated.
3. Finish: Shop primed.
4. Fabricate grating treads with rolled-steel floor plate nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
5. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.8 FINISHES

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

B. Finish metal stairs after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:

1. Exterior Stairs (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interior Stairs (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

E. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

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

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

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING STEEL TUBE RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

1. Anchor posts to steel by welding directly to steel supporting members.
2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:

1. Use type of bracket with predrilled hole for exposed bolt anchorage.
2. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
3. For hollow masonry anchorage, use toggle bolts.
4. For wood stud partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with carpentry work to locate backing members.
5. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.

3.4 ADJUSTING AND CLEANING

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

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

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 painting Sections.

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

END OF SECTION 05511

SECTION 05521 –PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Type 1 Aluminum pipe and tube railings.

1.3 UNIT PRICES

A. Unit prices for Pipe and Tube Railing Replacement are included in Division 1 Section "Unit Prices."

B. Pipe and Tube Railing Replacement Measurement: Linear Feet of railing including toe boards, measured in place. Unit measurement shall include price of demolition of existing concrete railings and patching.

1.4 PERFORMANCE REQUIREMENTS

A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.

B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied horizontally and concurrently with 100 lbf/ ft. applied vertically downward.
b. Concentrated load of 200 lbf applied in any direction.

c. Uniform and concentrated loads need not be assumed to act concurrently.

3. Infill of Guards:

a. Concentrated load of 200 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

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

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of railing through one source from a single manufacturer.

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

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

1.7 COORDINATION AND SCHEDULING

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

B. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 TYPE 1 ALUMINUM PIPE AND TUBE RAILINGS

A. MANUFACTURERS
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Aluminum Pipe and Tube Railings:
1) AlumaGuard Corp.
2) ATR Technologies, Inc.
3) Blum, Julius & Co., Inc.
4) Braun, J. G., Company; a division of the Wagner Companies.
5) CraneVeyor Corp.
6) Hollaender Manufacturing Company.
7) Moultrie Manufacturing Company.
8) Pisor Industries, Inc.
9) Sterling Dula Architectural Products, Inc.
10) Superior Aluminum Products, Inc.
11) Thompson Fabricating, LLC.
12) Tubular Specialties Manufacturing, Inc.
13) Tuttle Aluminum & Bronze.
14) Wagner, R & B, Inc.; a division of the Wagner Companies.

B. METALS, GENERAL
1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
2. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

C. ALUMINUM
1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
2. Extruded Bars and Tubing: ASTM B 221, Alloy 6063-T5/T52.
3. Extruded Structural Pipe and Round Tubing: ASTM B 429, Alloy 6063-T6.
a. Provide Standard Weight (Schedule 40) pipe, unless otherwise indicated.
4. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.

D. FASTENERS
1. General: Provide the following:
a. Aluminum Railings: Type 316 stainless-steel fasteners..
2. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
3. Fasteners for Interconnecting Railing Components:
a. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

E. MISCELLANEOUS MATERIALS

1. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
   a. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
2. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
3. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
   a. Water-Resistant Product: Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

F. FABRICATION

1. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage**,** but not less than that required to support structural loads.
2. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
3. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
4. Form work true to line and level with accurate angles and surfaces.
5. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
6. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
7. Connections: Fabricate railings with either welded or nonwelded connections, unless otherwise indicated.
8. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   b. Obtain fusion without undercut or overlap.
   c. Remove flux immediately.
   d. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
9. Form changes in direction as follows:
   a. By bending or by inserting prefabricated elbow fittings.
10. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
11. Close exposed ends of railing members with prefabricated end fittings.

12. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
13. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.
14. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
15. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.
16. Toe Boards: Provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

G. FINISHES, GENERAL
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

H. ALUMINUM FINISHES
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to 1 side, and locate joint within 6 inches (150 mm) of post.

3.3 ADJUSTING AND CLEANING

A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.4 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 05521

SECTION 05530 – METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Metal frames and supports for gratings.

1.3 UNIT PRICES

A. Unit prices for Metal Gratings Replacement are included in Division 1 Section "Unit Prices."

1. Areas that receive new metal gratings are included in the Base Bid.

B. Metal Gratings Replacement Measurement: Square Feet area of replacement grating, measured in place. Unit measurement shall include price of grating frames and supports and price of demolition of existing grating.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design gratings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
1. Uniform load of 288 lb/sf with 0.6 inch maximum deflection.
2. Uniform load of 100 lb/sf with 0.25 inch maximum deflection.
3. Concentrated load of 720 lb per foot of grating width at mid-span with 0.48 inch maximum deflection.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Meatal bar grating.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified NYS professional engineer responsible for their preparation.

D. Qualification Data: For qualified professional engineer.

E. Welding certificates.

1.6 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

B. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 PROJECT CONDITIONS

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

1.8 COORDINATION

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 ALUMINUM

A. Aluminum, General: Provide alloy and temper recommended by aluminum producer for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

B. Extruded Bars and Shapes: ASTM B 221, alloys as follows:

   1. 6061-T6, for bearing bars of gratings and shapes.
   2. 6063-T6, for grating crossbars.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 2 .

C. Plain Washers: Round, ASME B18.22.1.

D. Lock Washers: Helical, spring type, ASME B18.21.1.

E. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.3 MISCELLANEOUS MATERIALS

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

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

2.4 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

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

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

2.5 METAL BAR GRATINGS

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

B. Pressure-Locked, Rectangular Bar Aluminum Grating: Fabricated by pressing rectangular flush-top crossbars into slotted bearing bars.

   1. Bearing Bar Spacing: 15/16 inch o.c.
   2. Bearing Bar Depth: 1-1/2 inches.
   3. Bearing Bar Thickness: 3/16 inch.
   4. Crossbar Spacing: 4 inches o.c.
   5. Traffic Surface: Plain.
   6. Aluminum Finish: Mill finish.

C. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or as recommended by manufacturer for attaching to supports.
   1. Provide no fewer than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch or less in thickness and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.
   2. Furnish self-drilling fasteners with washers for securing grating to supports.

D. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

   1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

E. Do not notch bearing bars at supports to maintain elevation.

2.6 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

   1. Unless otherwise indicated, fabricate from same basic metal as gratings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

END OF SECTION 05530

SECTION 06176 - METAL-PLATE-CONNECTED WOOD TRUSSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes wood roof trusses and truss accessories.

1.3 DEFINITIONS

A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

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

1. NELMA - Northeastern Lumber Manufacturers Association.
2. NLGA - National Lumber Grades Authority.
3. SPIB - Southern Pine Inspection Bureau.
4. WCLIB - West Coast Lumber Inspection Bureau.
5. WWPA - Western Wood Products Association.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: Per New York State Building code.
2. Maximum Deflection Under Design Loads:

a. Roof Trusses: Vertical deflection of 1/360 of span.

1.5 SUBMITTALS

A. Product Data: For metal-plate connectors, metal framing anchors, bolts, and fasteners.

1. 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.

2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Shop Drawings: Show location, pitch, span, camber, configuration, and spacing for each type of truss required; species, sizes, and stress grades of lumber; splice details; type, size, material, finish, design values, orientation, and location of metal connector plates; and bearing details.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Preservative-treated wood.
2. Metal-plate connectors.
3. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with TPI quality-control procedures for manufacture of connector plates published in TPI 1.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that involves inspection by SPIB, Timber Products Inspection, TPI, or other independent testing and inspecting agency acceptable to Engineer and authorities having jurisdiction.

C. Source Limitations for Connector Plates: Obtain metal connector plates through one source from a single manufacturer.

D. Comply with applicable requirements and recommendations of the following publications:

1. TP1 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
2. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
3. TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."

E. Wood Structural Design Standard: Comply with applicable requirements in AFPA's "National Design Specifications for Wood Construction" and its "Supplement."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with TPI recommendations to avoid damage and lateral bending. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.8 COORDINATION

A. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

B. Grade and Species: Provide dimension lumber of any species for truss chord and web members, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AFPA's "National Design Specifications for Wood Construction" and its "Supplement."

2.3 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

1. Preservative Chemicals: Per one of the following:

a. Chromated copper arsenate (CCA).
b. Ammoniacal copper zinc arsenate (ACZA).
c. Ammoniacal, or amine, copper quat (ACQ).

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

C. Mark each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

D. Application: Treat all wood, unless otherwise indicated.

2.4 METAL CONNECTOR PLATES

A. General: Fabricate connector plates to comply with TPI 1 from metal complying with requirements indicated below:

B. Hot-Dip Galvanized Steel Sheet: ASTM A 653/A 653M, G60 (Z180) coating designation; Designation SS, Grade 33, and not less than 0.036 inch (0.9 mm) thick.

2.5 FASTENERS

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

1. Where trusses are exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Wire, Brads, and Staples: FS FF-N-105.

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

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1.

F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

G. 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: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.6 METAL FRAMING ANCHORS

A. General: Provide framing anchors made from metal indicated, of structural capacity, type, and size indicated, and as follows:

1. Research/Evaluation Reports: Provide products acceptable to authorities having jurisdiction and for which model code research/evaluation reports exist that show

compliance of metal framing anchors, for application indicated, with building code in effect for Project.

2. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.

C. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall studs below, 2-1/4 inches wide by 0.062 inch thick. Tie fits over top of truss and fastens to both sides of truss, face of top plates, and side of stud below.

D. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches wide by 0.050 inch thick. Clip is fastened to truss through slotted holes to allow for truss deflection.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

2.8 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. Before installing, splice trusses delivered to Project site in more than one piece.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses as indicated; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.

H. 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.

I. Install wood trusses within installation tolerances in TPI 1.

J. Do not cut or remove truss members.

K. Replace wood trusses that are damaged or do not meet requirements.

1. Do not alter trusses in field.

3.2 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

END OF SECTION 06176

SECTION 06253 - FIBERGLASS REINFORCED PRODUCTS

PART 1 - GENERAL

1.1 WORK SPECIFIED

A. Furnish and install, complete with accessories, all new weir plates, troughs and appurtenant items as shown on the Contract Drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Division 3 - Concrete

B. Division 5 - Metals

1.3 SUBMITTALS

A. Shop Drawings: Submit the following for approval:

1. Manufacturer's literature, illustrations, specifications and Engineering data including: materials of construction, dimensions, weight and performance data.
2. Drawings showing the general arrangement of the equipment and methods of installation with detailed mounting information. Indicate provisions for thermal expansion and contraction, and the capability to sustain all external and internal loads that may be applied during construction and operation.

B. Calculations: Submit, for record purposes only, design calculations for the following:

1. Maximum deflection of weirs and troughs.
2. Maximum stress developed in weirs and troughs.
3. Contraction and expansion of weirs and troughs.

C. Samples: Submit the following for approval:

1. Samples of each item furnished approximately 4-inches by 6-inches.

D. Affidavit of Compliance: Submit Affidavit of Compliance in accordance with Section 1.5 of AWWA F102.

E. Documentation: Submit evidence that manufacturer has fabricated, supplied, installed and placed into satisfactory service materials equipment substantially similar to that specified herein. Criteria shall be a minimum of five installations in satisfactory service for not less than five years.

1.4 FIELD MEASUREMENTS

A. The Contractor and/or the manufacturer shall obtain or verify all field measurements necessary to perform the work required under this Specification Section.

1.5 REFERENCES

A. AWWA F102, Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles and Mounting Brackets.

B. Standards of the Reinforced Plastics/Composites Institute.

C. National Bureau of Standards, PS 15 □69.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. The manufacturers of the weir plates shall have experience in the design, fabrication, and operation of the equipment specified. The manufacturers shall have equipment of the type and size required by this project operating successfully in at least five (5) separate installations, each for a period of at least five (5) years. Each manufacturer shall have a proven Quality Control Program and complete manufacturing and testing facilities. Unnamed manufacturers shall submit documents demonstrating compliance with the design, and the qualifications and experiences required above.

1.7 PRODUCT HANDLING

A. Contractor shall deliver, store, handle and protect all materials and equipment.

B. Handle all weirs, troughs and appurtenances to prevent damage and distortion to the equipment. Equipment which is cracked, chipped, distorted or otherwise damaged or dropped will not be acceptable.

C. Store all weirs, troughs and appurtenances in approved enclosed shelter and off the ground in accordance with the manufacturer's recommendations, unless otherwise directed by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Construct all items of fiberglass-reinforced polyester resin laminates and to the dimensions and shapes shown.

B. All items shall comply with the service conditions specified in Contract Documents.

2.2 LOADING CRITERIA:

A. Weirs and troughs shall be capable of supporting, within stress and deflection limitations, the following:

1. Deflection: Maximum wall horizontal deflection under full lateral load shall not exceed 3/16-inch or L/100, whichever is less, where L is the weir length, in inches.

B. Thermal Expansion/Contraction: Design all items to accommodate a thermally-induced expansion or contraction in length over a temperature range of 0°F to 100°F. Items shall be capable of withstanding ambient temperature variations of up to 80F that could occur within a 24-hour period without exceeding specified deflection or stress limitations.

C. Glass Fiber Stress: In addition to the deflection criteria specified above, construct all items such that the maximum wall stress under the most severe loading condition does not exceed 1,500 psi.

2.3 DETAILS OF CONSTRUCTION

A. Classification:

1. Weir plates, troughs, baffles and closure plates shall be Type I fabricated as defined in Section 1.7 of AWWA F102.

B. Materials of Construction:

1. Reinforcing Materials:

a. Weir Plates, troughs closure plates and baffles:

1) Fibrous Glass: Materials used shall be continuous filament Type E reinforcing materials shall have chrome or silane finish and a styrene soluble binder compatible with the resin. Surfacing veil, if used, shall be 0.020 inch thick Type C (chemical) or equivalent, with silane finish and a styrene soluble binder on both sides and compatible with the lay-up resin.
2) Synthetic Fibers: Use synthetic surfacing mat for chemical environment when Type C veil is not compatible with the intended chemical environment.
3) Metallic: Metal reinforcements shall be free of rust, oil and foreign matter. Completely encapsulate reinforcement with 1/8-inch laminate to ensure against pinhole bleeding and subsequent rust streaking. Galvanizing or rust inhibitive priming does not preclude requirement for encapsulation.
4) Composites: Use liquid-resistant materials such as end-grain balsa wood or closed-cell polyurethane foam for core materials. Standard wood products are not acceptable.

2. Additives: Use thixotropic agents, mold release agents, promoters catalysts and low-shrink thermoplastic agents required for molding compounds used in the matched-die molding. Manufacturer shall submit additive schedule for approval.
3. Plastic Resin:

a. Resin shall be a commercial-grade polyester thermosetting resin, which has either been evaluated in a laminate or which has been determined to be acceptable for the service conditions intended.

b. Resin shall contain no fillers or additives except as follows:

1) A thixotropic agent, up to 5 percent by weight, which does not interfere with laminate quality or with the required chemical resistance of the laminate, may be added for viscosity control.

2) Pigments, dyes or colorants used shall be suitable for contact with potable water. Pigments shall be light stable, not soluble in water and compatible with the resin. Color shall be translucent blue-green.

3) Ultraviolet Stabilization: Provide 0.25 percent by weight ultraviolet stabilizers in all laminates. The laminate shall exhibit not greater than 2 percent deterioration of flexural and tensile properties after 1000 hours of exposure in a Type E, single open-flame, sunshine carbon-arc lamp apparatus as detailed in ASTM G 23.

C. Laminate Construction for Weir Plates, Troughs, Baffles and Closure Plates:

1. General: Produce fiberglass-reinforced plastic fabrications by the matched-die molding process to ensure smooth resin-rich surfaces and edges, dimensional accuracy and consistency. Mold weir plate notches within dies for increased corrosion and weather resistance. Sand and seal all cut edges with non air inhibited resin to ensure edges are completely sealed and to prevent water or chemical penetration of laminate. Minimum thickness of weir plates shall be 1/4 inch. Minimum thickness of troughs shall be. The laminate shall consist of exterior layer and an interior layer.

2. Exterior Layer: The exterior surface shall be free of cracks and crazing with a smooth finish. This surface shall consist of 0.01 to 0.02 inch of resin-rich layer reinforced with chopped strand glass. Other methods of surface protection shall be submitted to the Engineer for approval.

3. Interior Layer: The interior layer shall be constructed to provide the necessary physical properties. Where separate layers such as mat, cloth or woven roving are used, all layers shall be lapped a minimum of one inch. Laps shall be staggered. If woven roving or cloth is used, a layer of chopped strand glass shall be placed as alternate layers. A minimum of 0.1 inch of the laminate next to the exterior surface shall be reinforced with non-continuous glass strands having fiber lengths from 0.5 to 2.0 inches.

4. Laminate glass to resin ratio shall be 30 percent glass and 70 percent resin.

5. Cut Edges: All cut or machined edges shall be coated with resin with all voids filled and no glass fibers exposed.

6. Dimensions:

a. V-Notch Weir Plates: Spacing and depth of 90-degree V-notches shall be shown. Dimensional tolerance shall be as specified in Section 3.1.2 of AWWA F102.

b. Rectangular Notch Weir Plates: Spacing and depth of rectangular notches shall be as shown. Dimensional tolerance shall be as specified in Section 3.1.3 of AWWA F102.

c. Flat Crested Weir Edge; Weir plates shall be straight and vary not more than ±1/32 inch in 12 feet. Draft angle across 0.25-inch thick dimension shall not exceed 7 degrees.

d. All weir plates shall be standard length not to exceed 12 feet, except for closure sections.

e. Weir Plate Anchor Bolt Holes - Holes for wall mounting may be round or square not less than 2-1/2 inches. Variation in center-to-center dimensions between holes shall not exceed ±1/8 inch.

f. Weir Plate Slots: Make slots for mounting to troughs 1/16 inch wider than bolts and provide for minimum adjustment of ±1/2 inch, after allowance for diameter of attachment bolt.

g. Troughs shall be furnished in sizes and quantities shown on Contract Drawings.

7. Finish and Appearance:

a. The flat surfaces and edges of all weir plates, baffles, mounting brackets, closure plates and gates shall be free from porosity, voids and dry glass. Make surfaces and edges resin-rich to provide maximum resistance to corrosion and weathering.

b. Fabrications containing porosity, voids, dry glass, delamination or defects not allowed in Table 1 of AWWA F102 may be rejected. Repair of defects to meet maximum allowable level of deviation specified in Table 1 of AWWA F102 will be permitted provided repair work is performed in a neat manner, is blended smooth and does not affect the serviceability of the fabrication. All such remedial work shall be subject to approval of Engineer.

8. Minimum Physical Requirements: All laminates shall meet the minimum physical properties listed below:

Property	Test Method	Value of Property
Tensile Strength	ASTM D638	15 x 103 psi
Flexural Strength	ASTM D790	25 x 103 psi
Flexural Modulus	ASTM D790	0.8 x 106 psi
Barcol Hardness	ASTM D2583	40
Izod Notched Impact Strength	ASTM D256	13 ft-lb/inch
Water absorption (24 hr @23°C)	ASTM D570	0.1% max.

2.4 IDENTIFICATION

A. Provide each product furnished under this Specification with product identification as described in Section 6.1.1 of AWWA F102.

2.5 ACCESSORIES

A. Provide all mounting brackets, anchor bolts, supports, stabilizing bars, angles or rods, fasteners and similar accessories required for installation of the equipment furnished. All metal accessories shall be Type 316 stainless steel.

B. Secure ends of weir plates with butt plates.

C. Countersink Holes: Countersink mounting holes in scum baffles so that flat heads bolts will be flush or below surface.

2.6 MANUFACTURER

A. NEFCO

B. Warminster Fiberglass Company.

C. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall install all Work in complete accordance with the manufacturer's instructions and recommendations, and the approved Shop Drawings.

B. Contractor shall not install damaged items until repairs are made in accordance with manufacturer's written instructions and approval by Engineer. Only minor repair work will be permitted in the field. All damaged items requiring remedial work shall be returned to the manufacturer for repair or replacement.

3.2 INSTALLATION OF WEIR PLATES, BAFFLES AND CLOSURE PLATES

A. Install all work in conformance with the approved Shop Drawings.

B. Install at locations and elevations shown, unless otherwise approved by the Engineer.

C. Weir plates shall be set within plus or minus 0.005 ft of the elevation indicated on the Contract Drawings.

D. Set all weir plates level within ±1/16-inch over the entire weir length.

3.3 START-UP AND TESTING

A. Contractor shall verify that all work furnished and installed conforms to the requirements the Contract Documents.

B. Contractor shall make all adjustments required to place all Work in proper operating condition.

END OF SECTION 06253

SECTION 07531 - EPDM MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Adhered membrane roofing system.
2. Roof insulation.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," before multiplication by a safety factor.

C. Factored Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," after multiplication by a safety factor.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist I-90 uplift pressure calculated according to ASCE 7.

1.5 SUBMITTALS

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

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Insulation fastening patterns.

C. Samples for Verification: For the following products:

1. 12-by-12-inch square of sheet roofing, of color specified, including T-shaped side and end lap seam.
2. 12-by-12-inch square of roof insulation.
3. 12-by-12-inch square of walkway pads or rolls.
4. 12-inch length of metal termination bars.
5. 12-inch length of battens.
6. Six insulation fasteners of each type, length, and finish.
7. Six roof cover fasteners of each type, length, and finish.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of meeting performance requirements.

F. Qualification Data: For Installer and manufacturer.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.

H. Research/Evaluation Reports: For components of membrane roofing system.

I. Maintenance Data: For roofing system to include in maintenance manuals.

J. Warranties: Special warranties specified in this Section.

K. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

B. Manufacturer Qualifications: A qualified manufacturer that has FMG approval for membrane roofing system identical to that used for this Project.

C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain components for membrane roofing system from same manufacturer as roofing membrane.

E. Preinstallation Conference: Conduct conference at Project site. Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with Owner; Engineer; Owner's insurer if applicable; testing and inspecting agency representative; roofing Installer; roofing system manufacturer's representative; deck Installer; and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Special warranty includes roofing membrane, base flashings, roofing accessories, roof insulation, fasteners, walkway products and other components of membrane roofing system.
2. Warranty Period: 15 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 EPDM ROOFING MEMBRANE

A. EPDM Roofing Membrane: ASTM D 4637, Type I, nonreinforced uniform, flexible sheet made from EPDM, and as follows:

1. Manufacturers:

a. Carlisle SynTec Incorporated.
b. Celotex Corporation.
c. ERSystems.
d. Firestone Building Products Company.
e. GenFlex Roofing Systems.
f. International Diamond Systems.
g. Johns Manville International, Inc.
h. Mule-Hide Products Co., Inc.
i. Protective Coatings, Inc.
j. Roofing Products International, Inc.
k. Stafast Roofing Products.
l. Versico Inc.

2. Thickness: 90 mils , nominal.
3. Exposed Face Color: Black.

2.3 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.

C. Bonding Adhesive: Manufacturer's standard bonding adhesive.

D. Cold Fluid-Applied Membrane Adhesive: Manufacturer's standard cold fluid-applied bonding adhesive formulated to adhere fleece-backed roofing membrane to substrate.

E. Seaming Material: Manufacturer's standard synthetic-rubber polymer primer and 3-inch- wide minimum, butyl splice tape with release film.

F. Lap Sealant: Manufacturer's standard single-component sealant, color to match roofing membrane.

G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

H. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

I. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

K. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.4 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers:

a. AlliedSignal Inc.; Commercial Roofing Systems.
b. Apache Products Company.
c. Atlas Roofing Corporation.
d. Carlisle SynTec Incorporated.
e. Celotex Corporation.
f. Firestone Building Products Company.
g. GAF Materials Corp.
h. GenFlex Roofing Systems.
i. Hunter Panels, LLC.
j. Johns Manville International, Inc.
k. Koppers Industries.
l. RMAX.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches, unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.5 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

2.6 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

3.4 ADHERED ROOFING MEMBRANE INSTALLATION

A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.

B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

E. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

F. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.

1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.

G. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.

H. Repair tears, voids, and lapped seams in roofing that does not meet requirements.

I. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

J. Install roofing membrane and auxiliary materials to tie in to existing roofing.

3.5 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.6 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency of Owners choosing to perform roof tests and inspections and to prepare test reports.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Engineer.

1. Notify Engineer or Owner 48 hours in advance of date and time of inspection.

C. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Engineer and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition

free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.9 ROOFING INSTALLER'S WARRANTY

A. WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

B. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

C. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding I-90 wind speed ;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

D. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.

1. Authorized Signature: <Insert signature.>
2. Name: <Insert name.>
3. Title: <Insert title.>

END OF SECTION 07531

SECTION 07591 - MEMBRANE REROOFING PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Roof tear-off.
2. Partial roof tear-off.
3. Temporary roofing membrane.
4. Roof re-cover preparation.
5. Removal of base flashings.
6. Protection of existing roofing system that is not reroofed.

B. Related Sections include the following:

1. Division 1 Section "Summary" for use of the premises and phasing requirements.
2. Division 1 Section "Construction Progress Documentation" for photographs taken before reroofing preparation.
3. Division 1 Section "Photographic Documentation" for photographs taken before reroofing preparation.
4. Division 1 Section "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.
5. Division 1 Section "Cutting and Patching" for cutting and patching procedures for reroofing preparation.
6. Division 7 Section "EPDM Membrane Roofing System" for roofing membrane, base flashings, roof insulation, and roofing accessories.
7. Division 7 Section "Manufactured Roof Specialties."

1.3 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.4 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Roof Re-Cover Preparation: Existing roofing membrane that is to remain and be prepared for reuse.

C. Roof Tear-Off: Removal of existing membrane roofing system from deck.

D. Partial Roof Tear-Off: Removal of a portion of existing membrane roofing system from deck or removal of selected components and accessories from existing membrane roofing system.

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

F. Existing to Remain: Existing items of construction that are not indicated to be removed.

1.5 SUBMITTALS

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

B. Temporary Roofing: Include Product Data and description of temporary roofing system. If temporary roof will remain in place, submit surface preparation requirements needed to receive permanent roof, and submit a letter from roofing membrane manufacturer stating acceptance of the temporary membrane, and that its inclusion will not adversely affect the roofing system's resistance to fire and wind or its FMG rating.

C. Fastener pull-out test report.

D. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

E. Landfill Records: Indicate receipt and acceptance of hazardous wastes, such as asbestos-containing material, by a landfill facility licensed to accept hazardous wastes.

F. Qualification Data: For Installer including certificate that Installer is approved by warrantor of existing roofing system.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Installer of new membrane roofing system approved by warrantor of existing roofing system to work on existing roofing.

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

C. Reroofing Conference: Conduct conference at Project site. Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with Owner; Engineer; Owner's insurer if applicable; testing and inspecting agency representative; roofing system manufacturer's representative; deck Installer; roofing Installer including project manager, superintendent, and foreman; and installers whose

work interfaces with or affects reroofing including installers of roof accessories and roof-mounted equipment.

2. Review methods and procedures related to reroofing preparation, including membrane roofing system manufacturer's written instructions.
3. Review temporary protection requirements for existing roofing system that is to remain, during and after installation.
4. Review roof drainage during each stage of reroofing and review roof drain plugging and plug removal procedures.
5. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
6. Review existing deck removal procedures and Owner notifications.
7. Review procedures to determine condition and acceptance of existing deck for reuse.
8. Review structural loading limitations of deck during reroofing.
9. Review base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that will affect reroofing.
10. Review HVAC shutdown and sealing of air intakes.
11. Review governing regulations and requirements for insurance and certificates if applicable.
12. Review existing conditions that may require notification of Engineer before proceeding.

1.7 PROJECT CONDITIONS

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

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

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

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

D. Owner assumes no responsibility for condition of areas to be reroofed.

1. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.

E. Limit construction loads on roof to uniformly distributed loads.

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

G. Hazardous Materials: It is not expected that hazardous materials such as asbestos-containing materials will be encountered in the Work.
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner.

1.8 WARRANTY

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

   1. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 INFILL MATERIALS

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

2.2 TEMPORARY ROOFING MATERIALS

A. Selection of materials and design of temporary roofing is responsibility of Contractor.

B. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).

C. Base Sheet: ASTM D 4601, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet.

D. Glass-Fiber Felts: ASTM D 2178, Type IV, asphalt-impregnated, glass-fiber felt.

E. Asphalt Primer: ASTM D 41.

F. Roofing Asphalt: ASTM D 312, Type III or IV.

2.3 AUXILIARY REROOFING MATERIALS

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

B. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FMG's "Approval Guide."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing membrane roofing system that is indicated not to be reroofed.

1. Loosely lay 1-inch- minimum thick, molded expanded polystyrene (MEPS) insulation over the roofing membrane in areas indicated. Loosely lay 15/32-inch plywood or OSB panels over MEPS. Extend MEPS past edges of plywood or OSB panels a minimum of 1 inch .
2. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
3. Maintain temporary protection and leave in place until replacement roofing has been completed.

B. Coordinate with Owner to shut down air intake equipment in the vicinity of the Work. Cover air intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

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

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

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

E. Verify that rooftop utilities and service piping have been shut off before commencing Work.

3.2 ROOF TEAR-OFF

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

B. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing with a power broom.

C. Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.

1. Remove roof insulation.
2. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.

3. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
4. Remove fasteners from deck or cut fasteners off slightly above deck surface.

D. Partial Roof Tear-Off: Where indicated, remove existing roofing membrane and other membrane roofing system components down to the deck.

1. Remove roof insulation.
2. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
3. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
4. Remove fasteners from deck.

3.3 DECK PREPARATION

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

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

3.4 FASTENER PULL-OUT TESTING

A. Retain independent testing and inspecting agency to conduct fastener pull-out tests according to SPRI FX-1, and submit test report to Engineer before installing new membrane roofing system.

1. Obtain Engineer's approval to proceed with specified fastening pattern. Engineer may furnish revised fastening pattern commensurate with pull-out test results.

3.5 DISPOSAL

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

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

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

END OF SECTION 07591

SECTION 07710 - MANUFACTURED ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following manufactured roof specialties:

1. Copings.
2. Roof edge flashings.

B. Related Sections include the following:

1. Division 7 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.3 PERFORMANCE REQUIREMENTS

A. General: Manufacture and install manufactured roof specialties to resist thermally induced movement and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. FMG Listing: Manufacture and install copings, roof edge flashings that are listed in FMG's "Approval Guide" and approved for Windstorm Classification, Class 1-90. Identify materials with FMG markings.

C. Thermal Movements: Provide manufactured roof specialties that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

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

D. Water Infiltration: Provide manufactured roof specialties that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Initial Selection: For each type of manufactured roof specialty indicated with factory-applied color finishes.

C. Fabrication Samples: For copings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, verifying compliance of copings with performance requirements.

E. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by Engineer, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.

1.6 COORDINATION

A. Coordinate installation of manufactured roof specialties with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

1.7 WARRANTY

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
5. Basis-of-Design Product: The designs for copings, roof edge flashings, and counterflashings and reglets are based on the products named. Subject to compliance with requirements, provide either the named products or comparable products by one of the other manufacturers specified.

2.2 EXPOSED METALS

A. Copper Sheet: ASTM B 370, Temper H00 or H01, cold rolled, mill finished.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for use and finish indicated, finished as follows:

1. Surface: Smooth, flat finish.

2. Anodic Finish: Apply the following finish:

a. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, separators, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.

C. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

D. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

E. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.4 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet , concealed anchorage, concealed splice plates with same finish as coping caps, mitered corner units, and end cap units.

1. Basis-of-Design Product: comparable product by one of the following:
2. Manufacturers:

    a. Architectural Products Co.
    b. ATAS International, Inc.
    c. Castle Metal Products.
    d. Cheney Flashing Company.
    e. Hickman, W. P. Company.
    f. Merchant & Evans, Inc.
    g. Metal-Era, Inc.
    h. Metal-Fab Manufacturing LLC.
    i. MM Systems Corporation.
    j. Perimeter Systems, a division of Southern Aluminum Finishing Co.
    k. Petersen Aluminum Corp.

3. Coping Caps: Snap-on, Face leg hooked to continuous cleat with back leg fastener exposed, fabricated from the following exposed metal:
    a. Aluminum: .050 inch thick.
    b. Vertical face: 10 inch minimum
4. Snap-on Coping Anchor Plates: Concealed, galvanized steel sheet, 12 inches wide, 0.028 inch thick, with integral cleats.

2.5 FINISHES

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

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.

1. Examine walls, roof edges, and parapets for suitable conditions for manufactured roof specialties.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install manufactured roof specialties according to manufacturer's written instructions. Anchor manufactured roof specialties securely in place and capable of resisting forces specified in performance requirements. Use fasteners, separators, sealants, and other miscellaneous items as required to complete manufactured roof specialty systems.

1. Install manufactured roof specialties with provisions for thermal and structural movement.
2. Torch cutting of manufactured roof specialties is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum manufactured roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing exposed-to-view components of manufactured roof specialties directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Install manufactured roof specialties level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil-canning, buckling, or tool marks.

D. Install manufactured roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.

E. Expansion Provisions: Provide for thermal expansion of exposed manufactured roof specialties. Space movement joints at a maximum of 12 feet with no unplanned joints within 18 inches of corners or intersections.

F. Fasteners: Use fasteners of type and size recommended by manufacturer but of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

G. Seal joints with butyl sealant as required by manufacturer of roofing specialties.

3.3 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings to resist uplift and outward forces according to performance requirements.

1. Interlock face and back leg drip edges into continuous cleats anchored to substrate at 16-inch centers.

3.4 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as manufactured roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace manufactured roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07710

SECTION 07720 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Roof curbs.
2. Equipment supports.
3. Preformed flashings.

B. Related Sections include the following:

1. Division 7 Section "Manufactured Roof Specialties" for fascia, copings, and gravel stops.

1.3 SUBMITTALS

A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.

C. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.

D. Samples: For each type of exposed factory-applied color finish required and for each type of roof accessory indicated, prepared on Samples of size to adequately show color.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

1. With Architect's approval, adjust location of roof accessories that would interrupt roof drainage routes.

1.8 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers listed in other Part 2 articles.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in other Part 2 articles.

2.2 METAL MATERIALS

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and finish. Coil-coat finish as follows:

1. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

B. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized to comply with ASTM A 123/A 123M, unless otherwise indicated.

2.3 MISCELLANEOUS MATERIALS

A. Polyisocyanurate Board Insulation: ASTM C 1289, 1 inch (25 mm) thick.

B. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.

C. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

D. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, and heavy bodied for hooked-type expansion joints with limited movement.

G. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.4 ROOF CURBS

A. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral metal cant and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Manufacturers:

a. Colony Custom Curbs.
b. Commodity Products Company, Inc.
c. Conn-Fab Sales, Inc.
d. Curbs Plus Inc.
e. Custom Curb, Inc.
f. LM Curbs.
g. Loren Cook Company.
h. Metallic Products Corporation.
i. Pate Company (The).
j. Roof Products & Systems Corporation.
k. Roof Products, Inc.
l. Thaler Metal Industries Ltd.
m. ThyCurb; Div. of Thybar Corporation.
n. Uni-Curb, Inc.
o. Vent Products Company, Inc.

2. Material: Aluminum sheet, 0.090 inch thick.

a. Finish: Clear anodic.

3. Liner: Same material as curb, of manufacturer's standard thickness and finish.
4. Factory install wood nailers at tops of curbs.
5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Factory insulate curbs with 1-1/2-inch-thick, cellulosic-fiber board insulation.
7. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
8. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

2.5 PREFORMED FLASHINGS

A. Exhaust Vent Flashings: Double-wall metal flashing sleeve, urethane insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted metal collar, and as follows:

1. Manufacturers:

a. Thaler Metal Industries Ltd.

2. Metal: Aluminum sheet, 0.064 inch thick, mill finished.
3. Diameter: As indicated.

B. Vent Stack Flashing: Metal flashing sleeve, with integral deck flange, uninsulated, and as follows:

1. Manufacturers:

a. Thaler Metal Industries Ltd.

2. Metal: Aluminum sheet, 0.064 inch thick, mill finished.
3. Height: 13 inches.
4. Diameter: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
2. Verify dimensions of roof openings for roof accessories.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Roof Curb Installation:

1. Set roof curb so top surface of roof curb is level.

F. Preformed Flashing Installation:

1. Secure to roof membrane according to vent and stack flashing manufacturer's written instructions.

G. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

3.3 TOUCH UP

A. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Division 9 painting Sections.

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

3.4 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 07720

SECTION 08111 - STANDARD STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Standard hollow-metal steel doors.
2. Standard hollow-metal steel frames.

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for building anchors into and grouting standard steel frames in masonry construction.
2. Division 8 Section "Glazing" for glazed lites in standard steel doors and frames.
3. Division 8 Sections for door hardware for standard steel doors.
4. Division 9 painting Sections for field painting standard steel doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating, and finishes for each type of steel door and frame specified.

B. Shop Drawings: In addition to requirements below, provide a schedule of standard steel doors and frames using same reference numbers for details and openings as those on Drawings:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details.
3. Frame details for each frame type, including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, accessories, joints, and connections.
7. Details of glazing frames and stops showing glazing.
8. Details of conduit and preparations for electrified door hardware and controls.

C. Coordination Drawings: Drawings of each opening, including door and frame, drawn to scale and coordinating door hardware. Show elevations of each door design type, showing dimensions, locations of door hardware, and preparations for power, signal, and control systems.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.

F. Oversize Construction Certification: For standard steel door assemblies required to be fire rated and exceeding limitations of labeled assemblies; include statement that doors comply with requirements of design, materials, and construction but have not been subjected to fire test.

G. Qualification Data: For Installer.

H. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.

D. Fire-Rated Door Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated.
   1. Test Pressure: Test according to NFPA 252 or UL 10C. After 5 minutes into the test, the neutral pressure level in furnace shall be established at 40 inches or less above the sill.
   2. Temperature-Rise Rating: At exit enclosures, provide doors that have a temperature-rise rating of 450 deg F maximum in 30 minutes of fire exposure.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

   1. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.

1. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating standard steel frames without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 COORDINATION

A. Coordinate installation of anchorages for standard steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Amweld Building Products, LLC.
2. Ceco Door Products; an ASSA ABLOY Group Company.
3. Pioneer Industries, Inc.
4. Republic Builders Products Company.
5. Steelcraft; an Ingersoll-Rand Company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.

C. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M.

D. Grout: Comply with ASTM C 476, with a slump of 4 inches for standard steel door frames built into concrete or masonry, as measured according to ASTM C 143/C 143M.

E. Glazing: Comply with requirements in Division 8 Section "Glazing."

F. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD STEEL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.

1. Design: As indicated on Drawings.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, mineral-board, or vertical steel-stiffener core that produces doors complying with ANSI A250.8.

    a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
    b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

        1) Locations: Exterior doors and interior doors where indicated.

3. Vertical Edges for Single-Acting Doors: Square edge.
4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch thick end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior door requirements. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. Physical Performance Level B (Heavy Duty), Model 2 (Seamless).

D. Hardware Reinforcement: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
3. Lock Face**,** Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD STEEL FRAMES

A. General: Comply with ANSI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped and welded face corners and seamless face joints.

C. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.
1. Fabricate knocked-down frames with mitered or coped corners, for field assembly.
2. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions.

D. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
3. Lock Face**,** Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

E. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.

F. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

G. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

H. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.5 STOPS AND MOLDINGS

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. Fixed Frame Moldings: Formed integral with standard steel frames, minimum 5/8 inch high, unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.6 FABRICATION

A. General: Fabricate standard steel doors and frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Standard Steel Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Glazed Lites: Factory cut openings in doors.

C. Standard Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners, unless otherwise indicated.
3. Where installed in masonry, leave vertical mullions in frames open at top for grouting.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches in height.
2) Three anchors per jamb from 60 to 90 inches in height.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches in height.
2) Four anchors per jamb from 60 to 90 inches in height.

c. Compression Type: Not less than two anchors in each jamb.
d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare standard steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."

1. Reinforce doors and frames to receive nontemplated mortised and surface-mounted door hardware.
2. Comply with applicable requirements in ANSI A250.6 and ANSI/DHI A115 Series specifications for door and frame preparation for hardware. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of door or frame.
2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
3. Provide loose stops and moldings on inside of doors and frames.
4. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.7 STEEL FINISHES

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

1. Finish standard steel door and frames after assembly.

B. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of standard steel doors and frames.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations of standard steel frame connections before frame installation.
2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory.

B. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install standard steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Standard Steel Frames: Install standard steel frames for doors and other openings, of size and profile indicated. Comply with SDI 105.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable glazing stops located on secure side of opening.
    d. Install door silencers in frames before grouting.
    e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    f. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    g. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in Division 4 Section "Unit Masonry Assemblies."
5. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. 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.

D. Glazing: Comply with installation requirements in Division 8 Section "Glazing" and with standard steel door and frame manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c., and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable.

B. Clean grout and other bonding material off standard steel doors and frames immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

END OF SECTION 08111

SECTION 08331 - OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of electric-motoroperated overhead coiling doors:

1. Insulated service doors.

B. Related Sections include the following:

1. Division 9 Section "Painting" for field-applied paint finish.

1.3 DEFINITIONS

A. Operation Cycle: One cycle of a door is complete when it is moved from the closed position to the fully open position and returned to the closed position.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:

1. Wind Load: Uniform pressure (velocity pressure) of 25 lbf/sq. ft, acting inward and outward.

B. Operation-Cycle Requirements: Provide overhead coiling door components and operators capable of operating for not less than 10,000 cycles.

1.5 SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:

1. Summary of forces and loads on walls and jambs.

B. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer's product data.

C. Samples for Initial Selection: Manufacturer's color charts showing full range of colors available for units with factory-applied finishes.

D. Samples for Verification: Of each type of exposed finish required, prepared on Samples of size indicated below.

1. Curtain Slats: 12 inches long.
2. Bottom Bar: 6 inches long.

E. Qualification Data: For Installer.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors through one source from a single manufacturer.

1. Obtain operators and controls from overhead coiling door manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Atlas Door; Div. of Clopay Building Products Company, Inc.
2. Clopay Building Products
3. McKeon Rolling Steel Door Company, Inc.
4. Overhead Door Corp.
5. Raynor.
6. Wayne-Dalton Corp.

2.2 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling door curtain of interlocking slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel (SS) sheet; complying with ASTM A 653/A 653M, G90 (Z275) coating designation.

a. Minimum Base-Metal (Uncoated) Thickness: 0.0209 inch
b. Flat profile slats.
c. Perforated slats, 25 percent of total door opening.

2. Insulation: Fill slat with manufacturer's standard rigid cellular polystyrene or polyurethane-foam-type thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within metal slat faces.

3. Astragal: Provide a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene; for placement between angles or fitted to shape, as a cushion bumper for interior door.

2.3 HOODS AND ACCESSORIES

A. Hood: Form to act as weatherseal and entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and provide fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sagging.

1. Fabricate hoods for steel doors of minimum 0.028-inch thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

2. Shape: Round.

B. Integral Frame, Hood, and Fascia: Provide welded assemblies of the following sheet metal:

1. Fabricate from minimum 0.064-inch thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.

C. Weatherseals: Provide replaceable, adjustable, continuous, compressible weather-stripping gaskets fitted to bottom and top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch- thick, replaceable, continuous sheet secured to inside of hood.

1. Provide motor-operated doors with combination bottom weatherseal and sensor edge.

D. Vision Windows: Provide 1/4-inch- thick, clear transparent acrylic sheet windows. Set glazing in vinyl, rubber, or neoprene glazing channel secured to curtain slats.

E. Push/Pull Handles: For push-up-operated or emergency-operated doors, provide galvanized steel lifting handles on each side of door.

F. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

G. Fabricate locking device assembly with lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.

1. Locking Bars: Single-jamb side operable from inside and outside.

2. Lock cylinder is specified in Division 8 Section "Door Hardware."

H. Chain Lock Keeper: Suitable for padlock.

I. If door unit is power operated, provide safety interlock switch to disengage power supply when door is locked.

1. Replaceable fusible links with temperature rise and melting point of 165 deg F; interconnected and mounted on both sides of door opening.

2.4 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to door curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast-steel barrel plugs to secure ends of springs to barrel and shaft.

D. Fabricate torsion rod for counterbalance shaft of cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Provide mounting brackets of manufacturer's standard design, either cast iron or cold-rolled steel plate.

2.5 ELECTRIC DOOR OPERATORS

A. General: Provide electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycle requirements specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

B. Comply with NFPA 70.

C. Disconnect Device: Provide hand-operated disconnect or mechanism for automatically engaging chain and sprocket operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

D. Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.

E. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V, ac or dc.

F. Door-Operator Type: Provide wall-, hood-, or bracket-mounted, jackshaft-type door operator unit consisting of electric motor, enclosed gear-head-reduction drive, and chain and sprocket secondary drive.

1. Provide totally enclosed, nonventilated or fan-cooled motor, fitted with plugged drain, and controller with NEMA ICS 6, Type 4 enclosure where indicated.

2. Provide exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

G. Obstruction Detection Device: Provide each motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of sensor immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.

b. Provide electrically actuated automatic bottom bar.

H. Limit Switches: Provide adjustable switches, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions

2.6 FINISHES, GENERAL

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

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 STEEL AND GALVANIZED STEEL FINISHES

A. Factory Primer for Field Finish: Manufacturer's standard primer, compatible with field-applied finish according to coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

1. Apply to ferrous surfaces except zinc-coated metal.

B. Baked Finish: Manufacturer's standard baked finish consisting of primer and topcoat according to coating manufacturer's written instructions for cleaning, pretreatment, application, thermosetting, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install coiling doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports.

3.2 ADJUSTING

A. Lubricate bearings and sliding parts; adjust doors to operate easily, free of warp, twist, or distortion and with weathertight fit around entire perimeter.

3.3 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08331

SECTION 08520 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of aluminum-framed windows:

1. Fixed windows.
2. Horizontal-sliding windows.

B. Related Sections include the following:

1. Division 8 Section "Glazing" for glazing requirements for aluminum windows, including those specified to be factory glazed.

1.3 DEFINITIONS

A. AW: Architectural.

B. C: Commercial.

C. Performance grade number, included as part of the AAMA/NWWDA product designation code, is actual design pressure in pounds force per square foot used to determine structural test pressure and water test pressure.

D. Structural test pressure, for uniform load structural test, is equivalent to 150 percent of design pressure.

E. Minimum test size is smallest size permitted for performance class (gateway test size). Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified and that are of test size indicated below:

1. Minimum size required by AAMA/NWWDA 101/I.S.2.

2. Minimum size required by gateway performance requirements for determining compliance with AAMA/NWWDA 101/I.S.2 for both gateway performance requirements and optional performance grades.
3. Size indicated.

B. AAMA/NWWDA Performance Requirements: Provide aluminum windows of the performance class and grade indicated that comply with AAMA/NWWDA 101/I.S.2.

1. Performance Class: C.
2. Performance Grade: Minimum for performance class indicated.
3. Performance Grade: 60.
4. Exception to AAMA/NWWDA 101/I.S.2: In addition to requirements for performance class and performance grade, design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length at design pressure based on the following:

    a. Testing performed according to AAMA/NWWDA 101/I.S.2, Uniform Load Deflection Test.
    b. Structural computations.

C. Structural Performance: Provide aluminum windows capable of withstanding the following, including wind loads based on passing AAMA/NWWDA 101/I.S.2, Uniform Load Structural Test, at basic wind speed indicated:

1. Deflection: Based on passing AAMA/NWWDA 101/I.S.2, Uniform Load Deflection Test.
2. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch, whichever is less, at design pressure based on structural computations.
3. Basic Wind Speed: As indicated in miles per hour at 33 feet above grade. Determine wind loads and resulting design pressures applicable to Project according to the following, based on mean roof heights above grade as indicated on Drawings:

    a. ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 6.4.2, "Analytic Procedure."
    b. Appendix B in AAMA/NWWDA 101/I.S.2.

4. Design Pressure: 25 lbf/sq. ft.

D. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/NWWDA 101/I.S.2, Air Infiltration Test.

1. Maximum Rate: 0.3 cfm/sq. ft. of area at an inward test pressure of 6.24 lbf/sq. ft.

E. Water Resistance: No water leakage as defined in AAMA/NWWDA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/NWWDA 101/I.S.2, Water Resistance Test.

1. Test Pressure: 15 percent of positive design pressure, but not less than 2.86 lbf/sq. ft. or more than 12 lbf/sq. ft.

F. Forced-Entry Resistance: Comply with Performance Level 10 requirements when tested according to ASTM F 588.

G. Condensation-Resistance Factor: Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45, where windows are indicated to be "thermally improved."

H. Thermal Transmittance: Provide aluminum windows with a whole-window U-value maximum indicated at 15-mph exterior wind velocity and winter condition temperatures when tested according to ASTM E 1423.

1. U-Value: 0.35 Btu/sq. ft. x h x deg F.

I. Solar Heat-Gain Coefficient: Provide aluminum windows with a whole-window SHGC maximum of 0.61, determined according to NFRC 200 procedures.

J. Thermal Movements: Provide aluminum windows, including anchorage, that accommodate thermal movements of units resulting from the following maximum change (range) in ambient and surface temperatures without buckling, distortion, opening of joints, failure of joint sealants, damaging loads and stresses on glazing and connections, and other detrimental effects. Base engineering calculation on actual surface temperatures of materials due to solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient.

K. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/NWWDA 101/I.S.2.

L. Casement Windows: Comply with AAMA/NWWDA 101/I.S.2 for the following tests:

1. Operating Force.
2. Deglazing: When tested according to ASTM E 987.

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. Samples for Initial Selection: For units with factory-applied color finishes.

C. Samples for Verification: For aluminum window components required, prepared on Samples of size indicated below.

1. Main Framing Member: 12-inch- long, full-size sections of extrusions with factory-applied color finish.
2. Hardware: Full-size units with factory-applied finish.
3. Weather Stripping: 12-inch- long sections.
4. Engineer reserves the right to require additional samples that show fabrication techniques, workmanship, and design of hardware and accessories.

D. Qualification Data: For Installer.

E. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

F. Product Test Reports: Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of aluminum window. Test results based on use of down-sized test units will not be accepted.

G. Maintenance Data: For operable window sash operating hardware weather stripping window system operators and finishes to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.

D. Product Options: Information on Drawings and in Specifications establishes requirements for aluminum windows' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

E. Fenestration Standard: Comply with AAMA/NWWDA 101/I.S.2, "Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors," for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Provide AAMA -certified aluminum windows with an attached label.

F. Glazing Publications: Comply with published recommendations of glass manufacturers and GANA's "Glazing Manual" unless more stringent requirements are indicated.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to aluminum windows including, but not limited to, the following:

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review required testing and inspecting procedures.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Failure to meet performance requirements.
2. Structural failures including excessive deflection.
3. Water leakage, air infiltration, or condensation.
4. Faulty operation of movable sash and hardware.
5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
6. Insulting glass failure.

B. Warranty Period: Three years from date of Substantial Completion.

C. Warranty Period for Metal Finishes: 10 years from date of Substantial Completion.

D. Warranty Period for Glass: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Casement Windows:
   a. Mannix; a Division of Interstate Window Corp.
   b. Peerless Products, Inc.
   c. Thermal Windows, Inc.
   d. TRACO.
   e. Winco Manufacturing Co.

2.2 MATERIALS, GENERAL

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi ultimate tensile strength, not less than 16,000-psi minimum yield strength, and not less than 0.062-inch thickness at any location for the main frame and sash members.

B. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

1. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125 inch thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action, and completely concealed when aluminum window is closed.

1. Weather-Stripping Material: Elastomeric cellular preformed gaskets complying with ASTM C 509.
2. Weather-Stripping Material: Dense elastomeric gaskets complying with ASTM C 864.
3. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/NWWDA 101/I.S.2.

F. Replaceable Weather Seals: Comply with AAMA 701/702.

G. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

2.3 GLAZING

A. Glass and Glazing Materials: Refer to Division 8 Section "Glazing" for glass units and glazing requirements applicable to glazed aluminum window units.

B. Glass: Clear, insulating-glass units complying with Division 8 Section "Glazing."

2.4 HARDWARE

A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals. Where exposed, provide nonmagnetic stainless steel.

B. Sill Cap/Track: Extruded-aluminum with natural anodized finish track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

C. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only. Provide extension pole to allow operation of windows.

2.5 INSECT SCREENS

A. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Locate screens on inside of window and provide for each operable exterior sash or ventilator.

1. Aluminum Tubular Frame Screens: Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," Architectural C-24 class.
2. Comply with SMA 1004, "Specifications for Aluminum Tubular Frame Screens for Windows," for minimum standards of appearance, fabrication, attachment of screen fabric, hardware, and accessories unless more stringent requirements are indicated.

B. Glass-Fiber Mesh Fabric: 18-by-14 or 18-by-16 mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration in the following color. Comply with ASTM D 3656.

1. Mesh Color: Charcoal gray.

2.6 ACCESSORIES

A. Integral Ventilating System/Device: Where indicated, provide weather-stripped, adjustable, horizontal, fresh-air vent, with a free airflow slot for full width of window sash by approximately 1 inch wide when open, complying with AAMA/NWWDA 101/I.S.2. Equip vent bar with an integral insect screen, removable for cleaning.

B. Window Cleaner Anchor Bolts: Provide window cleaner anchor bolts of standard design, complying with requirements of authorities having jurisdiction. Fabricate bolts of nonmagnetic stainless steel.

1. Reinforce window units or mullions to receive bolts and provide additional anchorage of units at bolt locations.

2.7 FABRICATION

A. General: Fabricate aluminum windows, in sizes indicated, that comply with AAMA/NWWDA 101/I.S.2 for performance class and performance grade indicated. Include a complete system for assembling components and anchoring windows.

B. General: Fabricate aluminum windows, in sizes indicated, that comply with requirements and that meet or exceed AAMA/NWWDA 101/I.S.2 performance requirements for the following window type and performance class. Include a complete system for assembling components and anchoring windows.

   1. Casement: C.

C. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.

D. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

   1. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
   2. Provide thermal barriers tested according to AAMA 505; determine the allowable design shear flow per the appendix in AAMA 505.
   3. Provide hardware with low conductivity or nonmetallic material for hardware bridging thermal breaks at frame or vent sash.

E. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.

   1. Horizontal-Sliding Windows: Provide operable sash with a double row of sliding weather stripping in horizontal rails and single- or double-row weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide compression-type weather stripping at perimeter of each movable panel where sliding-type weather stripping is not appropriate.

F. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

G. Provide water-shed members above side-hinged ventilators and similar lines of natural water penetration.

H. Mullions: Provide mullions and cover plates as shown, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections, as indicated. Provide mullions and cover plates capable of withstanding design loads of window units.

I. Subframes: Provide subframes with anchors for window units as shown, of profile and dimensions indicated but not less than 0.062-inch- thick extruded aluminum. Miter or cope corners, and weld and dress smooth with concealed mechanical joint fasteners. Finish to match window units. Provide subframes capable of withstanding design loads of window units.

J. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements in Division 8 Section "Glazing" and with AAMA/NWWDA 101/I.S.2.

K. Glazing Stops: Provide snap-on glazing stops coordinated with Division 8 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

2.8 FINISHES

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

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances; rough opening dimensions; levelness of sill plate; coordination with wall flashings, vapor retarders, and other built-in components; operational clearances; and other conditions affecting performance of work.

1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches of opening.
3. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.

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

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components; Drawings; and Shop Drawings.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/NWWDA 101/I.S.2.

3.3 ADJUSTING

A. Adjust operating sashes and ventilators, screens, hardware, operators, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

3.4 PROTECTION AND CLEANING

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION 08520

SECTION 08620 - SKYLIGHTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Specifies:

1. Furnish and install, complete with accessories, all skylights and appurtenant items as shown on the Contract Drawings and specified herein.
2. Skylights will be furnished as listed in the Schedule at the end of this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Division 7 - Thermal and Moisture Protection

1.3 SUBMITTALS

A. Working drawings, shop drawings and material specifications shall be submitted for the approval of the Engineer in accordance with the requirements of Division 1. Working drawings and shop drawings shall include, but not be limited to:

1. Product Data: For unit skylights. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Shop Drawings: For unit skylights. Include plans, elevations, sections, details, and attachments to other Work.
3. Samples for Initial Selection: For units with factory-applied color finishes.
4. Samples for Verification: For each type of exposed finish required, in a representative section of each unit in manufacturer's standard size.

1.4 FIELD MEASUREMENTS

A. Field measurements shall be taken prior to preparation of shop drawings and fabrication where required, to ensure proper fitting of the work.

1.5 PERFORMANCE REQUIREMENTS

A. Structural Loads: Provide unit skylights, including glazing and anchorage, capable of withstanding the effects of the following design loads:

1. Snow Load: 55 lb/sqft

1.6 PRODUCT HANDLING

A. Protection:

1. Use all means necessary to protect skylights before, during and after installation and to protect installed work and materials from other trades.

B. Cleaning:

1. All skylights shall be thoroughly cleaned with plain water, or an approved commercial cleaner.
2. No abrasive cleaning agent may be used.
3. Any work that has been damaged, discolored, defaced or does not comply with these specifications will not be accepted by the Engineer.

C. Replacement:

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the Owner.

1.7 QUALITY CONTROL

A. Fire-Test Response Characteristics of Plastic Glazing: Provide plastic glazing sheets identical to those tested for fire-exposure behavior per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Self-Ignition Temperature: 650 deg F (343 deg C) or greater for plastic sheets in thickness indicated when tested per ASTM D 1929.
2. Smoke Production Characteristics: Comply with either requirement below:

   a. Smoke-Developed Index: 450 or less when tested per ASTM E 84 on plastic sheets in manner indicated for use.
   b. Smoke Density: 75 or less when tested per ASTM D 2843 on plastic sheets in thickness indicated for use.
   c. Relative-Burning Characteristics: Tested per ASTM D 635.
   d. Acrylic Glazing: Class CC2, burning rate of 2.5 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.
   e. Polycarbonate Glazing: Class CC1, burning extent of 1 inch (25 mm) or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated for use.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Uncontrolled water leakage.
2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3. Yellowing of acrylic glazing.
4. Breakage of polycarbonate glazing.

5. Deterioration of insulating-glass hermetic seal.

B. Warranty Period: Three (3) years from Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

B. Products: Subject to compliance with requirements, provide the following:

1. American Skylites Inc. ; www.americanskylites.com
2. Major Industries; www.majorskylights.com

2.2 SKYLIGHTS

A. General: Factory-assembled units that meet the requirements listed in the Schedule at the end of this Section, and that are capable of withstanding design loads indicated.

B. Shape and Size: As listed in the Schedule at the end of this Section.

C. Colors and finishes: Submitted with Shop Drawings

D. Gaskets: Neoprene.

E. Aluminum Components:

1. Sheets: ASTM B 209 (ASTM B 209M), alloy and temper to suit forming operations and finish requirements but with not less than the strength and durability of alclad alloy 3005-H25.
2. Extruded Shapes: ASTM B 221 (ASTM B 221M), alloy and temper to suit structural and finish requirements but with not less than the strength and durability of alloy 6063-T52.
3. Anodic Coating: Class I, clear anodic coating complying with AAMA 611.

   a. Color: As selected from manufacturer's submittal.
   b. Pigmented Organic Coating: Manufacturer's standard baked enamel.
   c. Color and Gloss: As selected from manufacturer's full range.

F. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal as recommended by manufacturer. Finish exposed fasteners to match material being fastened.

G. Condensation Control: Fabricate unit skylights with integral internal gutters and nonclogging weeps to collect and drain condensation to the exterior.

H. Thermal Break: Fabricate unit skylights with thermal barrier separating interior metal framing from materials exposed to outside temperature.

2.3 INSTALLATION MATERIALS

A. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic, nominally free of sulfur and containing no asbestos fibers, formulated for 15-mil (0.4-mm) dry film thickness per coating.

B. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

C. Elastomeric Sealant: ASTM C 920; Type S; Grade NS; Class 25; and Uses NT, G, A, and (as applicable to joint substrates indicated) O; recommended by unit skylight manufacturer and compatible with joint surfaces.

D. Roofing Cement: ASTM D 4586, asbestos free, designed for trowel application or other adhesive compatible with roofing system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate unit skylight installation with installation of substrates, vapor retarders, roof insulation, roofing, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.

B. Unless otherwise indicated, install unit skylights according to construction details of NRCA's "The NRCA Roofing and Waterproofing Manual."

C. Where metal surfaces of units will contact incompatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation recommended in writing by unit skylight manufacturer.

D. Anchor unit skylights securely to supporting substrates.

E. Set unit skylight flanges in thick bed of roofing cement to form a seal, unless otherwise indicated.

F. Where cap flashing is indicated, install to produce waterproof overlap with roofing or roof flashing. Seal with thick bead of mastic sealant except where overlap is indicated to be left open for ventilation.

3.2 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

3.3 SKYLIGHT SCHEDULE

Location	Above RAS Pumps	Thickener Building Roof
Quantity	Three (3)	One (1)
Nominal Size	3’ x 8’	6’ x 10’
Description	Aluminum framed acrylic double domed, manual opening, Double Glazed Dome-25% Rise, Self Flashing	Ridge Type
Height	12 inches	12 inches
Manufacturer & Model	American SkylightsEZ Insulated Self Flashing 12”	Major Industries Guardian 275 Translucent Skylights

END OF SECTION 08620

SECTION 08711 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Commercial door hardware for the following:

a. Swinging doors.

2. Cylinders for doors specified in other Sections.

B. Related Sections include the following:

1. Division 8 Section "Standard Steel Doors and Frames" for astragals provided as part of a fire-rated labeled assembly and for door silencers provided as part of the frame.
2. Division 13 Section "Metal Building Systems" for door hardware, except cylinders.

1.3 DOOR HARDWARE ALLOWANCE

A. Submittals: Coordinate and process Submittals and templates for door hardware in same manner as Submittals for other Work.

B. Coordination: Coordinate door hardware with other Work. Furnish Shop Drawings of other Work where required or requested to coordinate installation.

C. Installation: General types and approximate quantities of door hardware are indicated in the Door Hardware Schedule to help estimate installation and other Work not included in door hardware allowance.

1.4 SUBMITTALS

A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.

C. Samples: For exposed door hardware of each type indicated below, in specified finish, full size. Tag with full description for coordination with the Door Hardware Schedule. Submit samples before, or concurrent with, submission of the final Door Hardware Schedule.

1. Door Hardware: As follows:

   a. Hinges.
   b. Pivots.
   c. Locks and latches.
   d. Bolts.
   e. Exit devices.
   f. Cylinders and keys.
   g. Operating trim.
   h. Closers.
   i. Stops and holders.
   j. Protective trim.
   k. Door gasketing.
   l. Thresholds.

2. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

D. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.

   a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.

3. Content: Include the following information:

   a. Type, style, function, size, label, hand, and finish of each door hardware item.
   b. Manufacturer of each item.
   c. Fastenings and other pertinent information.
   d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   e. Explanation of abbreviations, symbols, and codes contained in schedule.
   f. Mounting locations for door hardware.
   g. Door and frame sizes and materials.
   h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.

      1) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter;

authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

E. Keying Schedule: Prepared by or under the supervision of supplier, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

F. Product Certificates: Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.

1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

1. Include lists of completed projects with project names and addresses of Engineers and owners, and other information specified.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, indicating current products comply with requirements.

I. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 1.

J. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Engineer, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules.

C. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

D. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.

E. Regulatory Requirements: Comply with provisions of the following:

1. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1**,** as follows:

a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
b. Door Closers: Comply with the following maximum opening-force requirements indicated:

1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
2) Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

c. Thresholds: Not more than 1/2 inch. Bevel raised thresholds with a slope of not more than 1:2.

2. NFPA 101: Comply with the following for means of egress doors:

a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
b. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force not more than 15 lbf for not more than 3 seconds.
c. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
d. Thresholds: Not more than 1/2 inch high.

F. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

1. Test Pressure: Test at atmospheric pressure.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings." Review methods and procedures related to electrified door hardware including, but not limited to, the following:

1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
2. Review sequence of operation for each type of electrified door hardware.

3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review required testing, inspecting, and certifying procedures.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

1.7 COORDINATION

A. Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

B. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.8 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of operators and door hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

D. Warranty Period for Manual Closers: 10 years from date of Substantial Completion.

E. Warranty Period for Concealed Floor Closers: Five years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section**,** door hardware sets indicated in door and frame schedule.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturer's products.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

2.2 HINGES AND PIVOTS

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

1. Hinges:
   a. Hager Companies (HAG).
   b. PBB, Inc. (PBB).
   c. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
   d. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

2. Pivots and Pivot Hinges:
   a. Hager Companies (HAG).
   b. LCN Closers; an Ingersoll-Rand Company (LCN).
   c. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
   d. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

3. Continuous Geared Hinges:

   a. Hager Companies (HAG).
   b. Pemko Manufacturing Co., Inc. (PEM).
   c. Select Products Limited (SPL).

B. Standards: Comply with the following:

1. Butts and Hinges: BHMA A156.1.
2. Template Hinge Dimensions: BHMA A156.7.
3. Self-Closing Hinges and Pivots: BHMA A156.17.
4. Pivots: BHMA A156.4.

C. Quantity: Provide the following, unless otherwise indicated:

1. Two Hinges: For doors with heights up to 60 inches
2. Three Hinges: For doors with heights 61 to 90 inches
3. Four Hinges: For doors with heights 91 to 120 inches
4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

D. Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Maximum Door Size (inches)	Hinge Height (inches)	Metal Thickness (inches)	
		Standard Weight	Heavy Weight
32 by 84 by 1-3/8	3-1/2	0.123	-
36 by 84 by 1-3/8	4	0.130	-
36 by 84 by 1-3/4	4-1/2	0.134	0.180
42 by 90 by 1-3/4	4-1/2	0.134	0.180
48 by 120 by 1-3/4	5	0.146	0.190

E. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

F. Hinge Weight: Unless otherwise indicated, provide the following:

1. Entrance Doors: Heavy-weight hinges.
2. Doors with Closers: Antifriction-bearing hinges.
3. Interior Doors: Standard-weight hinges.

G. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel, with stainless-steel pin.
2. Interior Hinges: Stainless steel, with stainless-steel pin.
3. Hinges for Fire-Rated Assemblies: Stainless steel, with stainless-steel pin.

H. Fasteners: Comply with the following:

1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
2. Wood Screws: For wood doors and frames.
3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
4. Screws: Phillips flat-head screws; machine screws (drilled and tapped holes) for metal doors. Finish screw heads to match surface of hinges.

2.3 LOCKS AND LATCHES

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

1. Mechanical Locks and Latches:
   a. Best Lock Corporation (BLC).
   b. Brink: R. R. Brink Locking Systems, Inc. (RRB).
   c. Ives: H. B. Ives (IVS).
   d. Schlage Lock Company; an Ingersoll-Rand Company (SCH).
   e. Yale Security Inc.; Div. of Williams Holdings (YAL).

B. Standards: Comply with the following:

1. Bored Locks and Latches: BHMA A156.2.
2. Mortise Locks and Latches: BHMA A156.13.
3. Interconnected Locks and Latches: BHMA A156.12.
4. Auxiliary Locks: BHMA A156.5.
5. Push-Button Combination Locks: BHMA A156.2.
6. Exit Locks: BHMA A156.5.

C. Bored Locks: BHMA Grade 1; Series 4000.

D. Mortise Locks: Stamped steel case with steel or brass parts; BHMA Grade 1; Series 1000.

E. Certified Products: Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

F. Lock Trim: Comply with the following:

1. Lever: Wrought, forged, or cast.
2. Knob: Wrought, forged, or cast.
3. Escutcheon (Rose): Wrought, forged, or cast.
4. Dummy Trim: Match [lever] lock trim and escutcheons.
5. Lockset Designs: Provide the lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

G. Lock Functions: Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:

1. Bored Locks: BHMA A156.2.

2. Mortise Locks: BHMA A156.13.
3. Interconnected Locks: BHMA A156.12.

H. Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
3. Deadbolts: Minimum 1-inch bolt throw.

I. Rabbeted Doors: Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

J. Backset: 2-3/4 inches, unless otherwise indicated.

2.4 EXIT DEVICES

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

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

1. Adams Rite Manufacturing Co. (ARM).
2. American Device Manufacturing Company; Member of The DORMA Group (ADM).
3. Arrow Architectural Hardware; Div. of ESSEX Industries, Inc. (AAH).
4. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc. (CR).
5. Von Duprin; an Ingersoll-Rand Company (VD).

C. Standard: BHMA A156.3.

1. BHMA Grade: Grade 1.

D. Certified Products: Provide exit devices listed in BHMA's "Directory of Certified Exit Devices."

E. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

F. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

G. Outside Trim: Lever; material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latchsets, unless otherwise indicated.

H. Through Bolts: For exit devices and trim on metal doors.

2.5 CYLINDERS AND KEYING

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

1. Cylinders: Same manufacturer as for locks and latches.
2. Cylinders:
   a. Best Lock Corporation (BLC).
   b. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc. (CR).
   c. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
   d. Schlage Lock Company; an Ingersoll-Rand Company (SCH).
   e. Yale Security Inc.; Div. of Williams Holdings (YAL).

B. Standards: Comply with the following:

1. Cylinders: BHMA A156.5.
2. Key Control System: BHMA A156.5.

C. Cylinder Grade: BHMA Grade 1.

D. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Five.
2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
4. Bored-Lock Type: Cylinders with tailpieces to suit locks.

   a. High-Security Grade: BHMA Grade 1A, listed and labeled as complying with pick- and drill-resistant testing requirements of UL 437 (Suffix A).

E. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:

1. Interchangeable Cores: Core insert, removable by use of a special key, and usable with other manufacturers' cylinders.
2. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

F. Construction Keying: Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
2. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

   a. Furnish permanent cores to Owner for installation.

G. Keying System: Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:

1. No Master Key System: Cylinders are operated by change keys only.
2. Master Key System: Cylinders are operated by a change key and a master key.
3. Grand Master Key System: Cylinders are operated by a change key, a master key, and a grand master key.
4. Great-Grand Master Key System: Cylinders are operated by a change key, a master key, a grand master key, and a great-grand master key.
5. Existing System: Master key or grand master key locks to Owner's existing system.
6. Existing System: Re-key Owner's existing master key system into new keying system.
7. Keyed Alike: Key all cylinders to the same change key.

    a. Cylinders shall be master keyed.

H. Keys: Provide nickel-silver keys complying with the following:

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

    a. Notation: Information to be furnished by Owner**.**

2. Quantity: In addition to one extra blank key for each lock, provide the following:

    a. Cylinder Change Keys: Three.
    b. Master Keys: Five.
    c. Grand Master Keys: Five.
    d. Great-Grand Master Keys: Five.

I. Key Control System: BHMA Grade 1 system, including key-holding hooks, labels, two sets of key tags with self-locking key holders, key-gathering envelopes, and temporary and permanent markers. Contain system in metal cabinet with baked-enamel finish.

1. Multiple-Drawer Cabinet: Cabinet with drawers equipped with key-holding panels and key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.
2. Wall-Mounted Cabinet: Cabinet with hinged-panel door equipped with key-holding panels and pin-tumbler cylinder door lock.
3. Portable Cabinet: Tray for mounting in file cabinet, equipped with key-holding panels, envelopes, and cross-index system.
4. Capacity: Able to hold keys for 150 percent of the number of locks.

2.6 EXIT AND FIRE DOORS

A. Exit Doors: Always openable from inside by simple turn of lever handle or push on panic bar without use of key or any special knowledge or effort, to include each leaf of door pairs.

B. Hardware for Fire Doors: Underwriters Laboratories Inc., Fire Protection Equipment List.

2.7 KEY CONTROL SYSTEM

A. System: Key Control Systems Co., Telkee, Inc.; expandable system with 150 (E8351)-key capacity expandable to 425.

B. Cabinet:
   1. Manufacturer's standard surface mounted cabinet, single-door with continuous hinge, and pin tumbler lock, color as selected from standard colors to match Engineer's color schedule. Use Telkee; AWC 150-S.
   2. Complete system with standard components such as envelopes, transient key tags, reserve key tags, receipts and holders, and card index.

2.8 OPERATING TRIM

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Ives: H. B. Ives (IVS).
   2. Rockwood Manufacturing Company (RM).
   3. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

B. Standard: Comply with BHMA A156.6.

C. Materials: Fabricate from aluminum, unless otherwise indicated.

2.9 ACCESSORIES FOR PAIRS OF DOORS

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

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

   1. Coordinators:
      a. Glynn-Johnson; an Ingersoll-Rand Company (GJ).
      b. Hager Companies (HAG).
      c. Ives: H. B. Ives (IVS).
      d. Rockwood Manufacturing Company (RM).

   2. Removable Mullions:

      a. Adams Rite Manufacturing Co. (ARM).
      b. American Device Manufacturing Company; Member of The DORMA Group (ADM).
      c. Arrow Architectural Hardware; Div. of ESSEX Industries, Inc. (AAH).
      d. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc. (CR).

   3. Astragals:

      a. Hager Companies (HAG).
      b. Pemko Manufacturing Co., Inc. (PEM).

C. Standards: Comply with the following:

1. Coordinators: BHMA A156.3.
2. Removable Mullions: BHMA A156.3.

D. Carry-Open Bars: Provide carry-open bars for inactive leaves of pairs of doors, unless automatic or self-latching bolts are used.

2.10 CLOSERS

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

1. Surface-Mounted Closers:
   a. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc. (CR).
   b. LCN Closers; an Ingersoll-Rand Company (LCN).
   c. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
   d. Yale Security Inc.; Div. of Williams Holdings (YAL).

2. Concealed Closers:
   a. LCN Closers; an Ingersoll-Rand Company (LCN).
   b. Norton Door Controls; Div. of Yale Security Inc. (NDC).
   c. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
   d. Yale Security Inc.; Div. of Williams Holdings (YAL).

3. Closer Holder Release Devices:
   a. LCN Closers; an Ingersoll-Rand Company (LCN).
   b. Sargent Manufacturing Company; Div. of ESSEX Industries, Inc. (SGT).
   c. Yale Security Inc.; Div. of Williams Holdings (YAL).

B. Standards: Comply with the following:

1. Closers: BHMA A156.4.
2. Closer Holder Release Devices: BHMA A156.15.

C. Surface Closers: BHMA Grade 1.

D. Concealed Closers: BHMA Grade 1.

E. Certified Products: Provide door closers listed in BHMA's "Directory of Certified Door Closers."

F. Hold-Open Closers/Detectors: Coordinate and interface integral smoke detector and closer device with fire alarm system.

G. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.11 PROTECTIVE TRIM UNITS

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

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

1. Metal Protective Trim Units:
   a. Baldwin Hardware Corporation (BH).
   b. Hager Companies (HAG).
   c. NT Quality Hardware; an Ingersoll-Rand Company (NTQ).
   d. Pawling Corporation (PAW).
   e. Rockwood Manufacturing Company (RM).

2. Plastic Protective Trim Units:

   a. American Floor Products Co., Inc. (AFP).
   b. Hager Companies (HAG).
   c. Ives: H. B. Ives (IVS).
   d. Koroseal Wall Protection Systems, Inc. (KWS).

C. Standard: Comply with BHMA A156.6.

D. Materials: Fabricate protection plates from the following:

1. Aluminum: 0.050 inch thick; beveled top and 2 sides.
2. Brass: 0.050 inch thick; beveled top and 2 sides.
3. Bronze: 0.050 inch thick; beveled top and 2 sides.
4. Stainless Steel: 0.050 inch thick; beveled top and 2 sides.
5. Plastic Laminate: 1/8 inch thick; NEMA LD 3, Grade HGS; beveled 4 sides.
6. Rigid Plastic: 0.060-inch- thick, PVC or acrylic-modified vinyl plastic; beveled 4 sides.
7. Acrylic: 1/8 inch thick; beveled 4 sides.

   a. Color and Texture: As indicated by manufacturer's designations.
   b. Color and Texture: Match Engineer's sample.
   c. Color and Texture: As selected by Engineer from manufacturer's full range.

E. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.

F. Furnish protection plates sized 1-1/2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in Door Hardware Schedule.

2.12 STOPS AND HOLDERS

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

1. Architectural Builders Hardware Mfg., Inc. (ABH).

2. Baldwin Hardware Corporation (BH).
3. Hager Companies (HAG).
4. Ives: H. B. Ives (IVS).
5. LCN Closers; an Ingersoll-Rand Company (LCN).

B. Standards: Comply with the following:

1. Stops and Bumpers: BHMA A156.16.
2. Mechanical Door Holders: BHMA A156.16.
3. Electromagnetic Door Holders: BHMA A156.15.
4. Combination Overhead Holders and Stops: BHMA A156.8.
5. Door Silencers: BHMA A156.16.

C. Stops and Bumpers: BHMA Grade 1.

D. Mechanical Door Holders: BHMA Grade 1.

E. Floor Stops: For doors, unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic.

1. Where floor or wall stops are not appropriate, provide overhead holders.

F. Silencers for Metal Door Frames: BHMA Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

2.13 DOOR GASKETING

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

1. Door Gasketing:

a. Hager Companies (HAG).
b. Pemko Manufacturing Co., Inc. (PEM).
c. Reese Enterprises, Inc. (RE).
d. Sealeze Corporation (SEL).

2. Door Bottoms:

a. Hager Companies (HAG).
b. Pemko Manufacturing Co., Inc. (PEM).
c. Reese Enterprises, Inc. (RE).

B. Standard: Comply with BHMA A156.22.

C. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

D. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

E. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.

1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.

F. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL 10B or NFPA 252.

G. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

H. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

I. Gasketing Materials: Comply with ASTM D 2000 and AAMA 701/702.

2.14 THRESHOLDS

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

1. Hager Companies (HAG).
2. Pemko Manufacturing Co., Inc. (PEM).
3. Ultra Industries; a Macklanburg-Duncan Company (ULT).
4. Zero International, Inc. (ZRO).

B. Standard: Comply with BHMA A156.21.

2.15 FABRICATION

A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Engineer.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire-rated applications:

   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:

   a. Surface hinges to doors.
   b. Closers to doors and frames.
   c. Surface-mounted exit devices.

4. Spacers or Sex Bolts: For through bolting of hollow metal doors.
5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.16 FINISHES

A. Standard: Comply with BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. BHMA Designations: Comply with base material and finish requirements indicated by the following:

1. BHMA 606: Satin brass, clear coated, over brass base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

D. In accordance with manufacturer’s written instructions.

E. Make Work neat and secure, develop full strength of components, and provide proper function.

F. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.

G. Latchbolts:
   1. Install to engage in strikes automatically, whether activated by closers or manually.
   2. In no case shall additional manual pressure be required to engage latchbolt in strike.

H. Stops and Holders: Set to allow doors to open as far as possible.

I. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

   1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

   1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
   2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
   3. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

B. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:

   1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
   2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
   3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

Hardware Schedule basis of design :

Hinges:

H1 - Stanley FBB191-32D Regular Weight, two ball-races, full mortise, stainless steel

H3 - Hinges or pivots furnished by door manufacturer

Locks and Latches

L1 - Best 35H7F3H Mortise entrance lock with lever

L3 - Best 35H0N3H Mortise latch with lever handle

L5 - Best 35H7EW3H Mortise utility room lock with lever handle

L8 - Best 35H7LF3H Mortise privacy lock with lever handle

L16 - Lock by exit device manufacturer; furnish cylinders for keying to other locks as required

Exit Devices

X1 - VonDuprin 99L Rim type, active leaf, with removable mullion for pairs

Closer

C2 - LCN 4110 Series Parallel arm

Push-Pull

P1 - BBW 1017-3B and 47G 8” x ¾” Pull handle and plate, 0.050” thick

Stop and Holders

S2 - BBW WC9X Wall Bumber

Thresholds

T1 - Pemko 175A Saddle, smooth 4” x ½”

Weatherstrip

W1 - Pemko S88D Rubber vinyl bulb at jambs and head, and at meeting stiles.

Pemko 222AV	Door Shoe
Pemko 346C	Rain Drip

Kick-Plate

K1 -	Pemko	10” x 36”, Aluminum, 0.05” thick, each side, each door.

END OF SECTION 08711

SECTION 08800 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than

thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

    a. Specified Design Wind Loads: 25 lbs/s.f., but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads."

    b. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
    c. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

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

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For insulating-glass units, properties are based on units with lites 6.0 mm thick and a nominal 1/2-inch wide interspace.
3. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:

    a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.
    b. Solar Heat Gain Coefficient: NFRC 200.
    c. Solar Optical Properties: NFRC 300.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: For the following products, in the form of 12-inch square Samples for glass.

1. Each color of tinted float glass.
2. Each type of patterned glass.
3. Wired glass.
4. Insulating glass for each designation indicated.
5. For each color (except black) of exposed glazing sealant indicated.

C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

E. Qualification Data: For installers.

F. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

G. Product Test Reports: For each of the following types of glazing products:

1. Tinted float glass.
2. Insulating glass.
3. Glazing sealants.
4. Glazing gaskets.

H. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level 2 (Senior Glaziers) or Level 3 (Master Glaziers).

B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: insulating glass.

C. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.

D. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

E. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.

1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
2. Glass Testing Agency Qualifications: An independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

F. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

G. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

H. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

I. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.

J. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials; for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

K. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

L. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:

1. Insulating Glass Certification Council.
2. Associated Laboratories, Inc.

M. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
5. Basis-of-Design Product: The design for each glazing product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 GLASS PRODUCTS

A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

1. Ultra-Clear (Low-Iron) Float Glass: Class I (clear); with a minimum 91 percent visible light transmission and a minimum solar heat gain coefficient of 0.87.

a. Available Products:

1) AFG Industries Inc.; Krystal Klear.
2) Pilkington Building Products North America; Optiwhite.
3) PPG Industries, Inc.; Starphire.
4) Schott Corporation; Amiran.

B. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and of form and mesh pattern specified.

C. Tempered Patterned Glass: ASTM C 1048, Kind FT (fully tempered), Type II (patterned flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.

D. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:

E. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.
3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
4. Sealing System: Dual seal, with primary and secondary sealants as follows:

    a. Manufacturer's standard sealants.

5. Spacer Specifications: Manufacturer's standard spacer material and construction.

    a. Desiccant: Molecular sieve or silica gel, or blend of both.
    b. Corner Construction: Manufacturer's standard corner construction.

2.3 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:

1. Neoprene, ASTM C 864.
2. EPDM, ASTM C 864.
3. Silicone, ASTM C 1115.
4. Thermoplastic polyolefin rubber, ASTM C 1115.
5. Any material indicated above.

B. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.4 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As indicated by manufacturer's designations.

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

2.8 MONOLITHIC WIRED-GLASS UNITS

A. Polished Wired-Glass Units WG-: Form 1 (wired glass, polished both sides), Quality-Q6, Mesh 1 (M1) (Diamond), 6.0 mm thick.

1. Available Manufacturers:

a. Asahi/AMA Glass Corp.; affiliated with AFG Industries, Inc.
b. Central Glass Co., Ltd.; distributed by Northwestern Industries Inc.
c. Pilkington Sales (North America) Ltd.

2.9 INSULATING-GLASS UNITS

A. Passive Solar Low-E Insulating-Glass Units IG-:
1. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0.
2. Interspace Content: Argon.
3. Outdoor Lite: Class mirrored float glass.

a. Self-Cleaning, Low-Maintenance Coating: Pyrolytic coating on first surface.

4. Indoor Lite: Class 1 (clear) float glass.

a. Annealed

5. Low-E Coating: Pyrolytic on second surface.
6. Winter Nighttime U-Factor: 0.35 maximum.
7. Summer Daytime U-Factor: 0.38 maximum.
8. Solar Heat Gain Coefficient: 0.61 maximum.
9. Outdoor Visible Reflectance: 100 percent maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 08800

SECTION 09310 - CERAMIC TILE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included

1. Tile work required for this work indicated on the drawings and includes, but is not necessarily limited to, floors and curbs.

1.2 QUALITY ASSURANCE

A. Qualifications of Installers

1. For cutting, installing, and grouting of tile, use only thoroughly trained and experienced journeyman tile setters who are completely familiar with the requirements of this work and the recommendations contained in the referenced standards.
2. In acceptance or rejection of installed tile, no allowance will be made for lack of skill on the part of the tile setters.

B. Codes and Standards

1. In addition to complying with all pertinent codes and regulations:

   a. Manufacture all tile in accordance with the provisions of the Tile Council of America 137.1 - 1976; and
   b. Install all tile in accordance with the recommendations contained in "Handbook for Ceramic Tile Installation" of the Tile Council of America, Inc., latest edition.

1.3 SUBMITTALS

A. Samples

1. Submit samples of all available colors and patterns of ceramic tile.
2. Submit manufacturers' technical literature.

B. Master Grade Certificates

1. Prior to opening tile containers, submit to the Engineer a Master Grade Certificate, signed by an officer of the firm manufacturing the tile use, and issued when the shipment is made, stating the grade, kind of tile, identification marks for tile containers, and the name and location of the project.

1.4 PRODUCT DELIVERY, HANDLING, AND STORAGE

A. Delivery and Storage

1. Deliver all materials of this section to the job site in their original unopened containers with all labels intact and legible at time of use.
2. Store all materials under cover in a manner to prevent damage and contamination; store only the specified materials at the job site.

B. Protection

1. Use all means necessary to protect tile materials before, during and after installation and to protect the installed work and materials of all other trades.

C. Replacements

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 TILE

A. Ceramic Tile

1. Manufacturers

a. All ceramic tile shall be a product of the Endicott Tile, or equal.

B. Design

1. Ceramic Tile

a. Tile shall be smooth surface, glazed ceramic tile, 7-5/8" x 7-5/8” x ½”.

C. Colors

1. Ceramic Tile

a. All ceramic tiles shall be in colors selected by the Owner from the manufacturer's range of standard colors and patterns in the specified products.

2.2 MORTAR

A. On Floors

1. Epoxy mortar, ANSI A118.3, AO 4000 Epoxy or Altax Rezklad.

2.3 GROUT

A. Type

1. All grout for ceramic tile shall be a good grade commercial cement grout especially manufactured for this purpose and subject to review of the Engineer. Floor grout shall be gray, wall grout shall be white.

2.4 OTHER MATERIALS

A. All other materials, not specifically described but required for a complete and proper tile installation, shall be as selected by the Contractor subject to review of the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that tile may be installed in accordance with the original design, all pertinent codes and regulations, and the referenced standards.

B. Discrepancies

1. In the event of discrepancy, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 INSTALLATION

A. Follow installation specifications for specified mortars over various subfloor materials as recommended by standards of the Tile Council of America and in strict accordance with ANSI standards.

3.3 CLEANING UP

A. Upon completion of all tile installation and grouting, thoroughly clean the exposed surfaces of all tile.

END OF SECTION 09310

SECTION 09912 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Engineer will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

C. Do not paint prefinished items, concealed surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Finished mechanical and electrical equipment.
b. Light fixtures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Foundation spaces.
b. Furred areas.
c. Ceiling plenums.
d. Utility tunnels.
e. Pipe spaces.
f. Duct shafts.

3. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.

d. Motor and fan shafts.
e. Piping.

4. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:

1. Division 5 Section "Structural Steel" for shop priming structural steel.
2. Division 8 Section "Standard Steel Doors and Frames" for factory priming steel doors and frames.
3. Division 9 Section "High-Performance Coatings" for industrial paints and maintenance and for special coatings.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Initial Selection: For each type of finish-coat material indicated.

1. After color selection, Engineer will furnish color chips for surfaces to be coated.

C. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.

3. Submit three (3) Samples on the following substrates for Engineer's review of color and texture only:

   a. Concrete: 4-inch square samples for each color and finish.
   b. Concrete Unit Masonry: 4-by-8-inch, 6-by-10-inch samples of masonry, with mortar joint in the center, for each finish and color.
   c. Painted Wood: 8-inch square Samples for each color and material on hardboard.
   d. Stained or Natural Wood: 4-by-8-inch samples of natural or stained wood finish on representative surfaces.
   e. Ferrous Metal: 3-inch square Samples of flat metal and 6-inch long Samples of solid metal for each color and finish.

D. Qualification Data: For Applicator.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.

   1. Engineer will select one room or surface to represent surfaces and conditions for application of each type of coating and substrate.

      a. Wall Surfaces: Provide samples on at least 100 sq. ft.
      b. Small Areas and Items: Engineer will designate items or areas required.

   2. Apply benchmark samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.

      a. After finishes are accepted, Engineer will use the room or surface to evaluate coating systems of a similar nature.

   3. Final approval of colors will be from benchmark samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.

4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

1.7 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

2. Quantity: Furnish Owner with an additional 3 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: As selected by Engineer from manufacturer's full range.

2.2 INTERIOR PRIMERS

A. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.

1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
2. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
3. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

B. Interior Wood Primer for Acrylic-Enamel and Semigloss Alkyd-Enamel Finishes: Factory-formulated alkyd- or acrylic-latex-based interior wood primer.

1. Benjamin Moore; Moorcraft Super Spec Alkyd Enamel Underbody and Primer Sealer No. 245: Applied at a dry film thickness of not less than 1.5 mils.
2. Sherwin-Williams; PrepRite Wall and Wood Primer B49W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
3. Sherwin-Williams; PrepRite Classic Interior Primer B28W101 Series: Applied at a dry film thickness of not less than 1.6 mils.

2.3 EXTERIOR FINISH COATS

A. Exterior Semigloss Acrylic Enamel: Factory-formulated semigloss waterborne acrylic-latex enamel for exterior application.

1. Benjamin Moore; Moorcraft Super Spec Latex House & Trim Paint No. 170: Applied at a dry film thickness of not less than 1.1 mils.
2. Pittsburgh Paints; 6-900 Series SpeedHide Exterior House & Trim Semi-Gloss Acrylic Latex Paint: Applied at a dry film thickness of not less than 1.5 mils.
3. Sherwin-Williams; A-100 Latex Gloss A8 Series: Applied at a dry film thickness of not less than 1.3 mils.

2.4 INTERIOR FINISH COATS

A. Interior Flat Acrylic Paint: Factory-formulated flat acrylic-emulsion latex paint for interior application.

1. Benjamin Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
2. Pittsburgh Paints; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil.
3. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.

B. Interior Low-Luster Acrylic Enamel: Factory-formulated eggshell acrylic-latex interior enamel.

1. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils.
2. Pittsburgh Paints; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils.
3. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils.

C. Interior Semigloss Acrylic Enamel: Factory-formulated semigloss acrylic-latex enamel for interior application.

1. Benjamin Moore; Moorcraft Super Spec Latex Semi-Gloss Enamel No. 276: Applied at a dry film thickness of not less than 1.2 mils.
2. Pittsburgh Paints; 6-500 Series SpeedHide Interior Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.0 mil.
3. Sherwin-Williams; ProMar 200 Interior Latex Semi-Gloss Enamel B31W200 Series: Applied at a dry film thickness of not less than 1.3 mils.

D. Interior Semigloss Alkyd Enamel: Factory-formulated semigloss alkyd enamel for interior application.

1. Benjamin Moore; Moorcraft Super Spec Alkyd Semi-Gloss Enamel No. 271: Applied at a dry film thickness of not less than 1.4 mils.
2. Pittsburgh Paints; 6-1110 Series SpeedHide Interior Enamel Wall & Trim Semi-Gloss Oil: Applied at a dry film thickness of not less than 1.4 mils.
3. Sherwin-Williams; ProMar 200 Interior Alkyd Semi-Gloss Enamel B34W200 Series: Applied at a dry film thickness of not less than 1.7 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify Engineer about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.

2. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including cabinets, counters, cases, and paneling.
c. If transparent finish is required, backprime with spar varnish.
d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
10. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
3. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Uninsulated metal piping.
2. Uninsulated plastic piping.
3. Pipe hangers and supports.
4. Tanks that do not have factory-applied final finishes.
5. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
6. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
7. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

G. Electrical items not to be painted include, but are not limited to, the following:

1. Switchgear.
2. Panelboards.
3. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

I. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

J. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

K. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 PIPING COLOR AND LABEL SCHEDULE

A. All piping colors and labeling shall comply with the latest edition of Recommended Standards for Waste Water Facilities. The following schedule shall apply:

1. Raw sludge line - brown with black bands
2. Sludge recirculation suction line - brown with yellow bands
3. Sludge draw off line - brown with orange bands
4. Sludge recirculation discharge line - brown
5. Natural gas line- orange (or red) with black bands
6. Non-potable water line- blue with black bands
7. Potable water line - blue
8. Chlorine line - yellow
9. Sewage (wastewater) line- gray
10. Compressed air line - green
11. Fuel oil/diesel - red
12. Plumbing drains and vents - black
13. Polymer - purple

3.5 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke the following test procedure at any time and as often as Owner deems necessary during the period when paint is being applied:

1. Owner may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

3.6 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.7 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Engineer.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

C. Wood Trim: Provide the following finish systems over exterior wood trim:

1. Semigloss Acrylic-Enamel Finish: Two finish coats over a primer.

a. Primer: Exterior wood primer for acrylic enamels.
b. Finish Coats: Exterior semigloss acrylic enamel.

D. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.

1. Semigloss Acrylic-Enamel Finish: Two finish coats over a rust-inhibitive primer.

a. Primer: Exterior ferrous-metal primer.
b. Finish Coats: Exterior semigloss acrylic enamel.

3.8 INTERIOR PAINT SCHEDULE

A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:

1. Flat Acrylic Finish: Two finish coats over a primer.

a. Primer: Interior gypsum board primer.
b. Finish Coats: Interior flat acrylic paint.

2. Low-Luster Acrylic-Enamel Finish: Two finish coats over a primer.

a. Primer: Interior gypsum board primer.
b. Finish Coats: Interior low-luster acrylic enamel.

B. Wood and Hardboard: Provide the following paint finish systems over new interior wood surfaces:

1. Low-Luster Acrylic-Enamel Finish: Two finish coats over a primer.

a. Primer: Interior wood primer for acrylic-enamel and semigloss alkyd-enamel finishes.
b. Finish Coats: Interior low-luster acrylic enamel.

END OF SECTION 09912

SECTION 09960 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes surface preparation and field application of high-performance coating systems to items and surfaces scheduled.

B. Related Sections include the following:

1. Division 5 Section "Structural Steel" for shop priming structural steel.
2. Division 9 Section "Painting" for general field painting.

1.3 DEFINITIONS

A. Standard coating terms defined in ASTM D 16 apply to this Section.

B. Gloss ranges used in this Section include the following:

1. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
2. High gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

C. Environments: The following terms are used in Part 2 of this Section to distinguish between different corrosive exposures:

1. "Severe environments" are highly corrosive industrial atmospheres with sustained exposure to submergence, high humidity and condensation and with frequent cleaning using strong chemicals. Environments with heavy concentrations of strong chemical fumes and frequent splashing and spilling of harsh chemical products are severe environments.
2. "Moderate environments" are corrosive industrial atmospheres with intermittent exposure to high humidity and condensation, occasional mold and mildew development, and regular cleaning with strong chemicals. Environments with exposure to heavy concentrations of chemical fumes and occasional splashing and spilling of chemical products are moderate environments.
3. "Mild environments" are industrial atmospheres with normal exposure to moderate humidity and condensation, occasional mold and mildew development, and infrequent cleaning with strong chemicals. Environments with low levels of mild chemical fumes

and occasional splashing and spilling of chemical products are mild environments. Normal outdoor weathering is also considered a mild environment.

1.4 SUBMITTALS

A. Product Data: For each coating system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.

B. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, Engineer will furnish color chips for surfaces to be coated.

D. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. List of material and application for each coat of each sample. Label each sample for location and application.
3. Submit samples on the following substrates for Engineer's review of color and texture:

a. Ferrous and Nonferrous Metal: Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample of each type of coating and substrate required. Comply with procedures specified in PDCA P5. Duplicate finish of approved sample Submittals.

1. Engineer will select one room, area, or surface to represent surfaces and conditions for application of each type of coating and substrate.

   a. Wall Surfaces: Provide samples on at least 100 sq. ft. (9 sq. m) of wall surface.
   b. Small Areas and Items: Engineer will designate items or areas required.

2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface as specified. Provide the required sheen, color, and texture of each surface.

   a. After finishes are accepted, Engineer will use the room or surface to evaluate coating systems of a similar nature.

3. Final approval of colors will be from benchmark samples.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

1.7 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 45 and 95 deg F (7 and 35 deg C).

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

A. Furnish extra high-performance coating materials from the same production run as materials applied and in quantities described below. Package coating materials in unopened, factory-sealed containers for storage and identify with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.785 L) or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 COATINGS MATERIALS, GENERAL

A. Material Compatibility: Provide primers, undercoats, and finish-coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. VOC Classification: Provide high-performance coating materials, including primers, undercoats, and finish-coat materials, that have a VOC classification of 450 g/L or less.

2.3 COATING MATERIALS

D. Ferrous Metal: Provide the following finish systems over ferrous-metal surfaces; applied at spreading rate recommended by manufacturer.

1. Interior, Non-Submerged: One finish coat over an intermediate coat and a primer.

a. Primer:
1) Tnemec: 37H Chem Prime HS or 66-1211, 3.0-4.0 mils dft.
2) Carboline/Kop Coat: Rustarmor 29 or Carboline D898 LT, 2.0-3.0 mils dft.
3) Con Lux: Rust Barrier 55 Red Primer, 1.5-2.5 mils dft.

b. Intermediate Coat:
1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft.

2) Carboline/Kop Coat: Carbomastic 801, 3.0-4.0 mils dft.
3) Con Lux: Epolon Multi-Mil Series, 4.0-5.0 mils dft.

c. Topcoat:
1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft.
2) Carboline/Kop Coat: Carbomastic 801, 3.0-4.0 mils dft.
3) Con Lux: Epolon Multi-Mil Series, 4.0-5.0 mils dft.

2. Exterior, Non-Submerged: One finish coat over an intermediate coat and a primer.

a. Primer:
1) Tnemec: 37H Chem Prime HS or 66-1211, 3.0-4.0 mils dft.
2) Carboline/Kop Coat: Rustarmor 29 or Carboline D898 LT, 2.0-3.0 mils dft.
3) Con Lux: Rust Barrier 55 Red Primer, 1.5-2.5 mils dft.

b. Intermediate Coat:
1) Tnemec: 66 Epoxoline HB, 4.0-6.0 mils dft.
2) Carboline/Kop Coat: Carbomastic 801, 4.0-6.0 mils dft.
3) Con Lux: Epolon Multi-Mil Series, 4.0-6.0 mils dft.

c. Topcoat:
1) Tnemec: 73 Endura-Shield, 1.5-2.5 mils dft.
2) Carboline/Kop Coat: Carbothane 134 HS, 1.5-2.5 mils dft.
3) Con Lux: Acrolon II 2200 Series, 1.5-2.5 mils dft.

3. Submerged: One finish coat over an intermediate coat and a primer.

a. Primer:
1) Tnemec: 37H Chem Prime HS or 66-1211, 3.0-4.0 mils dft.
2) Carboline/Kop Coat: 340 Gold Primer, 2.0-3.0 mils dft.
3) Con Lux: Epoxide 34 Ceramic White, 2.0-3.0 mils dft.

b. Intermediate Coat:
1) Tnemec: 66 Epoxoline HB, 4.0-6.0 mils dft.
2) Carboline/Kop Coat: Super Hi-Gard 891, 4.0-6.0 mils dft.
3) Con Lux: Epoxide 33 Ceramic Buff, 4.0-6.0 mils dft.

c. Topcoat:
1) Tnemec: 66 Epoxoline HB, 4.0-6.0 mils dft.
2) Carboline/Kop Coat: Super Hi-Gard 891, 4.0-6.0 mils dft.
3) Con Lux: Epoxide 34 Ceramic White, 4.0-6.0 mils dft.

4. Surfaces Exposed to heat above 200 deg. F: One finish coat over an intermediate coat.

a. Intermediate Coat:
1) Tnemec: 39-661 Hot Surface Aluminum, 1.3-1.7 mils dft.
2) Carboline/Kop Coat: Carbo Zinc 11 HS, 1.3-1.7 mils dft.
3) Con Lux: 1200 Aluminum 57, 1.3-1.7 mils dft.

b. Topcoat:
1) Tnemec: 39-661 Hot Surface Aluminum, 1.3-1.7 mils dft.

2) Carboline/Kop Coat: Carbo Zinc 11 VOC, 1.3-1.7 mils dft.
3) Con Lux: 1200 Aluminum 57, 1.3-1.7 mils dft.

5. Encased in Concrete: One primer coat.

a. Primer:
1) Tnemec: 10-99 Red Metal Primer, 2.0-3.0 mils dft.
2) Carboline/Kop Coat: GP 818 Primer, 2.0-3.0 mils dft.
3) Con Lux: Epoxide Rust Arrestor 50 Red Primer, 2.0-3.0 mils dft.

6. Galvanized Surfaces: One finish coat over an intermediate coat.

a. Intermediate Coat:
1) Tnemec: 66 Epoxoline HB, 2.5-3.5 mils dft.
2) Carboline/Kop Coat: Rustbond Penetrating Sealer, 1.0-3.0 mils dft.
3) Con Lux: Epolon Multi-Mil Series, 2.5-3.5 mils dft.

b. Topcoat:
1) Tnemec: 66 Epoxoline HB, 2.5-3.5 mils dft.
2) Carboline/Kop Coat: Carbomastic 801, 4.0-6.0 mils dft.
3) Con Lux: Epolon Multi-Mil Series, 2.5-3.5 mils dft.

E. Nonferrous Metal: Provide the following finish systems over nonferrous-metal surfaces; applied at spreading rate recommended by manufacturer.

1. Intermediate Coat:

a. Tnemec: 66 Epoxoline HB, 2.5-3.5 mils dft.
b. Carboline/Kop Coat: Rustbond Penetrating Sealer, 1.0-3.0 mils dft.
c. Con Lux: Epolon Multi-Mil Series, 2.5-3.5 mils dft.

2. Topcoat:

a. Tnemec: 66 Epoxoline HB, 2.5-3.5 mils dft.
b. Carboline/Kop Coat: Carbomastic 801, 4.0-6.0 mils dft.
c. Con Lux: Epolon Multi-Mil Series, 2.5-3.5 mils dft.

F. Concrete Surfaces: Provide the following finish systems over concrete surfaces; applied at spreading rate recommended by manufacturer.

1. Submerged: One finish coat over an intermediate coat.

a. Intermediate Coat:
1) Tnemec: 46H-413 HB Tneme- tar, 8.0-10.0 mils dft, thinned 5%.
2) Carboline/Kop Coat: Bitumastic 300M, 8.0-10.0 mils dft, thinned 5%.
3) Con Lux: Epolon 22 Black Mastic, 8.0-10.0 mils dft, thinned 5%.

b. Topcoat:
1) Tnemec: 46H-413 HB Tneme- tar, 8.0-10.0 mils dft.
2) Carboline/Kop Coat: Bitumastic 300M, 8.0-10.0 mils dft.
3) Con Lux: Epolon 22 Black Mastic, 8.0-10.0 mils dft.

2. Interior, Ceilings: One finish coat over an intermediate coat.

   a. Intermediate Coat:
      1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft, thinned 5%.
      2) Carboline/Kop Coat: Carbomastic 801, 3.0-4.0 mils dft, thinned 5%.
      3) Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft, thinned 5%.

   b. Topcoat:
      1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft.
      2) Carboline/Kop Coat: Carbomatic 801, 3.0-4.0 mils dft.
      3) Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft.

3. Interior, Walls: One finish coat over an intermediate coat.

   a. Intermediate Coat:
      1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft, thinned 5%.
      2) Carboline/Kop Coat: Carbomastic 801, 3.0-4.0 mils dft, thinned 5%.
      3) Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft, thinned 5%.

   b. Topcoat:
      1) Tnemec: 66 Epoxoline HB, 5.0-6.0 mils dft.
      2) Carboline/Kop Coat: Carbomatic 801, 5.0-6.0 mils dft.
      3) Con Lux: Epolon Multi-Mil Series, 5.0-6.0 mils dft.

4. Exterior, Walls: One finish coat over an intermediate coat.

   a. Intermediate Coat:
      1) Tnemec: 52 Tneme-crete, 8.0-10.0 mils dft.
      2) Carboline/Kop Coat: Flexxide B Smooth, 8.0-10.0 mils dft.
      3) Con Lux: Cement Plex 800 Series, 8.0-10.0 mils dft.

   b. Topcoat:
      1) Tnemec: 52 Tneme-crete, 8.0-10.0 mils dft.
      2) Carboline/Kop Coat: Flexxide B Fine, 8.0-10.0 mils dft.
      3) Con Lux: Cement Plex 800 Series, 8.0-10.0 mils dft.

5. Floors, Non-Submerged: One finish coat over an intermediate coat and a primer.

   a. Primer:
      1) Tnemec: 66 Epoxoline HB, 2.0-3.0 mils dft, thinned 5%.
      2) Carboline/Kop Coat: 890, 2.0-3.0 mils dft, thinned 5%.
      3) Con Lux: Epolon Multi-Mil Series, 2.0-3.0 mils dft, thinned 5%.

   b. Intermediate Coat:
      1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft.
      2) Carboline/Kop Coat: 890, 3.0-4.0 mils dft.
      3) Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft.

   c. Topcoat:
      1) Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft.
      2) Carboline/Kop Coat: 890, 3.0-4.0 mils dft.

3) Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft.

6. Non-Slip Floors, Non-Submerged: One finish coat over an intermediate coat, a primer and a non-slip additive.

a. Primer:
1) Tnemec: 66 Epoxoline HB, 2.0-3.0 mils dft, thinned 5%.
2) Carboline/Kop Coat: 890, 2.0-3.0 mils dft, thinned 5%.
3) Con Lux: Epolon Series, 2.0-3.0 mils dft, thinned 5%.

b. Intermediate Coat:
1) Tnemec: 104 HS Epoxy, 3.0-4.0 mils dft.
2) Carboline/Kop Coat: 890, 3.0-4.0 mils dft.
3) Con Lux: Epolon Series, 2.0-2.5 mils dft.

c. Topcoat:
1) Tnemec: 104 HS Epoxy, 3.0-4.0 mils dft.
2) Carboline/Kop Coat: 890, 3.0-4.0 mils dft.
3) Con Lux: Epolon Series, 2.0-2.5 mils dft.

d. Non-Slip Additive:
1) Tnemec: Al2O3 #24 broadcast at 3.0-4.0 pounds per 100 SF, divided between the primer and 2ND coats.
2) Carboline/Kop Coat: Al2O3 #24 broadcast at 3.0-4.0 pounds per 100 SF, divided between the primer and 2ND coats.
3) Con Lux: Broadcast or incorporate Tek shells on/in the 3rd coat at a rate of 1.0 pound shells per gallon paint.

G. Unit Masonry Assemblies: Provide the following finish systems over unit masonry surfaces; applied at spreading rate recommended by manufacturer.

1. Primer:
a. Tnemec: 130 Envirofill, 75-100 SF per gallon.
b. Carboline/Kop Coat: Flexxide Masonry Block Filler, 75-100 SF per gallon.
c. Con Lux: Block-Plex 85 White, 75-100 SF per gallon.

2. Intermediate Coat:
a. Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft, thinned 5%.
b. Carboline/Kop Coat: Carbomastic 801, 3.0-4.0 mils dft, thinned 5%.
c. Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft, thinned 5%.

3. Topcoat:
a. Tnemec: 66 Epoxoline HB, 3.0-4.0 mils dft.
b. Carboline/Kop Coat: Carbomatic 801, 3.0-4.0 mils dft.
c. Con Lux: Epolon Multi-Mil Series, 3.0-4.0 mils dft.

4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

1. Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.
2. Start of application is construed as Applicator's acceptance of surfaces within that particular area.

B. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

a. Confirmation of primer's suitability for expected service conditions.
b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify Engineer about anticipated problems before using the coatings specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove plates, machined surfaces, and similar items already in place that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. After completing coating operations, reinstall items that were removed; use workers skilled in the trades involved.

B. Cleaning: Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

C. Surface Preparation: Clean and prepare surfaces to be coated according to manufacturer's written instructions for each substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove primers and reprime substrate.
2. Cementitious Substrates: Prepare concrete, brick, concrete masonry block, and cement plaster surfaces to be coated. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods to prepare surfaces.

a. Use abrasive blast-cleaning methods if recommended by coating manufacturer.

b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not coat surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

3. Ferrous-Metal Substrates: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC recommendations.

a. Blast-clean steel surfaces as recommended by coating manufacturer and according to SSPC-SP 10/NACE No. 2.
b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire brush, solvent clean, and touch up with same primer as the shop coat.

4. Nonferrous-Metal Substrates: Clean nonferrous and galvanized surfaces according to manufacturer's written instructions for the type of service, metal substrate, and application required.

a. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Material Preparation: Carefully mix and prepare coating materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. General: Apply high-performance coatings according to manufacturer's written instructions.

1. Use applicators and techniques best suited for the material being applied.
2. Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.
3. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
4. Provide finish coats compatible with primers used.
5. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, grilles, covers for finned-tube radiation, and similar components are in

place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.

a. Coat surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
b. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

6. All interior piping shall be painted in general accordance with Section 54.5 of "Ten States Recommended Standards for Wastewater Facilities". In lieu of painting colored bands, arrow tape and pipe labeling shall be used in the colors stated in Section 54.5.

B. Scheduling Coating: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required is the same regardless of application method.

a. Omit primer on metal surfaces that have been shop primed and touchup painted.
b. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.
c. Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.
d. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until coating has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat does not cause undercoat to lift or lose adhesion.

2. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance. Give special attention to edges, corners, crevices, welds, exposed fasteners, and similar surfaces to ensure that they receive a dry film thickness equivalent to that of flat surfaces.

C. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
b. Brush out and work brush coats into surfaces in an even film.
c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.

a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
b. Apply each coat to provide the equivalent hiding of brush-applied coats.
c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

D. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

F. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

1. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

G. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 FIELD QUALITY CONTROL

A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:

1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform appropriate tests for the following characteristics as required by Owner:

a. Quantitative materials analysis.
b. Absorption.
c. Accelerated weathering.
d. Accelerated yellowness.
e. Color retention.
f. Alkali and mildew resistance.
g. Abrasion resistance.
h. Apparent reflectivity.
i. Washability.
j. Dry opacity.
k. Recoating.
l. Skinning.

3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove

noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

3.5 CLEANING

A. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3.6 PROTECTION

A. Protect work of other trades, whether being coated or not, against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.
2. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

END OF SECTION 09960

SECTION 10431 - SIGNS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Panel signs.
2. Cast-metal plaques.
3. Signage accessories.

B. Related Sections include the following:

1. Division 15 Section "Mechanical Identification" for labels, tags, and nameplates for mechanical equipment.
2. See Division 16 Sections for electrical service and connections for illuminated characters and for access to remote transformers.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.

B. Shop Drawings: Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.

1. Provide message list for each sign, including large-scale details of wording, lettering, artwork.

C. Samples for Initial Selection: For each type of sign material indicated that involves color selection.

D. Samples for Verification: For each type of sign, include the following Samples to verify color selected:

1. Panel Signs: Full-size Samples of each type of sign required.
2. Casting: Show representative texture, character style, spacing, finish, and method of attachment.
3. Approved samples will not be returned for installation into Project.

E. Qualification Data: For Installer.

F. Maintenance Data: For signage cleaning and maintenance requirements to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by signage manufacturer.

B. Source Limitations: Obtain each sign type through one source from a single manufacturer.

C. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

1. Interior Code Signage: Provide signage as required by accessibility regulations and requirements of authorities having jurisdiction. These include, but are not limited to, the following:

a. Illuminated Exit Signs: Refer to Division 16.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 PROJECT CONDITIONS

A. Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

A. For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.

1. For signs supported by or anchored to permanent construction, furnish templates for installation of anchorage devices.

B. Coordinate location of remote transformers with building construction. Ensure that transformers are accessible after completion of Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
3. Basis-of-Design Product: The design for each sign is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 PANEL SIGNS

A. General: Provide panel signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

1. Produce smooth panel sign surfaces constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 inch measured diagonally.

B. Available Manufacturers:

1. Allenite Signs; Allen Marking Products, Inc.
2. American Graphics Inc.
3. Best Manufacturing Co.

C. Plastic Laminate: Provide high-pressure laminate engraving stock with face and core plies in contrasting colors.

D. Unframed Panel Signs: Fabricate signs with edges mechanically and smoothly finished to comply with the following requirements:

1. Edge Condition: Square cut.
2. Corner Condition: Radius

E. Laminated Panels: Permanently laminate face panels to backing sheets of material; use manufacturer's standard process.

F. Subsurface Copy: Apply minimum 4-mil- thick vinyl copy to back face of clear acrylic sheet forming panel face to produce precisely formed opaque image. Image shall be free from rough edges.

G. Applied Copy: Die-cut characters from vinyl film of nominal thickness of 3 mils with pressure-sensitive adhesive backing. Apply copy to exposed face of panel sign.

1. Panel Material: Opaque acrylic sheet.

H. Colored Coatings for Acrylic Sheet: For copy and background colors, provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are nonfading for application intended.

2.3 CAST-METAL PLAQUES

A. General: Provide castings free from pits, scale, sand holes, and other defects. Comply with requirements specified for metal, border style, background texture, and finish and in required thickness, size, shape, and copy.

B. Available Manufacturers:

1. A.R.K. Ramos.
2. American Graphics Inc.
3. Gemini Incorporated.

C. Bronze Castings: ASTM B 584, alloy UNS No. C83600 (No. 1 manganese bronze).

D. Border Style: Plain bevel.

E. Background Texture: Manufacturer's standard pebble texture.

F. Mounting: Concealed studs for substrates encountered.

2.4 PANEL SIGN TYPES

A. Room Signs:

1. Material: Plastic laminate.
2. Perimeter: Unframed.
3. Copy: Surface.
4. Character Style: Helvetica.
5. Sizes:

   a. Sign: 8x11.
   b. Character: Minimum 1-inch high characters.

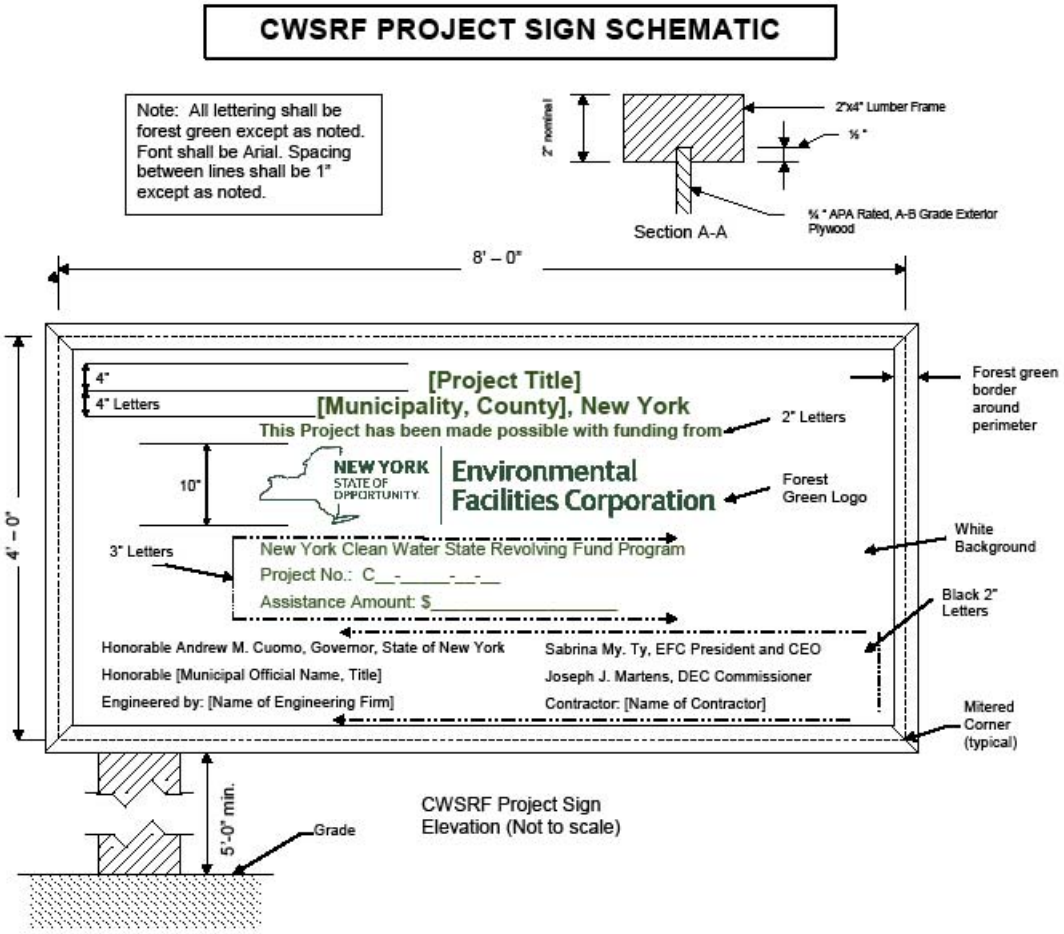
B. Toilet Room Signs:

1. Material: Plastic laminate.
2. Perimeter: Unframed.
3. Copy: Raised.
4. Character Style: Helvetica.
5. Text: According to requirements in the ADA or of authorities having jurisdiction, whichever are more stringent.
6. Message: Fixed.
7. Sizes:

   a. Sign: 8x11
   b. Character: Minimum 1-inch- high characters.

C. Symbols of Accessibility: Provide 6-inch- high symbol fabricated from opaque nonreflective vinyl film, 0.0035-inch nominal thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.

D. EFC Project Sign: Project sign shall be fabricated and erected within 21 days following the notice to proceed and shall be maintained by the Contractor until completion of construction and the Owner's acceptance of the work. Sign shall be constructed as noted on the contract plans. The sign panel shall be constructed of 3/4-inch APA rated, A-B grade exterior plywood, with rust proof fasteners. The sign shall be adequately supported and braced to remain in the proper positioning and alignment, including resistance to wind loads and toppling of the sign. Painting shall comply with specification section 09912. Sign details shall be as indicated in the following schematic:



2.5 ACCESSORIES

A. Vinyl Film: Provide opaque nonreflective vinyl film, 0.0035-inch minimum thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.

B. Mounting Methods: Use concealed fasteners fabricated from materials that are not corrosive to sign material and mounting surface.

C. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or

lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Note Holders: Manufacturer's standard aluminum paper sheet holders.

2.6 FINISHES, GENERAL

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

B. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify that items, including anchor inserts, provided under other sections of Work are sized and located to accommodate signs.

C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

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

3.2 INSTALLATION

A. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.
2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.

B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using methods indicated below:

1. Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.

2. Hook-and-Loop Tapes: Use hook-and-loop tapes to mount signs to smooth, nonporous surfaces.
3. Magnetic Tape: Use magnetic tape to mount signs to smooth, nonporous surfaces.
4. Silicone-Adhesive Mounting: Use liquid-silicone adhesive recommended in writing by sign manufacturer to attach signs to irregular, porous, or vinyl-covered surfaces. Use double-sided vinyl tape where recommended in writing by sign manufacturer to hold sign in place until adhesive has fully cured.
5. Shim Plate Mounting: Provide 1/8-inch- thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
6. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
7. Where panel signs are scheduled or indicated to be mounted on glass, provide matching plate on opposite side of glass to conceal mounting materials.

C. Bracket-Mounted Units: Provide manufacturer's standard brackets, fittings, and hardware as appropriate for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.

D. Cast-Metal Plaques: Mount plaques using standard fastening methods recommended in writing by manufacturer for type of wall surface indicated.

1. Concealed Mounting: Mount plaques by inserting threaded studs into tapped lugs on back of plaque. Set in predrilled holes filled with quick-setting cement.
2. Face Mounting: Mount plaques using exposed fasteners with rosettes attached through face of plaque into wall surface.

3.3 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

END OF SECTION 10431

SECTION 10520 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Portable fire extinguishers.
2. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

3. Mounting brackets for fire extinguishers.

B. Related Sections include the following:

1. Division 10 Section "Signs" for directional signage to out-of-sight fire extinguishers and cabinets.
2. Division 16 Section " Lighting" for fire extinguisher location lights.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.

1. Fire Extinguishers: Include rating and classification.
2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

B. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.

C. Samples for Verification: For each type of exposed factory-applied color finish required for fire-protection cabinets, prepared on Samples of size indicated below.

1. Size: 6 by 6 inches square.

D. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

D. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

1.6 SEQUENCING

A. Apply decals on field-painted fire-protection cabinets after painting is complete.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AVAILABLE MANUFACTURERS:

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
3. Basis-of-Design Product: The design for each product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Sheet: ASTM B 209.
2. Extruded Shapes: ASTM B 221.

C. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1.

D. Acrylic Bubble: One piece.

2.3 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:

1. Amerex Corporation.
2. Ansul Incorporated.
3. JL Industries, Inc.
4. Kidde Fyrnetics.
5. Larsen's Manufacturing Company.
6. Watrous; Div. of American Specialties, Inc.

B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Valves: Manufacturer's standard.
2. Handles and Levers: Manufacturer's standard.
3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

C. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.4 FIRE-PROTECTION CABINET

A. Manufacturers:
   1. JL Industries, Inc.
   2. Kidde Fyrnetics.
   3. Larsen's Manufacturing Company.

B. Cabinet Type: Suitable for fire extinguisher.

C. Cabinet Construction: Nonrated.

D. Cabinet Material: Enameled-steel sheet.

   1. Shelf: Same metal and finish as cabinet.

E. Finishes:

   1. Manufacturer's standard baked-enamel paint for the following:

      a. Exterior of cabinet door, and trim, except for those surfaces indicated to receive another finish.
      b. Interior of cabinet and door.

   2. Steel: Baked enamel.

      a. Color and Texture: As selected by Engineer from manufacturer's full range.

2.5 MOUNTING BRACKETS

A. Available Manufacturers:

   1. Amerex Corporation.
   2. Ansul Incorporated.
   3. Badger Fire Protection.
   4. Buckeye Fire Equipment Company.
   5. Fire End & Croker Corporation.
   6. General Fire Extinguisher Corporation.
   7. JL Industries, Inc.
   8. Larsen's Manufacturing Company.
   9. Potter Roemer; Div. of Smith Industries, Inc.

B. 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.

C. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

    a. Orientation: Horizontal.

2.6 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material.

    a. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 FINISHES, GENERAL

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

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 STEEL FINISHES

A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

B. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.

1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

C. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged units.

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

3.2 PORTABLE FIRE EXTINGUISHERS AND CABINETS

A. Provide three units at locations as directed by Owner or Engineer.

B. Mount hangers securely in position, following manufacturer’s recommendations.

C. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated below.

1. Fire-Protection Cabinets: 54 inches above finished floor to top of cabinet.
2. Mounting Brackets**:** 54 inches above finished floor to top of fire extinguisher.

D. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

E. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

F. Identification: Apply decals at locations indicated.

3.3 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10520

SECTION 11011 – SLUDGE AND MAKE-UP WATER CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 WORK SPECIFIED

A. Return Sludge Pumps, P-5-1, P-5-2 and P-5-3.

B. Make-Up Water Pump, P-5-4.

1.2 THE REQUIREMENTS

A. The Work requires that the manufacturer of the pumps be responsible for furnishing the work as specified, but without altering the Contractor's responsibilities under the Contract Documents.

B. Furnish, test, paint, install and place in satisfactory operation all pumps, motors, variable frequency drives and control panels, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

C. The equipment shall include the specified items plus all necessary shims, anchor bolts, couplings, sheaves, motor flanges, etc. that are required to mount the pumps, motors and appurtenances, as required for a complete operational system and as shown on the Drawings.

D. These specifications are intended to provide a general description of what is required, but does not cover all details which will vary in accordance with the requirements of the equipment furnished.

E. All necessary accessory equipment and appurtenances shall be provided for a complete and operating system whether or not specifically stated in the Specifications.

F. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Division 16 Section “Electric Motors”.

B. Division 16 Section “Variable Frequency Drives”

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings

1. Pump hydraulic characteristic curves, efficiencies, required NPSH, pump vibration readings and horsepower curves at pump rotative speeds corresponding to the conditions specified. Vibration limits as defined by the Hydraulic Institute shall also be provided. For those pumping units specified requiring flexibility for future modifications that are to be made by the Owner, "present" and "future" condition pump curves shall be submitted.
2. Certified pump performance test curves shall be submitted as specified in Part 3 of this Section.
3. Complete motor data, electrical nameplate data and wiring descriptions.
4. Copies of all factory test results.
5. A list of the manufacturer's recommended special tools, spare parts and recommended lubricants to be supplied.
6. Equipment specifications and data sheets identifying all materials used.
7. Calculations for B-10 bearing life, shaft size, coupling size and anchor bolt size.
8. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, design of baseplate, anchor bolt locations and forces, and layout required clearances.
9. Uncrated weight of the pump, weight of heaviest part of pump.
10. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A532. Each individual casting shall be Brinnell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a Professional Engineer. Test results shall verify the satisfaction of the required Brinnell hardness of the finished product as specified in respective subsections.

C. Reports of manufacturer representative field tests and visits.

D. Additional items specified in this Section.

E. Operation and Maintenance Manuals: Submit in accordance with Division 1.

1.5 REFERENCES

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the reference portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. AISC specification for the design and fabrication of structural steel;
2. American Bearing Manufacturers Association (ABMA)
3. American Gear Manufacturers Association (AGMA)
4. American Iron and Steel Institute (AISI)
5. American Welding Society (AWS)
6. New York State Industrial Code
7. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch).
8. ANSI S2.41 - Mechanical Vibration of Large Rotating Machines with Speed Range from 10 to 200 Rev/s - Measurement and Evaluation of Mechanical Vibration Severity In-situ.
9. ASTM A29 - Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for.

10. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
11. ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.
12. ASTM A532 - Abrasion-Resistant Cast Irons.
13. ASTM A536 - Ductile Iron Castings.
14. ASTM A743 - Castings, Iron-Chromium-Nickel, Corrosion Resistant for General Application.
15. ASTM B276 - Test Method for Apparent Porosity in Cemented Carbides.
16. ASTM C633 - Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings.
17. ASTM E10 - Test Method for Brinell Hardness of Metallic Materials.
18. ASTM E384 - Test Method for Microhardness of Materials.
19. ANSI/ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
20. ANSI/ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
21. ANSI/AWS A5.13 - Specification for Solid Surfacing Welding Rods and Electrodes.

1.6 PRODUCT DELIVERY, HANDLING AND STORAGE

A. All components shall be prepared for shipment in accordance with the carriers' specifications. Equipment and instruments shall be boxed (completely enclosed). All other components and loose pieces shall be skidded, crated or palleted to the carriers' specifications. Further, all skids, carriers and pallets shall be enclosed in water-tight plastic wrapping, 6 mil. minimum thickness.

B. Master shipping list shall be supplied showing the quantity of each section, subassembly, or piece, the piece number and the drawing on which each subassembly or piece is detailed.

C. All equipment shall be prominently marked for identification in assembly. The area(s) in which the equipment is/are designated to be used shall be indicated on the shop drawings. The part identification shall be stenciled conspicuously on large pieces of equipment. Small parts shall have a metal tag wired in place with identification stamped or etched.

D. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

E. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

F. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

G. Finished surfaces of all exposed equipment openings shall be protected by wooden blanks, strongly built and securely attached thereto.

H. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

I. After factory tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

J. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.7 QUALITY ASSURANCE

A. Provide the services of a manufacturer's representative as listed in the Schedule at the end of this Section.

1.8 DATA PLATES

A. The pump(s) will have a stainless steel nameplate attached with the following information:

1. Pump Size
2. Flow (gpm)
3. Total Dynamic Head (feet)
4. Speed
5. Material of Construction
6. Impeller Diameter
7. Serial Number

1.9 DRIVE COUPLINGS AND SHAFTING

A. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided if shown on the Drawings or specified in Part 2 - "PRODUCTS" to allow removal of the pump rotating element without disturbing the driver.

1.10 HARDWARE

A. Furnish and install stainless steel anchor bolts, washers and appurtenant items.

1.11 TOOLS, LUBRICANTS, SUPPLIES AND SPARE PARTS

A. Provide the following:

1. One (1) set of all special tools.
2. Lubricating oils and grease for each pump, sufficient for one (1) year of operation.
3. Spare parts, to be furnished as specified for each type of pump, in Part 2 "Products" of this Section and the Schedule at the end of this Section.

1.12 WARRANTY

A. Provide one (1) year warranty.

PART 2 - PRODUCTS

2.1 PUMPS

A. General: Each pump shall be an enclosed base-mounted non-clog, centrifugal pump, heavy duty, end suction type, designed for pumping municipal sludge, and arranged as shown on Contract Drawings.

B. Performance Requirements

1. Pump(s) shall meet the requirements listed in the Schedule at the end of this Section.

C. Basis of Design Manufacturer/Model: Pumps shall be as manufactured by ITT-AC.

1. Return Activated Sludge Pumps, P-5-1, P-5-2 and P-5-3: Type NSW, Horizontal Model 150.
2. Make-Up Water Pump, P-5-4: Type NSW, Vertical Model 300.

D. Materials and Construction

1. Pumps: The pumps shall be designed to handle municipal sludge at approximately 3 to 6 percent dry solids. The pump shall be end suction construction as shown in the drawings. The unit shall be designed such that the motor may be removed from the pump for independent servicing.

a. Casing: Casing shall be made of close grained cast iron conforming to ASTM A48, Class 30, and shall provide smooth unobstructed passages large enough to pass solids of the specified size. A cleanout handhole with removable cover shall be provided to allow for removal of any foreign material blocking or impeding performance of the pump. The inner contours of the handhole cover shall match the contours of the casing in which it fits. Casing shall be enclosed by a removable suction and stuffing box cover carefully machined and aligned. Suction and discharge connections shall be ANSI Standard flat faced 125 pound flanges, and shall be drilled and tapped for gauge, drain and vent connections or shall be self-venting. The necessary lifting bolts and eye lugs shall be provided for installation and maintenance of the pumps.
b. Suction Cover: The suction cover shall be constructed of the same material as the casing and shall be integrally cast with 125 pound ANSI standard flange. Cover shall be quickly removable for access to the impeller.
c. Impeller: The impeller shall be of the one piece, single suction, enclosed non-clog type and shall be made from closed grain cast iro
Class 30, and shall be statically, hydraulically, and dynamically balanced. The impeller shall be designed with smooth flow passages to pass solids of specified size and to prevent clogging by stringy materials. The impeller shall be bolted, keyed and locked to the pump shaft at the factory.
d. Rotation: Rotation of pumps shall be clockwise when viewed from the driven end, unless otherwise shown on the Drawings.
e. Stuffing Box Cover: The Stuffing box cover shall be constructed of cast iron, ASTM A48, Class 30, and shall be designed with a machined self centering fit
with the pump casing. Tapped holes shall be provided for oil or seal water connection as specified.
f. Stuffing Box: The stuffing box shall be capable of accepting both packing and mechanical seal. Provisions shall be made for five (5) rings of die-formed packing

plus split Teflon lantern ring. Packing glands shall be of the split type. Seals shall be provided as specified in the Schedule at the end of this Section.

g. Shaft: The shaft shall be Type SAE 1045 steel, minimum, sufficiently large in diameter to transmit safely the maximum torque developed by the drive unit and of such a design as to provide a rigid support for the impeller and to prevent excessive vibration. The shaft shall be suitably heat-treated, turned, ground, and polished over its entire length and shall be protected through the stuffing box by a removable hardened stainless steel shaft sleeve with seal to prevent leakage.

h. Shaft Sleeve: The shaft sleeve shall be constructed of 420 series stainless steel hardened to 450 Brinell or better or corrosion resistant bronze, and secured to prevent reversal of rotation. An "O" ring seal shall be provided between the shaft and the impeller hub to prevent leakage under the sleeve. The shaft sleeve shall not be threaded.

i. Bearings: Bearings shall be of the anti-friction ball or tapered roller type in a dust-proof housing. Bearings shall be oil lubricated by constant level oilers with provisions for the addition or draining of lubricant. The bearings shall be designed for continuous heavy duty loads and for both axial and radial thrust loads. The bearing frame shall be of rigid cast iron construction to support the shaft and the bearings, and shall be designed so that the complete rotating element can be removed from the casing without disconnecting the piping. Bearings shall have a minimum AFBMA B-10 life of 100,000 hours under worst possible operating conditions.

j. Bearing Housing: The bearing housing shall be constructed of cast iron, ASTM, A48, Class 30 designed to provide a fully enclosed bearing housing incorporating a seal water catch basin with a tapped drain and overflow ports where applicable.

k. Wearing Rings: Wearing rings shall be of the removable type, of 400 series stainless steel hardened to 450 Brinell. One wearing ring shall be on the impeller and one on the casing.

l. Wear Adjustment: Rotating assembly shall be readily adjustable by jack screws at the end of the bearing housing so that, as wear occurs, proper impeller □to□suction cover liner clearance can be maintained without dismantling the pump.

m. Base: The pump shall be supported by a cast iron mounting foot type pedestal cast integrally with, or especially fabricated for, the pump casing and sufficiently sized to ensure rigid support of the pump and motor. The common pump and motor base shall be suitably constructed to support the equipment and shall be provided with grout holes and drain connections with drip □lip, as necessary.

n. Coupling: Pump shaft connections to drives shall be directly connected through flexible couplings as manufactured by Falk, Dodge, or equal. Couplings shall be provided with coupling guards.

2. Electric Motors:

a. UL-listed, NEMA MG 1, totally enclosed fan cooled, induction motor complying with and NFPA 70.

b. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features shall be coordinated with and approved by controller manufacturer.

1) Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2) Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3) Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4) Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

c. The pump horsepower required for any point on the pump characteristic curve shall not exceed the rated motor horsepower. The service factor of the motors shall not be used to meet any operating conditions.

2.2 SHOP PAINTING

A. Before exposure to weather and prior to shop painting, all surfaces shall be thoroughly cleaned, dry and free from all mill/scale, rust, grease, dirt and other foreign matter.

B. All pumps, motors and drives shall be shop primed as specified in Section 09900 of the specifications.

C. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance.

2.3 SPARE PARTS

A. Supply the spare parts listed in the Schedule(s) at the end of this Section.

2.4 PRESSURE GAUGES

A. Where listed in the Schedule pressure gauges shall be furnished and installed. Pressure gauges shall comply with the following requirements.

1. The pressure gauge assembly shall generally consist of case, dial and pointer, movements, glass measuring element and socket assembly. The pressure gauge shall generally conform to ANSI Standard B40.1.
2. The case shall be weatherproof and watertight with solid front and furnished with a standard blowout back or blowout disc in the back. Nominal size of the case shall be 4-1/2 inches. Case material shall be phenolic or high impact polypropylene, unless otherwise specified.
3. The material for measuring element shall be 316 stainless steel.
4. The dial shall be made of laminated plastic with black scale lettering on white background. The scale shall extend over at least 270° of dial circumference. A stop pin shall be used to restrict the upper limit of the pointer travel. Raised dial, split pointer or mirror ring shall be provided to eliminate parallax error.
5. The movement shall be stainless steel, helically wound with jeweled bearings and shall be adjustable and accessible for recalibration in the field. It shall have easily accessible external zero adjustment.
6. The gauge shall have shatter-proof plastic front.

7. Diaphragm seals, when specified, shall be furnished assembled to the pressure gauge, completely filled and calibrated. Top housing material shall be SS with 1/2 inch NPT connection for the gauge. Diaphragms seal fill liquid shall be silicone.
8. Bottom housing connection shall be 1-inch NTPF for threaded type. Flushing connection shall be ¼-inch NPTF. Bottom housing material shall be 316 stainless steel.
9. Pulsation dampeners shall be provided for gauges used to monitor pump discharge pressure. Pulsation dampener material shall be 316 SS.
10. The accuracy of the pressure gauge shall be ±1% of full scale. The pressure gauges shall be as manufactured by Ametek Ashcroft, U.S. Gauge, Weksler or equal.

PART 3 - EXECUTION

3.1 ALIGNMENT, INSTALLATION AND IDENTIFICATION

A. Tolerances for alignment, installation requirements for equipment and piping, and piping and equipment identification shall be in accordance with Manufacturer's requirements and Contract Documents.

3.2 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades for oil and grease shall be in accordance with the manufacturers recommendations.

B. Pumps shall be installed and adjusted in such a manner that connecting piping will not impose any strain whatever on any pump. Pump shall be set upon level, fully grouted foundations so that connecting flanges, screwed connection, or flexible connections will meet without strain or distortion.

3.3 EQUIPMENT SHOP TESTS

A. General

1. Pump shop tests shall be made by the manufacturer and certified curves shall be submitted.
2. The shop tests shall consist of standard IEEE tests of motors, operation of the pumps and motors installed on the actual pump and motor bases to be furnished for proper balance of equipment and all other requirements as specified under this section.
3. Factory testing shall be performed in accordance with the standards of the Hydraulic Institute and shall be required for all pumps and drives as scheduled.
4. All electronic transducers, meters, gauges, and test instruments shall be calibrated within Thirty (30) days prior to the scheduled test and certified calibration data shall be provided.

B. Pump Tests

1. Hydrostatic tests of each pump casing shall be performed in accordance with Hydraulic Institute Standards at no less than two times the shut-off head shown on the characteristic curve for at least one (1) hour.
2. All pumps shall be tested through the specified range of flow vs. head/capacity/efficiency curves plotted at pump design speed. During each test, the pump shall be run at each head/capacity condition as specified in the pump schedule for sufficient time to accurately determine discharge, head, power input, pump efficiency and motor efficiency. The pumps will be tested with a submergence as required to demonstrate that the NPSH and submergence required by the pump at the runout operating point listed in the pump schedule will be satisfied by pump settings furnished.
3. Pumping run tests shall conform to standards of the Hydraulic Institute with the pumps tested at rated full speed for at least five (5) points on the entire pump characteristic curve including the specified operating conditions of head and capacity.
4. Pump tests shall utilize the actual motors and pump motor bases to pumping equipment. Use of the manufacturers standard test motor is not acceptable.
5. Test information shall include noise measurements, capacities, heads, speeds, drawn horsepower, pump efficiencies and motor efficiencies.

C. Electric Motors Tests: Each electric motor shall be tested as specified in Division 16.

D. Report of Tests: Test reports shall include a pump and motor speed torque curve from zero to 100 percent full load speed.

3.4 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform functional test:

1. Alignment: test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:

   a. Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified. Certify vibration characteristics are within manufacturers acceptable design limits.
   b. If units exhibit vibration in excess of the limits specified. Adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor and record bearing areas on pump and motor. Certify temperatures are within manufacturers acceptable design limits.

B. Engage a factory-authorized service representative to perform a performance test: In accordance with Hydraulic Institute Standards.

1. Conduct on each pump separately and in two- and three-pump parallel operation.
2. Perform under actual operating conditions.
3. Test for continuous 2-hour period alone and 1-hour period for each parallel pump combination without malfunction.

4. Test Log: Record the following:

   a. Total Head.
   b. Capacity.
   c. Horsepower requirements with calibrated meter.
   d. Flow measured with calibrated field instruments.
   e. Pump suction and discharge pressure converted to feet of liquid pumped and corrected to pump suction and discharge centerline.
   f. Calculated velocity head at the suction and discharge flange.
   g. Driver motor voltage and amperage measured for each phase.

5. Adjust, realign or modify units and retest in accordance with the above if units fail to meet any specified parameters.

C. Engage a factory-authorized service representative to coordinate with controls contractor to determine pump speeds other than full speed that cause excessive vibration.

3.5 FIELD PAINTING

A. All pumps, piping, and motors shall be field painted as specified in Section 09900.

3.6

CENTRIFUGAL PUMPING EQUIPMENT SCHEDULE

Item	Return Activated Sludge Pumps
Identification	P-5-1, P-5-2, P-5-3
Location	Pipe Gallery
Quantity	Three (3)
Pump Type	Horizontal Non-Clog
Basis of Design Manufacturer/Model	ITT-AC, Type NSW, Horizontal Model 150
Size	6 x 6 x 17
Liquid Pumped	Return Sludge
Design Flow (gpm)/Head (ft)	1,875 gpm/75 feet
Shutoff Head	110 feet
Pump Speed	1180 rpm
Pump Efficiency at Rating Point	73%
Minimum Flow	500 gpm @ 15 feet
Suction Condition	Flooded
Diameter, Minimum-Inlet/Discharge	6 inches/6 inches
Solids Concentration (percent)	2,000 mg/l
Diameter of sphere which can pass through pump	Three (3) inches
Seals	Packing
Temperature	Ambient-Poughkeepsie, NY
Electric Power	480 volt/60 cycle/three phase
Motor Horsepower (minimum)	60
Motor Speed (rpm)	1200
Motor Enclosure	TEFC
Appurtenant Items, for each pump	Inlet Pressure Gauges Discharge Pressure Gauges Local Control Stations
Spare Parts	• Three (3) complete sets of gaskets, "O"-rings, etc. • One (1) shaft sleeve, key and accessories. • Motor and electrical spare parts in accordance with Division 16. • One (1) pump impeller with nut, washer and key. • Three (3) drive couplings. • Three (3) sets of packing. • One (1) shaft.
Services of a Manufacturer's Representative	Three days-one (1) day per pump One (1) day for training

Item	Make-Up Water Pump
Identification	P-5-4
Location	Pipe Gallery
Quantity	One (1)
Pump Type	Vertical Non-Clog
Basis of Design Manufacturer/Model	ITT-AC, Type NSW, Vertical Model 300
Size	4 x 4 x 10
Liquid Pumped	Effluent Water
Design Flow (gpm)/Head (ft)	400 gpm/52 feet
Shutoff Head	68 Feet
Pump Speed	1750 rpm
Pump Efficiency at Rating Point	68%
Minimum Flow	
Suction Condition	Flooded
Diameter, Minimum-Inlet/Discharge	4 inches/4 inches
Solids Concentration (percent)	2,000 mg/l
Diameter of sphere which can pass through pump	2.5 inches
Seals	Mechanical
Temperature	Ambient-Poughkeepsie, NY
Electric Power	480 volt/60 cycle/three phase
Motor Horsepower (minimum)	10
Motor Speed (rpm)	1800
Motor Enclosure	TEFC
Appurtenant Items	Inlet Pressure Gauge Discharge Pressure Gauge Local Control Station
Spare Parts	• One (1) complete set of gaskets, "O"-rings, etc. • One (1) shaft sleeve, key and accessories. • Motor and electrical spare parts in accordance with Division 16. • One (1) pump impeller with nut, washer and key. • One (1) drive coupling. • One (1) mechanical seal. • One (1) shaft.
Services of a Manufacturer's Representative	One (1) day

END OF SECTION 11011

SECTION 11012 – DOUBLE DISC SLUDGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Furnish and install double disc sludge pumps as specified in this section and where shown on the drawings. Pumps shall be complete pump unit consisting of pump, v-belt drive arrangement, and motor all completely assembled on fabricated stainless steel base and shall conform to the pump requirement described herein.
   1. Primary Sludge Pumps, P-2-1 and P-2-2.
   2. Thickened Sludge Pumps, P-6-1 and P-6-2.

1.3 SUBMITTALS

A. Shop Drawings
   1. Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, drive unit, parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the submittals section. The data and specifications for each shall include detailed information on the pump to include:

      a. Pump
         1) Manufacturer
         2) Type and model
         3) RPM at rated and future condition
         4) Size of suction and discharge flanges
         5) Complete performance curves
         6) Net weight of pump and baseplate
         7) Base and anchor bolt details
         8) Data on pressure sensor and switch assemblies

      b. Motor
         1) Manufacturer
         2) Type, model, and enclosure
         3) Rated size of motor, HP, and service factor
         4) Temperature rise and insulation rating
         5) Full load rotative speed
         6) Net weight
         7) Efficiency at full, ¾, and ½ load
         8) Full load current

9) Locked rotor current
10) Overall dimensions and base details
11) Power factor at no load and at full load
12) Complete motor data, electrical nameplate data and wiring descriptions.

c. Certified pump performance test curves shall be submitted as specified in Part 3 of this Section.

d. A list of the manufacturer's recommended special tools, spare parts and recommended lubricants to be supplied.

e. Copies of all factory test results

1) Equipment specifications and data sheets identifying all materials used.
2) Calculations for B-10 bearing life, shaft size, coupling size and anchor bolt size.

f. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, design of baseplate, anchor bolt locations and forces, and layout required clearances.

g. Uncrated weight of the pump, weight of heaviest part of pump.

h. Foundry certificates and results of Brinell hardness testing showing compliance to ASTM A532. Each individual casting shall be Brunel tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a Professional Engineer. Test results shall verify the satisfaction of the required Brinell hardness of the finished product as specified in respective subsections.

B. Reports of manufacturer representative field tests and visits.

C. Additional items specified in this Section.

D. Operation and Maintenance Manuals: Complete with manufacturer’s instructions for equipment installation, equipment function, start-up procedures, operation, preventative maintenance, servicing and troubleshooting. Submit in accordance with Division 1.

1.4 REFERENCES

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the reference portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. AISC specification for the design and fabrication of structural steel;
2. American Bearing Manufacturers Association (ABMA)
3. American Gear Manufacturers Association (AGMA)
4. American Iron and Steel Institute (AISI)
5. American Welding Society (AWS)
6. New York State Industrial Code
7. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (inch).

8. ANSI S2.41 - Mechanical Vibration of Large Rotating Machines with Speed Range from 10 to 200 Rev/s - Measurement and Evaluation of Mechanical Vibration Severity In-situ.
9. ASTM A29 - Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for.
10. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
11. ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.
12. ASTM A532 - Abrasion-Resistant Cast Irons.
13. ASTM A536 - Ductile Iron Castings.
14. ASTM A743 - Castings, Iron-Chromium-Nickel, Corrosion Resistant for General Application.
15. ASTM B276 - Test Method for Apparent Porosity in Cemented Carbides.
16. ASTM C633 - Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings.
17. ASTM E10 - Test Method for Brinell Hardness of Metallic Materials.
18. ASTM E384 - Test Method for Microhardness of Materials.
19. ANSI/ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
20. ANSI/ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
21. ANSI/AWS A5.13 - Specification for Solid Surfacing Welding Rods and Electrodes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All components shall be prepared for shipment in accordance with the carriers' specifications. Equipment and instruments shall be boxed (completely enclosed). All other components and loose pieces shall be skidded, crated or palleted to the carriers' specifications. Further, all skids, carriers and pallets shall be enclosed in water-tight plastic wrapping, 6 mil. minimum thickness.

B. Master shipping list shall be supplied showing the quantity of each section, subassembly, or piece, the piece number and the drawing on which each subassembly or piece is detailed.

C. All equipment shall be prominently marked for identification in assembly. The area(s) in which the equipment is/are designated to be used shall be indicated on the shop drawings. The part identification shall be stenciled conspicuously on large pieces of equipment. Small parts shall have a metal tag wired in place with identification stamped or etched.

D. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

E. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

F. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

G. Finished surfaces of all exposed equipment openings shall be protected by wooden blanks, strongly built and securely attached thereto.

H. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

I. After factory tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

J. Each box or package shall be properly marked to show its net weight in addition to its contents.

K. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

1.6 EXPERIENCE AND QUALITY ASSURANCE

A. The equipment manufacturer shall be experienced in manufacturing pumping equipment of this technology as specified and have a record of successful in-service performance. Manufacturer must have at least ten (10) years' experience with (20) similar facilities in operation.

B. All equipment must strictly conform to the requirements herein. If there are any exceptions they must be clearly listed. If the equipment is approved for use on this project and is found at any time in the future that exceptions were not listed, the Owner shall have the right to reject the equipment or require the manufacturer to modify the equipment to bring it into compliance at no increase in cost to the contract.

C. The equipment shall be 100% manufactured in the U.S. and all spare parts shall be available for same day shipment and next day delivery. The manufacturer shall maintain a fully equipped shop facility to perform all operations including welding, fabrication, assembly and testing. These integrated operations provide the level of quality necessary for the equipment specified. All materials shall be designed to withstand the stresses encountered in fabrication, erection and operation. All equipment shall be of corrosion resistant materials or shall be suitably protected by the supplier with corrosion resistant industrial coatings approved by the engineer.

1.7 DATA PLATES

A. The pump(s) will have a stainless steel nameplate attached with the following information:

1. Pump Manufacturer
2. Model Number
3. Serial Number
4. Year Built
5. Contact Information

1.8 HARDWARE

A. Furnish and install stainless steel anchor bolts, washers and appurtenant items.

1.9 TOOLS, LUBRICANTS, SUPPLIES AND SPARE PARTS

A. Provide the following:

1. One (1) set of all special tools.
2. Lubricating oils and grease for each pump, sufficient for one (1) year of operation.

3. Spare parts, to be furnished as specified for each type of pump, in Part 2 "Products" of this Section and the Schedule at the end of this Section.

1.10 WARRANTY

A. The equipment shall be warranted for a period of two (2) year against defects in workmanship and materials under normal use, operation and service. If the equipment should fail during the warranty period due to a defective part, it shall be replaced and the units restored at no expense to the owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
3. Basis-of-Design Product: The design for each item is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product.

B. Basis-of-Design Product: Subject to compliance with requirements, provide double disc sludge pumps Model PVD 728 6DDSX107 Rev.C “Piggy Back” as manufactured by Penn Valley Pump Co, Inc. or a comparable product.

2.2 PUMPS

A. Each pump shall be a simplex heavy duty, free diaphragm, disc style positive displacement type, with Class 30 Cast Iron Housings. Duplex pumping arrangements shall not be acceptable. The pump shall consist of three (3) housings horizontally split to allow access to the internal components. The pump shall incorporate a Maintain-in-Place hinged design that allows the pump to be serviced and discs replaced without removal of the pump or disturbing the suction and discharge piping. The discharge housing shall contain the mounting lugs and be bolted directly to the mounting frame. The discharge, intermediate and suction housings shall incorporate an integral hinge arrangement that allows the suction and intermediate housings to be lowered and removed. The hinges shall be connected to each other with a quick release ball detent pin allowing for easy pin removal.

B. The pumps shall be capable of providing 1.07 gallons per revolution when operating at 60ft head. The pumps shall be capable of operating dry for an indefinite period of time without damage. The pumps shall be capable of self-priming up to 14”Hg and 25”Hg when fully primed.

C. The pumping action shall be achieved by two (2) free floating reciprocating discs attached to high tensile aluminum connecting rods driven by a rotating eccentric shaft. Each disc shall be mounted to the connecting rod by a stub shaft constructed of hardened high tensile 400 series stainless steel. The discs shall be of integral design and constructed of high tensile neoprene with multiple layers of fabric for longevity and strength. Pump designs that use a captive diaphragm with metal plate shall not be acceptable. The suction and discharge discs shall be universal and interchangeable with each other to increase the commonality of spare parts and eliminate confusion. The reciprocating action of the discs shall also perform the duty of valves. Pumps that require internal check valves for operation shall not be acceptable.

D. Sealing of the pump fluid chamber shall be achieved by flexible trunnions. The trunnion seal shall not be designed to provide any pumping action. The trunnion construction shall be of fabric-reinforced neoprene and shall be capable of withstanding pressures from 0 to 110 PSI on an intermittent basis. Maximum operating pressure is 140' TDH. Pump designs utilizing packing glands, mechanical seals or water seal systems will not be acceptable.

E. The swan neck entry port to the suction housing shall be a two (2) piece design allowing for mounting of the suction connection in 90 degree increments and easy access for clack replacement. The upper swan neck shall be provided with a 3" NPT connection to allow mounting of the suction pulsation dampener if required. The opening shall be a full 6" diameter with a minimum opening of 28.26 square inches to minimize debris buildup and blockages. The seating surface for the clack valve shall be machined on the mounting face of the swan neck. The clack valve shall be integrally mounted to the swan neck to facilitate access and replacement. The clack valve shall be manufactured of neoprene construction with multiple layers of fabric encapsulating a rigid core. The clack valve shall incorporate an integral O-ring seal for positive sealing. Designs that incorporate a separate clack valve plate and smaller diameter opening shall not be acceptable.

F. The bearing drive assembly shall consist of two (2) aluminum modular pedestals designed to provide accurate bearing alignment, superior bearing loading and ease of assembly. The drive shaft shall be a minimum 1-15/16" diameter and capable of withstanding a dead head situation. The shaft shall be constructed of hardened 400 series high-tensile stainless steel and shall be mounted on four (4) self-aligning, sealed bearings. The eccentric cams shall be constructed of high tensile, cast bronze alloy and shall be pinned to the shaft by Spirol drive pins to allow for the absorption of reciprocating loads generated by the pumping action. Pump drive assemblies that utilize keyways and setscrews will not be acceptable. All drive bearings must be completely sealed with no provisions for scheduled grease lubrication. No grease fittings shall be supplied for the bearings.

G. The pump shall be driven through a V-belt and drive assembly consisting of a 2 or 3 groove Type B arrangement. The pulley ratio's shall be sized to provide the maximum pump speed listed in the pump schedule in this section and to provide the required torque generated between the pump and motor.

H. Pump shall be provided with OSHA approved guards and covers. The V-belt drive cover and pump drive assembly cover shall be manufactured from SS304 material.

I. Each pump and V-Belt assembly shall be mounted on a common SS304 sub base. Base design shall have raised cross-members on the suction and discharge end to allow for complete wash-out and draining without trapping liquid. Each sub base shall be manufactured from 2-1/2" SS304 square tubing. Base shall be sufficient gusseted, reinforced and braced to withstand all

shock loads and resist all wearing and buckling during pump operation. Tubing ends shall be capped with black plastic plugs for neat appearance.

J. Pulsation dampeners shall be provided on the suction and discharge lines. The dampeners shall be 6” ASA 150# flanged units and the main tube shall be 8” diameter SCH 40 carbon steel pipe with fully welded end caps. The suction dampener shall mount directly to the suction swan neck through the 3” NPT connection. The discharge dampener shall be a separate piece with 6” ASA 150# flanged connections. The dampeners shall be pressure tested to 60 psi for leaks. Each dampener shall be provided with a 1-inch half coupling located at the top. This connection shall be suitable for the vacuum and pressure switch assembly or the ball valve/quick disconnect assembly should a switch not be specified. Each dampener shall be supplied with a 1 ½” NPT coupling and plug in the bottom to act as a drain/sample port. Bladder type and three-piece assemblies using connecting rods and gasket shall not be acceptable.

2.3 MOTOR

A. The motor shall be adequately sized to withstand the loads during starting and pump operation. The power the horsepower and motor speeds shall conform to the specifications as outlined in the pump schedule in this section. Motor shall be severe duty, premium efficient, inverter ready per NEMA STD MG1 Part 31.4.4.2 with epoxy coated cast iron frame or equal.

B. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation.

2.4 SUCTION VACUUM PROTECTION

A. The pump manufacturer shall provide a suction vacuum sensor and switch assembly to mount on the suction pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 or equal 1-inch NPT isolation pressure sensor with SS316 body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360- degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with SS316 fittings. The vacuum assembly shall be fitted with 4” stainless steel 30”Hg – 30psi gauge and Ashcroft, Barksdale, or equal adjustable vacuum switch set at 10”Hg. The units shall be capable of being cleaned in place by simply using the process pressure through a SS316 isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.5 DISCHARGE PRESSURE PROTECTION

The pump manufacturer shall provide a discharge pressure sensor and switch assembly to mount on the discharge pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 or equal 1-inch NPT isolation pressure sensor with SS316 body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360-degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with SS316 fittings. The discharge assembly shall be fitted with a 4” stainless steel 0 -100 psi pressure gauge and shall be fitted with Ashcroft, Barksdale, or equal, adjustable switch preset at 30 psi. The units shall be capable of being cleaned in place by simply using the process pressure through a SS316 isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick

acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.6 SPECIAL TOOLS AND SPARE PARTS

A. Provide the following factory recommended spare parts, one (1) set total consisting of:

1. Two (2) Discs
2. Two (2) Trunnions
3. One (1) Complete set of gaskets
4. One (1) Clack valve

B. The pump manufacturer shall supply a universal, adjustable tool to aid in disc removal.

2.7 SHOP PAINTING

A. All cast iron and carbon steel components shall be finished with manufacturer's standard industrial grade primer 2 – 3 mils DFT suitable for multiple top coat finishes. The top coat shall be industrial enamel 2 – 3 mils DFT.

B. All stainless steel and aluminum surfaces will remain unpainted. All weld splatter shall be removed and all welds ground smooth for a neat appearance.

2.8 PRESSURE GAUGES

A. Where listed in the Schedule pressure gauges shall be furnished and installed. Pressure gauges shall comply with the following requirements.

1. The pressure gauge assembly shall generally consist of case, dial and pointer, movements, glass measuring element and socket assembly. The pressure gauge shall generally conform to ANSI Standard B40.1.
2. The case shall be weatherproof and watertight with solid front and furnished with a standard blowout back or blowout disc in the back. Nominal size of the case shall be 4-1/2 inches. Case material shall be phenolic or high impact polypropylene, unless otherwise specified.
3. The material for measuring element shall be 316 stainless steel.
4. The dial shall be made of laminated plastic with black scale lettering on white background. The scale shall extend over at least 270° of dial circumference. A stop pin shall be used to restrict the upper limit of the pointer travel. Raised dial, split pointer or mirror ring shall be provided to eliminate parallax error.
5. The movement shall be stainless steel, helically wound with jeweled bearings and shall be adjustable and accessible for recalibration in the field. It shall have easily accessible external zero adjustment.
6. The gauge shall have shatter-proof plastic front.
7. Diaphragm seals, when specified, shall be furnished assembled to the pressure gauge, completely filled and calibrated. Top housing material shall be SS with 1/2 inch NPT connection for the gauge. Diaphragms seal fill liquid shall be silicone.

8. Bottom housing connection shall be 1-inch NTPF for threaded type. Flushing connection shall be ¼-inch NPTF. Bottom housing material shall be 316 stainless steel.
9. Pulsation dampeners shall be provided for gauges used to monitor pump discharge pressure. Pulsation dampener material shall be 316 SS.
10. The accuracy of the pressure gauge shall be ±1% of full scale. The pressure gauges shall be as manufactured by Ametek Ashcroft, U.S. Gauge, Weksler or equal.

2.9 PUMP SCHEDULE

	P-2-1, P-2-2	P-6-1, P-6-2
Material Being Pumped	Primary sludge	Thickened sludge
Number of Units	2	2
Percent Solids	1-3%	1.5-4.5%
Maximum Capacity - Each Pump (GPM)	250 @ 25’ TDH	170 @ 20’ TDH
Minimum Capacity - Each Pump (GPM)	130 @ 7’ TDH	70 @ 5’ TDH
Suction & Discharge Port Size	6”, 150 lbs., flanged	6”, 150 lbs., flanged
Drive Type	V-belt and pulley arrangement	V-belt and pulley arrangement
Maximum Pump Speed (RPM)	200	150
Minimum Motor Horsepower	10	10
Maximum Motor Speed (RPM)	1200	1200
Service Factor	1.15 minimum	1.15 minimum
Motor Enclosure	TEFC	TEFC
Motor Electrical	230-460/3 Ph./60 Hz	230-460/3 Ph./60 Hz

PART 3 - EXECUTION

3.1 FIELD REPRESENTATIVE’S SERVICES

A. The equipment manufacturer shall furnish a qualified field service representative for the purpose to inspect the equipment after installation and to supervise its initial operation. The manufacturer’s representative shall inspect the installation and shall provide a written certification that the pump is installed in accordance with the manufacturers requirements. In addition to the time required to verify pump installation the following shall be provided:
   1. 2 man-day(s) for start-up and training services

3.2 ALIGNMENT, INSTALLATION AND IDENTIFICATION

A. Tolerances for alignment, installation requirements for equipment and piping, and piping and equipment identification shall be in accordance with Manufacturer’s requirements and Contract Documents.

3.3 INSTALLATION

A. Install all items in strict accordance with the manufacturer's instructions, as indicated and specified, in the locations shown on the Drawings.

B. Dowel to frame after alignment in the field to facilitate realignment after disassembly.

C. Install and align on a concrete pad as specified in the drawings.

D. Brace all piping at suction and discharge connections to withstand all shock loads and vibration.

E. Installation shall include furnishing the required oil and grease for initial operation. The grades for oil and grease shall be in accordance with the manufacturer's recommendations.

F. Pumps shall be installed and adjusted in such a manner that connecting piping will not impose any strain whatever on any pump. Pump shall be set upon level, fully grouted foundations so that connecting flanges, screwed connection, or flexible connections will meet without strain or distortion.

3.4 EQUIPMENT SHOP TESTS

A. General

1. Pump shop tests shall be made by the manufacturer and certified curves shall be submitted.
2. The shop tests shall consist of standard IEEE tests of motors, operation of the pumps and motors installed on the actual pump and motor bases to be furnished for proper balance of equipment and all other requirements as specified under this section.
3. Factory testing shall be performed in accordance with the standards of the Hydraulic Institute and shall be required for all pumps and drives as scheduled.
4. All electronic transducers, meters, gauges, and test instruments shall be calibrated within Thirty (30) days prior to the scheduled test and certified calibration data shall be provided.

B. Pump Tests

1. Hydrostatic tests of each pump casing shall be performed in accordance with Hydraulic Institute Standards at no less than two times the shut-off head shown on the characteristic curve for at least one (1) hour.
2. All pumps shall be tested through the specified range of flow vs. head/capacity/efficiency curves plotted at pump design speed. During each test, the pump shall be run at each head/capacity condition as specified in the pump schedule for sufficient time to accurately determine discharge, head, power input, pump efficiency and motor efficiency. The pumps will be tested with a submergence as required to demonstrate that the NPSH and submergence required by the pump at the runout operating point listed in the pump schedule will be satisfied by pump settings furnished.
3. Pumping run tests shall conform to standards of the Hydraulic Institute with the pumps tested at rated full speed for at least five (5) points on the entire pump characteristic curve including the specified operating conditions of head and capacity.
4. Pump tests shall utilize the actual motors and pump motor bases to be furnished with the pumping equipment. Use of the manufacturer's standard test motor is not acceptable.
5. Test information shall include noise measurements, capacities, heads, speeds, drawn horsepower, pump efficiencies and motor efficiencies.

C. Report of Tests: Test reports shall include a pump and motor speed torque curve from zero to 100 percent full load speed.

3.5 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform functional test:

1. Alignment: test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:

    a. Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified. Certify vibration characteristics are within manufacturers acceptable design limits.
    b. If units exhibit vibration in excess of the limits specified. Adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor and record bearing areas on pump and motor. Certify temperatures are within manufacturers acceptable design limits.

B. Engage a factory-authorized service representative to perform a performance test: In accordance with Hydraulic Institute Standards.

1. Conduct on each pump separately and in two- and three-pump parallel operation.
2. Perform under actual operating conditions.
3. Test for continuous 2-hour period alone and 1-hour period for each parallel pump combination without malfunction.
4. Test Log: Record the following:

    a. Total Head.
    b. Capacity.
    c. Horsepower requirements with calibrated meter.
    d. Flow measured with calibrated field instruments.
    e. Pump suction and discharge pressure converted to feet of liquid pumped and corrected to pump suction and discharge centerline.
    f. Calculated velocity head at the suction and discharge flange.
    g. Driver motor voltage and amperage measured for each phase.

5. Adjust, realign or modify units and retest in accordance with the above if units fail to meet any specified parameters.

C. Engage a factory-authorized service representative to coordinate with controls contractor to determine pump speeds other than full speed that cause excessive vibration.

3.6 ACCEPTANCE TESTS

A. Install all items in accordance with the printed instructions of the manufacturer, as indicated and specified.

B. Furnish labor, piping, equipment and material for conducting the tests.

C. Give each pump a running test in the presence of the ENGINEER demonstrating its ability to operate without vibration or overheating and deliver its rated capacity under specified conditions. Specifically the following items shall be measured at five (5) points over the entire operating range:
   1. Discharge Head
   2. Suction Head
   3. Capacity
   4. Pump Speed
   5. Amperage draw

D. Correct all defects or replace defective equipment, revealed and noted during tests. Make necessary adjustments at the time of tests at the expense of contractor.

E. Repeat tests if necessary to obtain results acceptable to engineer.

3.7 FIELD PAINTING

A. All piping and valves shall be field painted as specified in Section 09900.

END OF SECTION 11012

SECTION 11150 – DIFFUSED AERATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK SPECIFIED

A. The Contractor shall furnish all labor, materials, tools, and equipment necessary for supply, installation, testing, and placing into satisfactory operation all diffused aeration equipment shown on the Contract Drawings and specified herein.

B. Diffused aeration equipment shall be provided for three (3) aeration basins.

C. The diffused aeration equipment shall be provided complete with all adapters, piping, couplings, accessories, special tools, spare parts, supports, mountings, anchor bolts and other appurtenances as specified and as may be required for a complete and operating installation.

D. All items furnished by the equipment supplier under this section are for installation by the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 11213 - Packaged Aeration System.

1.4 SUBMITTALS

A. The Contractor shall submit Shop Drawings, Operation and Maintenance Instructions and other information as specified in accordance with the Specifications. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

B. The manufacturer shall guarantee the oxygen transfer efficiency of the equipment. Certified oxygen transfer efficiency and headloss curves shall be submitted based on previous testing conducted in accordance with the latest revision of ASCE Standards for the design submergence and range of operating airflows specified herein. The diffuser manufacturer shall submit performance and operational guarantees fully warranting all system components and performance for a period of 2 years from the date of substantial completion. Warranty shall include providing all labor for any repair or replacement required.

C. The manufacturer shall submit oxygen transfer efficiency and headloss data from three previous tests. Tests shall have been performed on diffusers identical to those provided for this project with submergence of 10 to 11 feet. If three (3) previous test reports are not available tests shall be performed in accordance with ASCE Test methods as required by the Engineer.

D. Installation instructions shall be complete including leveling, fastening, inspection, etc. The manufacturer's installation instructions shall be submitted prior to shipment of the diffuser equipment.

1.5 REFERENCES

A. American Society of Civil Engineers, (ASCE); latest applicable standards.

1.6 HANDLING AND STORAGE

A. Special care shall be exercised during delivery, handling, and storage of equipment and material to prevent damage, degradation of materials, and fouling. Delivery, handling, and storage of the piping and equipment shall be in accordance with manufacturer's recommendations and as specified in applicable sections of these specifications

PART 2 - PRODUCTS

2.1 GENERAL

A. Under this Section the Contractor shall provide a fine bubble diffusers system, consisting of multiple diffuser assemblies connected to lengths of air distribution piping, factory assembled.

B. The following number of diffusers shall be furnished and installed.

1. Number of Aeration Tanks: Three (3).
2. Number of Diffusers per Aeration Tank: 1068.
3. Total Number of Diffusers (not including spares): 3204.
4. Average airflow per diffuser: 1.21 scfm.
5. Maximum airflow per diffuser : 2 scfm.

C. Basis of Design: SSI Aeration Systems, Poughkeepsie, New York, POD Diffuser System.

2.2 MATERIALS

A. Diffuser assemblies.

1. Furnish disc type 9” membrane fine bubble diffusers
2. Diffuser to consist of a membrane with integral gasket, base, retaining ring, air flow control orifice of ¼”.
3. Membrane material to be premium quality compression molded EPDM with an oil content of less than 12% and two layer PTFE coating.
4. Membrane shall collapse and seal when aeration system air is turned off. Membrane shall collapse onto base when air is not being diffused. Design should permit air to exit through the entire periphery of the membrane. Membrane shall be designed to resist clogging, and should have a minimum of 6600 perforations. Membrane to be at least 70% hydrophilic. Characteristics follow:

a.	Surface Layer	PTFE
b.	Substrate Layer	EPDM
c.	Tensile strength	2000 PSI
d.	Tear strength	110 Lb/linear inch
e.	Ozone resistance	Pass
f.	UV resistance	Pass
g.	Durometer	60
h.	Ultimate elongation	700%
i.	FOG Resistant	Yes
j.	Solvent Resistant	Yes
k.	Biofouling Resistant	Yes
l.	Friction Coefficient	0.09

5. Diffuser base and retaining ring to be constructed of polypropylene with organic UV stabilizers. Plastics that do not utilize UV protection shall not be acceptable. Characteristics follow:

a.	Specific Gravity	0.905
b.	Water absorption	0.02%
c.	Tensile Strength	5000 PSI
d.	Coefficient of thermal expansion	05
e.	Maximum Temperature	100C

6. Diffuser assemblies shall be preassembled and factory press fit into 4” dia. header pipes.

B. Header Piping and Supports.

1. Header Stainless-Steel Pipe and Fittings: Schedule 10, ASTM A 312/A 312M, Grade TP304L or TP316L, welded seam, and grooved joint fittings unless otherwise indicated.

   a. Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron casting; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   b. Grooved-End-Pipe Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

      1) Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2. Diffuse Header Piping Supports: Shop-fabricated pipe-support assembly made of ASTM A 312/A 312M, Grade TP304L or TP316L stainless steel and stainless steel 3/8” threaded rod.

   a. Anchors: Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3. Diffuser system consisting of diffusers and header piping shall be shipped to site in pods consisting of preassembled header pipe laterals with pre-mounted diffusers. No individual component assembly shall occur at the job site to ensure the integrity of the aeration system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unless otherwise shown or specified, all equipment shall be installed in strict accordance with manufacturers' instructions and recommendations.

B. The Contractor shall replace any diffusers which are broken or damaged in shipment in relocation or during installation at no additional cost to the Owner. The Contractor shall also be responsible for providing proper storage at no additional cost to the Owner. Those diffusers to be stored by the Owner at the end of construction shall be inspected for integrity prior to acceptance for storage.

C. The Contractor shall comply with manufacturer's recommendations after diffusers are installed and before and during being placed in operation to insure that diffusers are maintained in "new" condition and to prevent any sliming or biofouling of the diffuser elements. The Contractor shall be fully responsible for replacement of any fouled diffusers due to improper installation conditions prior to acceptance by the Owner.

D. Contractor shall clean all air piping prior to installing diffuser elements. Contractor shall protect diffuser elements from unpressurized submergence in wastewater.

3.2 TOOLS, SUPPLIES AND SPARE PARTS

A. The Contractor shall furnish all required special tools necessary to adjust, service, repair, assemble, and disassemble the equipment.

B. The Contractor shall furnish all spare parts as recommended by the equipment manufacturers in addition to those listed below. All of these materials shall be properly packed, labeled and stored where directed by the Engineer, including:

1. Headers with POD mounted – 2
2. Diffuser Membranes - 20
3. Ø4” 304SS Supports - 5
4. Ø4” SS souplings – 3
5. Special Tool Kit – 1

3.3 SHOP QUALITY CONTROL TESTING FOR FINE BUBBLE DIFFUSERS

A. Prior to the start of production of membrane diffusers, the Contractor shall submit with the shop drawings a testing and sampling plan to insure consistently good quality and uniformity of the membrane diffusers. All diffusers that are tested shall be suitably marked with their test results.

B. All work of testing and inspecting shall be done at the point of manufacture. Imperfect or defective diffusers and those not meeting the requirements specified herein, shall be rejected. If any diffuser fails to meet the requirements of the individual tests stated below, additional tests shall be made on 5 percent of all the assembled diffusers. If these additional tests indicate that 10 percent or more of the assembled diffusers do not meet the requirements, the entire batch of

assembled diffusers shall be tested and the additional cost shall be borne by the Contractor. Alternative test procedures shall be required as directed by the Engineer if more than 10 percent of assembled diffusers do not meet test requirements. Assembled diffusers which fail to meet the requirements shall be discarded. Testing shall be in accordance with Military Standard 105D, AQL, Level 1.5, Double Normal Sampling. The expense of testing shall be borne by the Contractor and manufacturer.

C. One percent of all diffusers shall be tested to insure uniformity. Uniformity shall be defined as substantially even distribution of air bubbles when the diffuser is submerged and operating at 1 scfm.

D. All diffusers tested for uniformity shall be randomly sampled to insure adequate strength and for testing diffuser headloss. Adequate strength shall be defined as the ability of the sampled diffuser to withstand a vertical load of 1500 lbs. applied to the center one (1) inch diameter of the diffuser when the diffuser is properly supported in a fixture similar to the diffuser element holder. The manufacturer shall submit diffuser headloss results.

E. All diffusers accepted for uniformity shall be tested for dynamic wet pressure. Dynamic wet pressure shall be defined as the pressure loss across the diffuser when operated at a specific air flow minus any pressure for orifice head loss or diffuser submergence. The dynamic wet pressure shall be between 9.0 and 10.0 inches of water column when operated at 1.0 scfm.

F. Full details of test procedures shall be submitted with test results. All costs for performing tests shall be considered as included in the price bid.

3.4 FIELD TESTS

A. The Contractor shall conduct the installation and performance tests for the diffuser systems specified herein. Detailed procedures for all field testing shall be submitted with the shop drawings.

B. Level measurements shall be made for each diffuser during installation to insure that all diffusers are installed to within + 1/8 inch of a com
the existing basins. Field surveying equipment used shall be as approved by the Engineer. A final level check shall be made during air distribution tests. During filling, visual inspection shall be made when the water level is at the top of the diffuser elements to confirm that air diffusers are installed to within + 1/8 inch of a common horizontal plane.

END OF SECTION 11150

SECTION 11201 - SLIDE GATES AND WEIR GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Slide Gates
2. Weir Gates

1.3 SUBMITTALS

A. Product Data: Provide catalog cut sheets for the following:

1. Slide Gates and Weir Gates showing general construction, materials, sealing details and leakage rate.

B. Shop Drawings: Show fabrication details, including dimensions, for slide and weir gates.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

1.4 QUALITY ASSURANCE

A. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirement of the latest edition of ASME, Section IX.

B. Gates shall be shop inspected for proper operation before shipping.

C. The manufacturer shall be ISO 9001: 2000 certified.

PART 2 - PRODUCTS

2.1 SLIDE GATES AND WEIR GATES

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

1. Available Manufacturers:
    a. Rodney Hunt Company

B. General Design
1. Gates shall be either self-contained or non-self-contained and of the rising stem or non-rising stem configuration, as indicated on the gate schedule.

C. Gates
1. Frame
    a. The gate frame shall be constructed of structural members or formed plate. The frame shall be suitable for mounting on a concrete wall at the end of a channel, embedded inside a channel or mounted on the channel surface. The guide slot shall be of UHMWPE (ultra high molecular weight polyethylene). The slide gate frame configuration shall be of the flush-bottom type.
2. Slide
    a. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.
3. Guides And Seals
    a. Guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.
    b. Seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate. (The bottom seal of the slide gates shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush-bottom.)
    c. Seals shall maintain the specified leakage rate in both seating and unseating conditions.

D. Operators And Stem
1. Stem And Couplings
    a. The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lbs effort on the crank or handwheel.
    b. The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.
    c. Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.
2. For stems in more than one piece and with a diameter of 1 ¾ inches and larger, the different sections shall be joined together by solid bronze couplings. Stem with a diameter smaller than 1 ¾ inches shall be pinned to an extension tube.
3. The couplings shall be grooved and keyed and shall be of greater strength than the stem.
4. Gates having width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.
5. Stem Guides
    a. Stem guides shall be fabricated from type 304L (or 316L) stainless steel. The guide shall be equipped with a UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

6. Stem Cover
   a. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.
7. Lifting Mechanism
   a. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.
   b. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.
   c. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs on the crank or handwheel and shall be able to withstand, without damage, an effort of 80 lbs.
   d. The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 15 inches and the maximum handwheel diameter shall be 24 inches.
8. Yoke
   a. Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

E. Materials

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A-240 type 304L or 316L
Guides, side seals, bottom seals (weir gates),stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D-4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Bottom seal (slide gates)	Neoprene ASTM D2000 Grade 2 BC-510
Threaded stem	Stainless steel ASTM A-276 type 303 MX or 316
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316
Pedestal, handwheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D-3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS-C86500

F. Performance
1. Leakage
   a. Channel gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.05 U.S. gallon per minute per foot of seal periphery under the design seating head and unseating head.
2. Design Head

a. The gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).

2.2 NONADJUSTABLE WEIR PLATES

A. Nonadjustable weir plates shall be furnished and installed as shown on the Contract Drawings.

B. Materials:

1. Materials for the Slide Gates shall be as follows:

a. Weir Plate: A276 Type 316 Stainless Steel.
b. Frame and Guides: A276 Type 316 Stainless Steel.
c. Retainer Bars and Fasteners for Seals: A276 Type 316 Stainless Steel.
d. Anchor Bolts: A276 Type 316 Stainless Steel.

2.3 SLIDE GATE SCHEDULE

A. Location/Service: Headworks Building:

1. Quantity: Eight (8)
2. Nominal Size: Varies (see Drawings).
3. Type of Gate: Self Contained, Unsubmerged Opening.
4. Frame Type: In-Channel Mounted.
5. Operator: Manual, Handwheel Mounted on Frame.
6. Design Head: Ten (10) Feet.
7. Appurtenances: Stem Covers.

B. Location/Service: Diversion Chamber No. 1/Primary Settling Tanks Isolation:

1. Quantity: Six (6).
2. Nominal Size: Approximately 30” ht x 38” wide.
3. Type of Gate: Self Contained, Unsubmerged Opening.
4. Frame Type: End of Channel Mounted.
5. Operator: Manual, Handcrank Mounted on Frame.
6. Design Head: Twenty (20) Feet.
7. Appurtenances: Stem Covers.

C. Location/Service: Diversion Chamber No. 1/Overflow Isolation

1. Quantity: One (1).
2. Nominal Size: Approximately 48” ht x 38” wide.
3. Type of Gate: Self Contained, Unsubmerged Opening.
4. Frame Type: End of Channel Mounted.
5. Operator: Handwheel Mounted on Frame.
6. Design Head: Twenty (20) Feet.
7. Appurtenances: Stem Cover.

D. Location/Service: Diversion Manhole/Primary Settling Tanks #3 and #4 Isolation.

1. Quantity: Two (2).
2. Size: Approximately 20” ht x 18” wide; for 16” dia. pipe.
3. Type of Gate: Self Contained, Submerged Opening.
4. Frame Type: End of Channel.
5. Operator: Manual, handwheel mounted on frame.
6. Design Head: Twenty (20) Feet.
7. Appurtenances Stem Cover

E. Location/Service: Diversion Chamber No. 2/Aeration Bypass Isolation.

1. Quantity: One (1).
2. Size: Approximately 36” ht x 26” wide.
3. Type of Gate: Self Contained, Unsubmerged Opening.
4. Frame Type: End of Channel Mounted.
5. Operator: Manual, handwheel mounted on frame.
6. Design Head: Twenty (20) Feet.
7. Appurtenances: Stem Cover.

F. Location/Service: Diversion Chamber No. 2/Aeration Tank No. 1 Step Feed Inlet.

1. Quantity: One (1) – Two section Multi-Slide Gate Assembly
2. Type: Self Contained, Unsubmerged Opening.
3. Size: 20” ht x 15” wide; both gates.
4. Frame Type: End of Channel Mounted.
5. Operator Manual, Handcrank Mounted on Frame.
6. Design Head: Twenty (20) Feet.
7. Appurtenances: Stem Cover.

2.4 WEIR GATE SCHEDULE

A. Location/Service: Aeration Tank No. 1, No. 2 and No. 3:

1. Quantity: Three (3).
2. Nominal Size: Approximately 60” wide x 25¼” tall.
3. Type of Weir Plate: Self Contained; Thin Plate Weir.
4. Frame Type: End of Channel Mounted.
5. Operator: Manual, Handwheel Mounted on Frame.
6. Design Head: Ten (10) Feet.
7. Appurtenances: Stem Covers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Install the Work of this Section in strict accordance with the manufacturer’s recommendations.

B. Install equipment level and plumb.

C. Upon completion of installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored and adjust to achieve optimum operation.

D. Gates shall be checked for leakage (refer to the “Performance” section for approval criteria).

3.3 CLEANING

A. After completing installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 11201

SECTION 11207 - FLUMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Parshall Flumes

B. Related Sections include the following:

   1. Division 11 Section "Ultrasonic Flow Transmitter" for ultrasonic level/flow transmitter.

1.3 PERFORMANCE REQUIREMENTS

A. Flow Capacity: The Parshall flume shall have the ability to measure flow from a minimum of 273,000 gallons per day (gpd) to a maximum of 21,400,000 gpd or greater.

1.4 SUBMITTALS

A. Product Data: For the following, provide material descriptions, dimensions of components, and flow range capacity information:
   1. Parshall Flume

B. Shop Drawings: Show fabrication and installation details including:
   1. Critical dimensions, jointing and connections, fasteners and anchors.
   2. Materials of construction.
   3. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.

C. Material Data: Submit test results of representative fiberglass reinforced laminate.

D. Samples for Verification: For each type of flume required, submit 8” square samples of representative fiberglass reinforced plastic laminate.

E. Other Information Submittals:

   1. Manufacturer’s installation instructions.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following codes:
   1. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
   2. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   3. ASTM D 2583 – Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   4. "Generalized Discharge Relations for Cutthroat Flumes." Journal of the Irrigation and Drainage Division, ASCE..
   5. United States Department of the Interior, Bureau of Reclamation, Water Measurement Manual.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FLUMES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Plasti-Fab, Inc.
   2. Tracom Fiberglass Products

B. Parshall Flume: The flume shall be full length, molded fiberglass reinforced polyester laminated in one piece. The interior surface shall have a 10 to 15 mil white gelcoat backed by a resin rich layer of resin and chopped glass to form a water and chemical resistant surface. The remainder of the laminate shall be fiberglass reinforced polyester containing not less than 30% glass content by weight. The thickness of the walls and floor of the flume shall be not less than 1/4". The flume shall be reinforced with box section stiffeners down the sides and across the bottom. The stiffeners shall be joined together at the knee to form a rigid dimensionally stable flume. The flume shall be free standing, strong enough to hold a 30" depth of water without visible distortion. There shall be locking clips fastened along the side of the flume to be used for anchorage into the concrete.
   1. Typical physical properties shall be:
      1) Tensile strength 14,000 psi

2) Percent elongation 1.65%
3) Flexural strength 25,000 psi
4) Flexural modulus 0.90×10^6 psi
5) Barcol hardness 30

2. Flume dimensions shall be within plus or minus 3/32nd inch in the throat and plus or minus 1/8 inch elsewhere.
3. The flume shall be supplied with the following ancillary equipment:
   a. An attached 12" diameter floatwell (stilling well) mounted as shown on the Contract Drawings.
   b. A 2" FNPT threaded tap for interconnection with remote floatwell.
   c. An adjustable T-304 stainless steel support bracket to mount an ultrasonic transmitter such that the transmitter reads the water level within the floatwell.
   d. An integral molded track and a stainless steel ground plate for characterized capacitance probe.
   e. A molded in head gage graduated in 100ths of a foot and centimeters. The foot scale shall be graduated in half tenths with 3/4" high black numerals at each tenth. The gage shall have 3/4" high black numerals at each tenth of a foot.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine flume for damage and verify dimensions prior to offloading.

3.2 PARSHALL FLUME INSTALLATION

A. Install products in accordance with the contract plans.

B. The flume should be installed level end-to-end and side-to-side.

C. Set the flume at the elevation indicated on the contract plans.

D. Embed flume in grout; pour grout in maximum 12 inch lifts; internally brace flume as necessary to ensure bowing does not occur.

E. Clean surfaces in accordance with the manufacturer’s instructions.

F. Remove trash and debris; leave the site in a clean condition.

END OF SECTION 11207

SECTION 11208 – ULTRASONIC FLOW TRANSMITTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Ultrasonic Flow Transmitter

1.3 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for ultrasonic flow transmitter. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Wiring Diagrams.

B. Product Data: Provide material descriptions, dimensions of components, and flow range capacity information:

C. Other Information Submittals:

   1. Manufacturer's installation instructions.

D. Operation and Maintenance Data: The contractor shall submit two (2) copies of Operation and Maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 ULTRASONIC FLOW TRANSMITTER

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

B. General: The contractor shall furnish and install a totalizing open channel ultrasonic flow transmitter suitable for fixed-site monitoring to be utilized in conjunction with the Parshall Flume.

C. Basis of design equipment: Greyline Instruments, Inc. Model OCF 4.0 Open Channel Flow Monitor.

D. General
   1. Flow Monitor to consist of an non-contacting ultrasonic sensor, connecting cable, and a remote enclosure with indicating, transmitting, controlling and data logging electronics.
   2. Measurement accuracy shall be ±0.25% and shall be automatically temperature compensated.
   3. Sensor cable length shall be as required by installation.
   4. System shall have no moving parts and shall not contact flowing water.
   5. System shall be warranted against defects in materials and workmanship for one year.

E. Sensing Element
   1. Sensor shall withstand accidental submersion to 20 psi.
   2. Sensor minimum range shall be 8" and maximum range shall be 15 ft.
   3. Sensor shall be constructed of PVC.
   4. Sensor operating temperature shall be from -40°F to 150°F.
   5. Sensor shall include integral temperature sensor. Temperature sensors requiring separate mounting and wire runs will not be accepted.

F. Sensor Connecting Cable
   1. Provide RG62AU coaxial cable, length as needed to go from sensor to transmitter without splicing, with waterproof, potted bond to the Sensor head.
   2. Level and temperature signals shall be conducted on one single coaxial cable. Separate or multiple-conductor cables shall not be accepted.

G. Transmitter
   1. The transmitter shall provide for field calibration to common primary metering devices, plus allow entry of "K" and "n" values for calibration to nonstandard flumes, weirs or open channels.
   2. Field-calibration shall be via built-in 3-key calibration system with menu selection of parameters. Systems requiring calibration by Parameter codes, BCD switches or external calibrators will not be accepted.
   3. Calibration data shall be password protected and permanently stored through power interruptions for a minimum of 12 months.

4. Field calibration shall allow selection and automatic conversion of measurement units, measurement span, high/low flow alarm relay and flow proportional relay pulse rates.
5. Transmitter shall permit field programmable damping to smooth output in turbulent flow conditions, and programmable rejection time to disregard false signals from rain, wind, floating objects and spurious echoes.
6. Transmitter operating temperature shall be from -5° to 140°F. Transmitter shall contain a thermostat-controlled enclosure heater for condensation protection below 30°F.
7. Transmitter shall have a built-in 50,000 point data logger with USB and RS232C output and connecting cables. Data logger shall support time and date-stamped logging and display daily flow reports including total, average, minimum, maximum and times of occurrence.
8. Manufacturer shall include Windows based software for data log retrieval, graphing and export.
9. Transmitter shall have an isolated 4-20mA output into a 1000 ohm maximum load and user-selectable 0-5V output.
10. Provide 3 relay contacts rated 5 amp SPDT programmable to operate a remote totalizer, a sampler, high-low flow alarm plus echo loss alarm.
11. Provide a 4-digit LCD display scaled in user-selected engineering units and visible without opening the Transmitter enclosure.
12. Provide a 16-digit alphanumeric display for calibration menu, running totalizer, flow reports, or error message display of echo loss or other fault conditions.
13. Transmitter shall be housed in a wall-mount, watertight NEMA4X (IP66) enclosure with hinged, clear cover. Mounting hardware shall be included.
14. Transmitter Displays indicating flow rate, units of calibration, maximum flow rate and flow totalizer shall be visible without opening cover.
15. Transmitter electronics shall be surge protected on AC power input, sensor, 0-5V and 4-20 mA output.
16. Transmitter power input shall be 115VAC 60Hz with power consumption of 6.2 Watts or less.

H. Optional Features
1. Electronics enclosure shall include an Intrinsic Safety Barrier. Sensor, connecting cable and junction boxes shall be rated intrinsically safe to Class I,II,III, Div. I,II, Groups C,D,E,F,G.
2. Have manufacturer's recommended sensor mounting stand.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Install the mounting bracket, sensor and transmitter in the location shown on the Contract Drawings and according to manufacturer’s instructions.

B. Upon completion of installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored and adjust to achieve optimum operation.

C. Calibrate unit according to manufacturer’s instructions.

3.3 CONNECTIONS

A. Electrical power and wiring are specified in Division 16 Sections.

3.4 FIELD QUALITY CONTROL

A. Perform the following field quality-control tests and inspections and prepare test reports:

1. After installing ultrasonic flow transmitter and after electrical circuitry has been energized, test for compliance with requirements.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Program unit for level measurement at flume or weir, as applicable.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ultrasonic flow meters. Refer to Division 1 Section "Closeout Procedures” and”Demonstration and Training."

END OF SECTION 11208

SECTION 11209 – PACKAGED BOOSTER STATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Packaged Booster Station, P-1-1
2. Hydro-Pneumatic Tank

B. Related Sections include the following:

1. Division 3 Section "Reinforced Concrete" for base installation.
2. Division 13 Section “Control Panels” for control panel fabrication.
3. Division 15 Section "Process Piping" for piping installation.

1.3 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for Packaged Booster Station. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Wiring Diagrams.

C. Product Data: Provide material descriptions, dimensions of components, and flow range capacity information.

D. Factory Testing
1. Factory test and quality control reports shall be provided for the following:
a. Pump performance tests
b. System hydrostatic test
c. Control panel
d. Paint
e. Overall system checklist

E. Other Information Submittals:
1. Furnish written certification that the manufacturer is listed by UL/C-UL as an approved manufacturer of factory assembled pumping systems.
2. Furnish written certification of the manufacturers listing with Underwriters Laboratories as an approved manufacturer of control panels.

3. Furnished written certification from the manufacturers representative of the proper installation of the station.
4. Manufacturer's installation instructions.

F. Operation and Maintenance Data: The contractor shall submit two (2) copies of Operation and Maintenance manuals. They shall include complete parts list including manufacturers reference and ordering number, the local representative name, address and phone number, the model and serial number of the system.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

1.5 QUALITY ASSURANCE

1. To ensure total quality control, the complete unit will be designed, fabricated, assembled and tested in-house by the station manufacturer. The supplier shall have sole responsibility for proper functioning of the system and equipment supplied. Equipment shall be a manufacturer's standard product presently in commercial production. The manufacturer shall have in place a quality assurance program to assure the quality of the material furnished.
2. The manufacturer shall have a minimum of ten years manufacturing and application experience. Upon request from the engineer, the pump station manufacturer shall demonstrate proof of financial responsibility with respect to performance and delivery date. Upon request from the engineer, the pump station manufacturer shall provide proof or evidence of facilities, equipment and skills required to produce the equipment specified herein. The manufacturer shall have at least five (5) installations of similar packaged booster systems within 200 miles of the project location.
3. Third Party Testing, OSHA Requirement

    1) The package shall be UL Listed as a system for its intended use, so meeting OSHA Federal Regulations 29 CFR1910.303 and 399 as well as NFPA Pamphlet #70 (National Electric Code) Article 90-7.

1.6 WARRANTY

A. The packaged booster station system supplier shall be warrantee for a period of (18) months from date of shipment or (12) months from date of startup, whichever occurs first, that the supplied equipment shall meet the performance requirements of these specifications and that the equipment supplied will be free of defects in material or workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

B. Basis of Design: The materials and equipment specified in the Section are based on the materials and equipment manufactured or supplied by Tigerflow, of Dallas, TX.

2.2 PUMPS

A. Pumps shall be close-coupled vertical multi-stage pumps. Each pump shall be Grundfos Model CR 15-4, or approved equal. Each pump shall be rated for 75 GPM @ 220 FT TDH. A secondary duty point shall be 40 GPM @ 250 FT TDH. Each pump shall be close-coupled to a 7.5 HP, 3600 RPM, premium efficiency, open dripproof (ODP) motor (460 V, 3 phase, 60Hz).

B. The pump suction/discharge chamber, motor stool and pump shaft coupling shall be constructed of cast iron. The impellers, pump shaft, diffuser chambers, outer discharge sleeve, and impeller seal ring or seal ring retainers shall be constructed of stainless steel. The impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement. Intermediate and lower shaft bearings shall be tungsten carbide and ceramic. Pumps shall be equipped with a high temperature mechanical seal assembly with tungsten carbide seal faces mounted in stainless steel seal components.

C. The pump motor shall be sized to insure the pump is non-overloading when operating on the specified pump curve. Motor design shall be of the open drip proof with a NEMA C face design operating at a nominal 3500 RPM with a minimum service factor of 1.15. Lower motor bearings shall be adequately sized to ensure long motor life.

2.3 VALVES

A. Pressure Regulating Valves:

1. A combination pressure regulating valve and check valve shall be manufactured by Watts and provided on the discharge of each pump. The valve shall be angle body style. The pressure regulating and check valve shall be a pilot operated diaphragm valve designed to automatically reduce a fluctuating higher upstream pressure to a constant lower downstream pressure regardless of varying flow rates, and close drip-tight when downstream pressure becomes greater than upstream pressure.
2. Materials of construction:

    a. Body: Cast iron, fused epoxy coated 100% inside and out, with Class 125 flanges
    b. Seat: Stainless steel
    c. Stem: Stainless steel
    d. Spring: Stainless steel

e. Elastomers:

1) Diaphragm - Nylon reinforced BUNA-N (Nitrile)
2) Quad Seal- BUNA-N (Nitrile)

f. Hydraulic Control Pilots:

1) Bodies: Brass
2) Internals: Stainless Steel
3) Elastomers: BUNA-N (Nitrile)

g. Miscellaneous Control Accessories

1) Bodies: Brass
2) Internals: Stainless Steel
3) Elastomers (where applicable): BUNA-N

h. Control tubing/fittings: seamless annealed/brass flared end

B. Butterfly Valves:

1. Individual pump suction and discharge valves shall be Watts Series BF resilient seated, full lug style butterfly valve rated for up to 200 PSI. Valves shall be provided with a ten position locking handle
2. Valve body shall be ASTM A126 Class B cast iron and shall be designed for use between ANSI 125 and 150 flanges. Face-to-face dimensions comply with API 609 and MSS-SP-67.
3. Shaft shall be 416 SS. Shaft bushings shall be Duralon® and shall provide shaft support for proper shaft alignment and minimize shaft deflection. Shaft seal shall be bidirectional and shall prevent external contamination of stem area and provides backup for the primary shaft seal formed by the disc/seat interface.
4. Disc shall be ductile iron. Disc edge shall be machined and polished 360° to assure leak-tight shutoff while minimizing operating torque. Positive, disc-to-shaft connection is provided by stainless steel precision taper pins that are vibration proof.
5. Seat shall be Phenolic backed, non-collapsible, resilient seat is mechanically secured to provide dead-end service to the full 200 psi (13.8 bars) pressure rating. Seat face eliminates the need for flange gaskets. Full 360° sealing shall isolate the body components from the media and provides the primary shaft seal. Seat shall be field replaceable.

C. Pressure Relief Valve:

1. A pressure relief valve shall be provided to protect the packaged system from pressure surges in the system. The pressure relief valve shall be angle body style and shall be piped from the discharge header to the suction header. The pressure relief valve setting shall be adjustable from 20 PSI to 200 PSI. The pressure relief valve shall be as manufactured by Watts, or approved equal.
2. Materials of construction:

a. Body: Ductile iron, fused epoxy coated 100% inside and out, with Class 125 flanges
b. Seat: Stainless steel

c. Stem: Stainless steel
d. Spring: Stainless steel
e. Elastomers:

1) Diaphragm - Nylon reinforced BUNA-N (Nitrile)
2) Quad Seal- BUNA-N (Nitrile)

f. Hydraulic Control Pilots:

1) Bodies: Brass
2) Internals: Stainless Steel
3) Elastomers: BUNA-N (Nitrile)

g. Miscellaneous Control Accessories

1) Bodies: Brass
2) Internals: Stainless steel
3) Elastomers (where applicable): BUNA-N (Nitrile)

h. Control tubing/fittings: seamless annealed/brass flared end

2.4 OVERTEMPERATURE PROTECTION

A. Each pump shall be equipped with overheating, pump failure and “anti-scald” protection. The thermal relief valve shall be installed on the pump discharge volute. The thermal relief valve shall be a non-electric temperature probe and purge assembly. The valve shall automatically sense the rise in temperature and discharge some of the hot fluid, causing the cooler fluid to enter the system, at which point the valve will then close.

B. The temperature probe shall be all brass construction. Opening temperature shall be 140°F and closing temperature shall be 135°F. Probe shall have ½” NPT inlet connection and have an operating pressure of 3,000 PSI. The total elapsed time, from when the valve opens until it closes, shall be 2 to 5 seconds.

2.5 CONTROL PANEL

A. The Control Panel shall have the project label, control panel RP-1-5.

B. Control panel shall be Tiger's Eye Mark V E-Series controller or approved equal. The control panel shall operate on 460 volt, three phase, 60 Hz incoming power. The enclosure and all pilot devices shall be NEMA 4 indoor rated. An inner door or viewing window shall not be acceptable.

C. The control panel shall include the following:

1. U.L./C-U.L. 508 Label
2. Micro programmable logic controller shall be NEMA 4 and mounting on door and include:

a. Flash Memory

b. EPROM Latched Main Memory
c. Multi Level Security Passwords
d. E-Series Touch screen operator interface Model B-6 with 6” Color Scale screen
e. Functions Included:

1) -Suction and Discharge Pressure Read-out in PSI
2) -Event History Log
3) -Individual virtual Pump Run Indication
4) -Hand-Off-Auto virtual Selectors
5) -Elapsed Time Meter
6) -Low Suction Pressure Alarm with On-Off Time Delays
7) -Low System Discharge Pressure Alarm with On-Off Time Delays
8) -High System Discharge Pressure Alarm with On-Off Time Delays
9) -Automatic Alternation of Equal Sized Pumps
10) -32-bit RISC Micro-Controller
11) -USB Port
12) -RS-232, RS-485, RS-422 Communication Ports

f. Thru door disconnect(s) with individual motor circuit protection
g. 24 volt U.L./C-U.L., CE approved switching power supply. Unit must have built-in breaker bar with over demand protection
h. 120 volt fused control circuit transformer
i. Power on pilot light
j. Alarm horn
k. Two (2) common auxiliary alarm contacts
l. Two (2) panel mounted stainless steel pressure transducers, one (1) suction, and one (1) discharge

D. PUMP SEQUENCE OF OPERATION

1. The PLC shall monitor system suction and discharge pressure via 4-20 mA analog signals from pressure transducers in order to provide precise pressure control and maximum user flexibility.
2. The pumps shall be staged ON and OFF based on System pressure and lag pumps are staged ON/OFF with pressure and flow.
3. Manual Operation:

a. Manual Pump Run by touch screen:

1) The touch screen shall have a pump Hand-Off-Auto for each pump that rotates to the “Hand” position when pressed. The pump shall start after a 2 second delay to prevent a pump from attempting to start while the Hand-Off-Auto switch passes through the Hand position to reach other modes. Running pumps in hand position shall override all system safeties and alarm shutdown features with the exception of low suction.

b. Manual Pump Run by emergency bypass selector switch:

1) In the event of a PLC or transducer failure, the controller shall have a manual override selector switch(s) to bring on pump(s). The emergency bypass selector switch shall be mounted inside the control panel and marked

with a red identification tag. Emergency bypass position shall override all system safeties and alarm shutdown features including low suction.

4. Automatic Operation:

a. The touch screen shall have a pump Hand-Off-Auto for each pump(s) that rotates to the “Auto” position when pressed.

b. Pump Start:

1) In the “Auto” position, the lead pump shall start when A) system pressure falls to start pressure setting and B) on-delay timer has expired. If system pressure continues to fall to lag pump shall start based on start pressure or if system flow exceeds lead pump capacity, the lag pump will start after its on-delay timer has expired.

c. Pump Stop:

1) The lag pump shall shut down after the system pressure reaches the stop pressure setting and the flow rate is lower the flow start setting. Both conditions must be satisfied during the off delay time period. The lead pump will not shut down until stop pressure is satisfied for the off delay time period.

d. Alternation:

1) Lead pump alternation shall be set through the touch screen. Four (4) alternation modes shall be available: automatically (each lead pump call), daily, weekly or monthly.

e. Alarms:

1) Pressure alarms shall include: Low Suction, Low System, and High System. Each alarm condition shall have a menu of adjustable pressure settings and time delays. Alarm menus shall also provide manual and automatic reset points. Low suction alarm shall be generated from the suction pressure transducer signal. This alarm shall protect the pump by preventing dry running or cavitating when suction pressure is not adequate. Low and high system alarms shall be generated from the system pressure transducer signal. Low system alarm shall be provided to help detect major failures in the water distribution piping and shut down pumps to minimize water loss and damage to property. High system alarm shall prevent system over pressurization, by shutting down pumps when pressure reaches this alarm setting.

2) All pumps selected in “Auto” shall shutdown when an alarm condition occurs. Only the Low Suction alarm shall shut down pump(s) in “Hand” mode. The controller shall have the option for a manual alarm reset which would require operator acknowledgement of the alarm at the touch screen. The controller shall also have an option for auto alarm reset whereby any alarm would automatically reset the once the alarm condition no longer exists for the selected OFF delay time period.

E. HMI (TOUCH SCREEN)

1. The HMI (Human Machine Interface) shall be a six inch color graphic scaled touch screen and shall be used to operate pump Hand-Off-Auto selection mode, change settings and monitor system operation.
2. The HMI main operating screen shall go into a screen saver mode after a programmable time.
3. The HMI main operating screen shall display system pressure, suction pressure, flow, “Menu” touch button, and pump(s) run status. Pump status shall include pump operating mode (Hand, Off, Auto) and running status. The Hand-Off-Auto switch shall be a touch switch to change pump operating mode to “Hand”, “Off”, or “Auto”.
4. The HMI shall have a “Menu” touch button which provides access to all sub-screens. The access buttons shall cause the screen to go to a sub-screen for the option selected. All sub-screens shall have a return to main “Menu” touch button, a “Return” to previous screen touch button
5. HMI sub-screens shall include:

    a. “Config System”: this screen shall be designed to provide quick access to all system settings during initial startup.
    b. “Flow Sequencing”: The screen shall also provide flow setpoints that can stage on lag pump(s) based on flow as well as pressure. Pumps stage ON when flow is > Lag start OR if system pressure is < Lag start pressure. Pumps stage OFF when flow is < start flow AND system pressure is > stop pressure.
    c. “Flow Meter Setup”: This screen shall provide standard flow meter options for 4-20 mA flow signals and Data Industrial pulse insertion meters. A “Scaling” touch button shall be required to complete flow meter setup. A “Sensor” touch button shall be required to set up 4-20 mA flow signal for present signal and enter maximum flow meter range.
    d. “Flow Scaling”: This screen shall provide the pipe size in which the flow meter is installed. If correct pipe size and type is not shown, a “Manual” button shall be required and user able to enter K Value and Offset provided by Data Industrial or TIGERFLOW.
    e. “Alarm Settings”: This screen shall provide the following programmable set points:

        1) Low System Alarm pressure set point.
        2) High System Alarm pressure set point.
        3) Low Suction Alarm pressure set point.
        4) High Suction Econo mode pressure.
        5) Auto or manual alarm reset buttons for above alarms.
        6) On and Off delay settings button for above alarms.

    f. “Timed Alternation”: This screen shall display current data/day/time and shall provide the following programmable set points:

        1) Monthly selection which pumps will alternate on the first Monday of each month at 12 pm.
        2) Selecting the weekly selection, which cause the pumps to alternate each Monday at 12 pm.
        3) Adjust the day of the week by touching the current setting, which shall include entering a number between 1 and 7 (1=Monday, 7=Sunday).
        4) Adjust the hour in like manor by touching the hour setting. Hour shall be based on the 24 hour clock.

g. “Security Setup”: This screen shall provide the following levels of security:

1) Levels 0 through 4 are reserved for customer use.
2) Passwords for each of these levels are customer definable.
3) A level 4 password are required to access and change passwords.

h. System Settings”: This screen shall provide the following programmable setups:

1) Max suction and system sensor ranges.
2) Number of pump on skid and pump failure ON-delay.
3) Level switch present allowing low suction alarm to be controlled with a float switch or pressure switch.
4) Pump failure requires optional pump DP switches or overload wiring.
5) The ON-delay is the time allowed to verify a pump is running.

i. “Pump Settings”: This screen shall provide the following programmable set points:

1) Lead pump start and stop pressures set points
2) Lag1 pump start and stop pressures set points
3) Lag2 pump start and stop pressures set points
4) Lead ON and OFF delay time set points.
5) Lag1 ON and OFF delay time set points.
6) Lag2 ON and OFF delay time set points.

j. “Alarm Status”: This screen shall provide the following list of all active system events including:

1) Pump starts and stops
2) Pump failure
3) Alarm acknowledgement / silence
4) Alarm reset
5) Remote System failure
6) System disable

k. “Event History”: This screen shall provide a history of the last ten system events, including begin and end time. Events shall include the following:

1) Pump starts and stops
2) Pump failure
3) Alarms
4) Alarm acknowledgement / silence
5) Alarm reset
6) Econo Mode
7) System disable

2.6 HYDRO-PNEUMATIC TANK

A. Provide a Section VIII, ASME CODE, National Board stamped, Hydro-Pneumatic tank. Tank shall be provided complete with an FDA approved replaceable bladder, bottom connection, air fill valve, and gauge. Tank shall Model TF-132, 132 GAL., 125 PSI working pressure. The

Hydro-Pneumatic tank shall be remote mounted with feed line between pumps and pressure regulating valve.

2.7 INSERTION TYPE FLOW SENSOR

A. Provide an insertion type flow sensor with a six blade impeller design. The sensing mechanism shall not be magnetic. The sensor shall have stainless steel housing. The sensor shall be Data Industrial Corporation Model 220SS or approved equal.

2.8 PIPING AND FABRICATION

A. Suction and discharge headers shall be 3” stainless steel with grooved system connections.

B. The complete packaged system shall be installed on a structural steel mounting frame, piped, tubed, mounted and wired. Unit shall be factory primed and painted with machine grade finish coat. All welding shall be performed by ASME Section 9 certified welders.

C. The packaged system manufacturer shall isolate all ferrous from all non-ferrous materials.

2.9 PRESSURE GAUGES

A. System shall have gauges to indicate pressure in the suction and discharge headers. Gauges shall also be provide to indicate individual pump suction and discharge. Gauges shall be 2 ½" diameter, liquid filled pressure gauges complete with shut-off cocks.

B. Suction and discharge headers shall be 3” stainless steel with grooved system connections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Install the packaged booster station in the location shown on the Contract Drawings and according to manufacturer’s instructions.

B. Upon completion of installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored and adjust to achieve optimum operation.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 15 sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Electrical power and wiring are specified in Division 16 Sections.

C. Install piping to permit service and maintenance of equipment.

3.4 CLEANING

A. After completing installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the packaged booster station. Refer to Division 1 Section "Closeout Procedures" and"Demonstration and Training."

END OF SECTION 11208

SECTION 11210 – pH TRANSMITTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. pH Transmitter

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   2. Details of control panel faces, including controls, instruments, and labeling.
   3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   4. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

C. Operation and Maintenance Data: The contractor shall submit two (2) copies of Operation and Maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2.2 pH TRANSMITTER

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

B. General: The contractor shall furnish and install a pH electrode and transmitter suitable for fixed-site monitoring.

C. Transmitter.

1. Basis of design equipment: Endress+Hauser, Model Liquisys M CPM253-MR10051

2. Enclosure:

   a. Corrosion resistant, wall-mount, NEMA 4X enclosure.

3. Power Supply:
   a. 115VAC, 60Hz
   b. Power Consumption: <7.5VA.

4. Input:
   a. Measured variable: pH
   b. Measuring range: -2 to 16

5. Output:
   a. Current range: 4-20 mA
   b. Alarm current: 2.4 to 22 mA
   c. Output range: Adjustable, min. delta 1 pH

6. Performance:
   a. Resolution: 0.01 pH
   b. Deviation of Indication: Max. 0.5% of measuring range
   c. Repeatability: Max. 0.2% of measuring range

7. Display:
   a. LCD for display of measured values, configuration data and current menu items.
   b. Additional field for user labeling.
   c. 4 main control keys for calibration and instrument configuration.
   d. Key for switching between automatic/manual operations.
   e. LED indicators for switched limit outputs.
   f. LED indicator for alarm function.

g. Display of active contact and key for relay switching in manual mode.

8. Environmental Data:

a. Operating temperature limits: 14° to 131°F.
b. Operating humidity limits: 10 to 95%RH non-condensing.

D. Electrode:

1. Basis of design equipment: Endress+Hauser, Model CPS11D-7AA2G
2. Measured Variables: pH and temperature
3. Measuring Range: pH: 0 – 12 pH, temperature: 5 – 176F
4. Electrode shall be suitable for use in a NEC Class 1, Division 1 environment.
5. Accessories:
   1) PVC Immersion Assembly: Endress+Hauser, Model CYA611-0B

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Install the transmitter mounting brackets and electrode in the locations shown on the Contract Drawings and according to manufacturer's instructions.

B. Upon completion of installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored and adjust to achieve optimum operation.

C. Calibrate unit according to manufacturer's instructions. Ensure communication compatibility with the master control panel.

3.3 CONNECTIONS

A. Electrical power and wiring are specified in Division 16 Sections.

3.4 FIELD QUALITY CONTROL

A. Perform the following field quality-control tests and inspections and prepare test reports:

1. After installing pH transmitter and after electrical circuitry has been energized, test for compliance with requirements.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pH transmitter. Refer to Division 1 Section "Closeout Procedures" and"Demonstration and Training."

END OF SECTION 11210

SECTION 11213 – PACKAGED AERATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the Packaged Aeration System and associated accessories:

1. Blower B-3-1.
2. Blower B-3-2.
3. Blower B-3-3.
4. Blower B-3-4.
5. Three (3) Local Control Panels (B-3-1, -2, -3, -4) for the Blowers.
6. One (1) Master Control Panel (RP-3-1).
7. One (1) Main Header Pressure Transmitter (PDIT-3-1).
8. One (1) Main Header Temperature Transmitter (TIT-3-1).
9. Three (3) Dissolved Oxygen Transmitters (AIT-3-1,-2,-3), with remote sensors (AE-3-1, -2, -3), and jet cleaning systems (CA-1-1, -2, -3).
10. Seven (7) Electrically Actuated Butterfly Valves (CV-3-1, -2, -3, -4, -5, -6, -7).
11. Three (3) Thermal Dispersion Flow Meters (FIT-3-1,-2,-3) with remote probes (FE-3-1,-2,-3).

B. Related Sections include the following:

1. Division 3 Section "Reinforced Concrete" for base installation.
2. Division 11 Section “Aeration Equipment” for aeration diffuser installation.
3. Division 13 Section “Control Panels” for control panel fabrication.
4. Division 15 Section "Process Piping" for aeration piping installation.

1.3 SUBMITTALS

A. Product Data:

1. Blower characteristics, specifications and performance

a. Descriptive brochures and blower data.
b. Predictive performance curves indicating capacity and input kW over the range of operation.
c. Catalog information showing blower construction.
d. Outline installation drawings for each unit.
e. Blower weight and weights of major components of equipment.
f. List of recommended spare parts for five (5) years of operation.

g. Complete bill of materials of all components and equipment supplied.
h. Air-end characteristics and specifications.

1) Descriptive bulletins.
2) Nameplate data.
3) Service factor of motor.
4) Efficiency at ½, ¾, and full load.
5) Power Factor at ½, ¾, and full load.
6) Special features including instrumentation.

B. Shop Drawings.

1. Certified dimensional drawings of the blower enclosure.
2. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
3. Any necessary dimensional drawings to coordinate piping layout with structural, architectural, electrical and or other mechanical work.
4. Certified drawings of the local control panel and master control panel.

C. Operation and Maintenance Data: For all materials and equipment used in fabrication and assembly to be included in operation and maintenance manuals.

D. Quality Control Submittal:

1. Factory functional performance tests and logs.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturers Certificate of Proper installation.
4. Field quality-control test reports.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. General:

1. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these specifications.
2. All parts of duplicate machines shall be interchangeable without modification.
3. The construction of the packaged high speed turbo blowers shall be rugged so that the blowers will not be damaged during continuous operation and will not have undue vibration above the blowers' surge limit.
4. The design and construction of the packaged high speed turbo blowers shall not cause any unbalanced floor loadings.
5. Sizes and capacities of equipment components specified shall be understood to establish minimum requirements only, and do not relieve the Contractor of responsibility for providing a properly functioning system.
6. The packaged high speed turbo blower manufacturer shall furnish all piping, fittings and valves which are an integral part of, or are customarily supplied as standard appurtenances for equipment furnished.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of the packaged high speed turbo blower units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Manufacturer Qualifications:

1. The materials covered by the Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment.
2. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers recommendations.
3. Blower manufacturer shall have a minimum of 400 units installed of same product type within North America.
4. Established in the US market for 20 years.
5. ISO 9001-2008 Certified
6. UL/ULC – Manufacturing Facility must be UL508A Certified

D. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

E. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel D1.3, "Structural Welding Code--Sheet Steel."

1.5 REFERENCES

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the latest editions of standards from these organizations, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. American Society of Mechanical Engineers (ASME).
2. National Electric Code (NEC)
3. Underwriters Laboratories (UL)
4. American Iron and Steel Institute (AISI).
5. National Electrical Manufacturers Association (NEMA).
6. Anti-friction Bearing Manufacturers Association (AFBMA)
7. American Gear Manufacturers Association (AGMA)
8. American National Standards Institute (ANSI)
9. American Institute of Steel Construction (AISC)
10. American Welding Society (AWS)

1.6 DELIVERY, STORAGE, AND HANDLING

A. All components shall be prepared for shipment in accordance with the carriers' specifications. Equipment and instruments shall be boxed (completely enclosed). All other components and loose pieces shall be skidded, crated or palleted to the carriers' specifications. Further, all skids, carriers and pallets shall be enclosed in water-tight plastic wrapping, 6 mil. minimum thickness.

B. Master shipping list shall be supplied showing the quantity of each section, subassembly, or piece, the piece number and the drawing on which each subassembly or piece is detailed.

C. All equipment shall be prominently marked for identification in assembly. The area(s) in which the equipment is/are designated to be used shall be indicated on the shop drawings. The part identification shall be stenciled conspicuously on large pieces of equipment. Small parts shall have a metal tag wired in place with identification stamped or etched.

D. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

E. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

F. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

G. Finished surfaces of all exposed equipment openings shall be protected by wooden blanks, strongly built and securely attached thereto.

H. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

I. After factory tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

J. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate final electrical power and control connections.

1.8 WARRANTY

A. Warranty Period: Standard manufacturers warrantee to cover one (1) year from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish all special tools and appliances necessary to disassemble service, repair and adjust the equipment and appurtenances. The following spare parts shall be furnished:

1. Six (6) spare filter elements for the blowers.

2. Three (3) spare fuses for each type in the control panels.

B. Other spare parts shall be furnished as recommended by the equipment manufacturer or listed in this Section.

C. All materials shall be properly packed, labeled and stored where directed by the Engineer

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: The packaged high speed turbo blower packaged units are based on the product specified. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers.

B. Description, General: The packaged high speed turbo blowers shall include factory assembled and tested packaged units including a blower/motor air-end, carbon steel enclosure, local control panel, electric actuated discharge butterfly valve, check valve, safety valve and all necessary auxiliary equipment, appurtenances and accessories, spare parts required for a complete installation.

1. All equipment specified in this section shall be designed, fabricated and assembled by the blower manufacturer who shall be responsible for the suitability and compatibility of all included equipment.

2.2 HIGH SPEED TURBO BLOWERS

A. Basis-of-Design Product: Atlas Copco / HSI Frame 4 High Speed Turbo Blower.

B. Operating Requirements

1. The primary operating requirement of the packaged high speed turbo blower system shall be to provide adequate airflow at specified conditions.
2. Each high speed turbo blowers shall satisfy all the following conditions of service listed:

a. Fluid: Atmospheric air.

1) Specific weight: 0.071 lbm/ft^3.
2) Cp/Cv: 1.397.
3) Altitude: 100 ft.
4) Pressure: 14.64 psia.
5) Temperature: 95°F.
6) Relative humidity: 40%.

b. Packaged high speed turbo blower Operating Characteristics:

1) Delivery flow rate: 2,698 acfm.
2) Delivery flow rate: 2,520 scfm.
3) Differential pressure: 8.25 psi.
4) Inlet pressure: 14.44 psia.
5) Outlet pressure: 22.69 psia

6) Temperature rise: 120°F.
7) Inlet temperature: 95°F.
8) Outlet temperature: 215°F.
9) Total efficiency: 63%.
10) Absorbed Power: 133 hp.
11) Speed: 35,540 rpm.
12) Design speed/Max. speed (n/nmax.): 93%.
13) Sound Pressure Level: 85 dBA.

C. The high speed turbo blowers shall be designed to deliver varying airflow rates by a variable frequency drive.

D. High speed turbo centrifugal blower for oil free atmospheric air

E. Enclosure: Each blower shall be supplied with a UL/ULC certified standard sound enclosure.

F. The sound enclosure must be designed for easy inspection and maintenance of all blower package components. Control panels shall have hinged doors to provide easy and quick access for routine maintenance of the blower and the package components. Doors shall use a frame, reinforcements and supporting elements as required.

G. The enclosure housing the blower and blower appurtenances shall be UL 508A, painted carbon steel.

H. Blower shall be leaf-type or journal air bearing type turbo blowers and shall not require oils or lubricants for adequate operation. Blowers shall be capable of variable speed and output operation.

I. Blower casing shall have a maximum continuous duty design temperature of 400 degrees Fahrenheit.

J. Regardless of theoretical bearing life calculations, the bearings shall be designed for a minimum of expect ten (10) years between major overhauls.

K. Blower impellers shall be of the backswept three dimensional high efficiency configuration, designed using computational fluid dynamics (CFD) with two stages in one (axial and centrifugal), milled from forged aluminum alloy, and with first lateral critical speed at least 120 percent of maximum allowable operating speed. The impellers shall be mounted directly to the motor shaft and shall be statically and dynamically balanced. Blowers using single impeller design shall not be allowed.

L. Blower impeller blades and hub shall be anodized to prevent corrosion and erosion. Anodizing shall be per AMS-A8625, Type III, Class 1 with coating thickness of .0005” - .0040”. Coating shall not vary by more than +/- .0004” thickness across the blades and hub of the impellers.

M. Provide an electrical distribution cabinet integrally mounted on the blower package. The electrical panel shall consist of main disconnect, control power transformer, fuses and breakers, blower VFD including input reactor and output filter, and support electrical components required for a complete, operable system. Remotely located components shall be identified.

N. Each blower shall be provided with a Variable Frequency Drive. The VFD shall be UL certified and manufacturer must have demonstrated full factory support for US market and have been established in the US market for 10 years. The VFD shall be selected and sized for proper operation with blower motor. All adjustments and settings shall be performance by the manufacturer. VFD shall be manufactured by VACON.

O. Each blower shall be provided with an internal harmonic filter to be in compliance with IEEE-519. Harmonic filter shall filter harmonic noise generated by the VFD on the incoming A/C power supply. Harmonic filter shall be manufactured by TCI.

P. The blower manufactured motor shall be a UL recognized motor manufacturer for rotor and stator components under UL 1004, Electric Motors or ANSI/UL 1004-1, Rotating Electrical Machines. Motor must be tagged individually as UL recognized with file number. The motor shall be 460V, 3 phase, 60 Hz, Permanent Magnet Synchronous Motor.

Q. The motor shall have a 1.15 service factor above maximum design conditions and shall be able to start under the starting conditions required. The blower manufacturer shall be responsible for the coordinating the starting torque requirement of the blower with the VFD to ensure proper operation of the system.

R. Motor stator cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be form wound and identical size, shape, insulation and number of turns. Stators shall be form wound and insulated with glass and mica applied directly to the coils. Motors shall have a Class H non-hygroscopic epoxy vacuum/pressure impregnated insulation system, limited to the temperature rise specified herein. All connections shall be brazed, with no crimp connections used expect for terminals.

S. The motor shall be capable of continuous operation at full load and rated frequency with a voltage variance of +/- 10 percent of the nameplate voltage.

T. The motor shall be provided with three (3) internal RTD’s imbedded in the motor windings, with one (1) RTD being a spare, and motor protection relay that provided high motor temperature alarm and shutdown contact.

U. All motors and variable frequency drives rated 150HP and over must be liquid cooled using an internal heat exchanger system to draw the heat from the blower assembly components and discharge as specified.

V. Cooling system design shall consist of a NEMA 48Z centrifugal pump with aluminum housing and stainless steel seals. The heat exchanger will pump a liquid glycol solution to the blower enclosure and circulate the flow through the cooling jacket around the motor as well as to the heat sink of the liquid cooled VFD. CONTRACTOR shall provide a glycol solution that is rated for Aluminum.

2.3 INLET FILTER

A. Air will be drawn through the rear panel filter of the enclosure with no external piping or ducting required. The filter media shall have a minimum efficiency of 98% at 10 microns.

B. Maximum clean pressure loss across the filter shall be less than .2” WG and a low velocity of less than 120 fpm through the media.

C. The design of the filter shall be a panel, dry-type filter with a galvanized steel frame that is fully gasketed to eliminate contaminants from bypassing the filter. The media shall be a hydrophobic pleated synthetic.

2.4 DISCHARGE EXPANSION JOINT

A. Provide each blower with an EPDM discharge expansion joint capable of withstanding the vacuum, pressure, and temperature under all operating conditions. The flexible connector shall prevent the transmission of noise and vibration from the blower package to the piping. The expansion joint shall be included with galvanized retaining rings drilled for ASME/ANSI B16.5, Class 150 bolt pattern and arrive at the jobsite connected to the blower unit. Designs using control rods are not allowed. The expansion joints shall be manufactured by General Rubber or equal.

2.5 CHECK VALVE

A. Provide each blower with a wafer type discharge check valve of the dual flat plate type with center hinge, spring closure, cast iron body, EPDM seal and 316 aluminum plates rated for 250 degrees Fahrenheit. Check valves shall be manufactured by Flexi-hinge or equal.

2.6 BLOW OFF VALVE

A. Provide each blower with a blow off valve so that the unit can start/stop without being under load. Blow off valve must be mounted inside the blower enclosure. Blow off valves mounted outside of the enclosure will not be acceptable.

B. Blow off valve shall be electrically operated and shall open in not less than two (2) tenths of a second. The blow off valve shall be powered and controlled by the blower controls.

C. Provide a carbon steel blow off silencer for the blow-off (bypass) valve. The blow off valve silencer shall be mounted to the top of the blower enclosure. Silencer sound attenuation shall not be less than 20 dBa. Provide a factory 45 degree discharge elbow, with screen. Point upward away from operator.

2.7 CONTROLS AND INSTRUMENTATION

A. The blower manufacturer shall supply the following items in order to furnish a complete functional variable input process sequencing control panel system.

1. One (1) Master Control Panel, RP-3-1.
2. Four blower Local Control Panels mounted on its respective blower, B-3-1, -2, -3, -4
3. One (1) Main Header Pressure Indicating Transmitter, PDIT-3-1
4. One (1) Main Header Temperature Indicating Transmitter, TIT-3-1
5. Three (3) Dissolved Oxygen Transmitter kits, AIT/AE-3-1, -2, -3.

6. Three (3) aeration tank header electric actuated modulating butterfly valves, CV-3-5, -6, -7. Valves shall be field installed at their respective aeration tank headers.
7. Four (4) blower electric actuated butterfly valves, CV-3-1, -2, -3, -4. Valves shall be field installed at their respective blower discharge pipes.
8. Three (3) Thermal Dispersion Flow Meters, FIT/FE-3-1, -2, -3.

B. Master Control Panel, RP-3-1.

1. The packaged control system will be a process control system with the Master Control Panel, RP-3-1 coordinating each blower through their respective blower Local Control Panel (LCP) in order to satisfy a variable control set point from the Dissolved Oxygen Transmitters, AIT/AE-3-1, -2, -3.
2. For VFD-controlled blower systems, the manufacturer is required to calculate the actual mass flow of each blower in each LCP without the need for a flow meter on the discharge of each blower.
3. The Master Control Panel, RP-3-1 will use the Most Open Valve (MOV) principle logic to maintain the process variable set point required.
4. Blower shall be sequences/alternated based on lead-lag scenario to ensure an optimum number of blowers are running to meet total airflow requirements as calculated by the Master Control Panel, RP-3-1.
5. All PLC controls, alarms and monitoring shall be accessible through a touch screen.
6. Basic information to be displayed on the Master Control Panel, RP-3-1:

    a. Process Variable
    b. Valve Positions
    c. Total Flow Rate
    d. Flow Rate at each aeration zone via the flow meter
    e. Header Pressure via the PDIT
    f. Communication Checks
    g. Air Temperature

7. Trends to be displayed on the Master Control Panel, RP-3-1:

    a. Input Variable
    b. Total Flow Rate
    c. Header Pressure
    d. Power Consumption

8. Alarms to be displayed on the Master Control Panel, RP-3-1:

    a. Blower Fault Signal
    b. Communication Failure
    c. Unable to reach process variable
    d. High/Low input variable (Dissolved Oxygen)

9. The PLC shall be an Allen Bradley CompactLogix PLC based control panel with a 10” Allen Bradley Panelview Plus color touch screen.
10. An interface shall be provided between the blower Local Control Panels, B-3-1, -2, -3, -4 located in the Blower housing, and the Master Control Panel, RP-3-1. Interface shall be Ethernet TCP/IP.

11. The Master Control Panel, RP-3-1 shall be mounted separately from the blowers in a steel NEMA 4 enclosure with a lockable quarter-turn latch. Communication protocol between the LCPs and RP shall be Ethernet through an Ethernet Switch.

C. Local Control Panels, B-3-1, -2, -3, -4.

1. Required Inputs and Outputs from LCPs

   a. Common Blower Alarm/Failure
   b. Blower Permissive Enabled
   c. Blower HOA in Remote
   d. Blower Run Status
   e. Communication Check
   f. E-stop Status
   g. Calculated Flow
   h. Outlet Pressure
   i. Operating Mode
   j. Runtime Hours
   k. HP or kW

2. Required Inputs from Instrumentation

   a. Valve Control Input
   b. Flow Meter Input
   c. Header Pressure

3. Output to LCPs

   a. Remote Start/Stop
   b. Communication Check
   c. Remote Set Point to LCP

4. The control system shall be functionally tested prior to shipment by simulations.
5. The PLC shall be an Allen Bradley MicroLogix PLC based control panel with a 6” Allen Bradley Panelview Plus color touch screen.
6. The Local Control Panels, B-3-1, -2, -3, -4 shall be mounted the respective blower in a steel NEMA 4 enclosure with a lockable quarter-turn latch. Communication protocol between the Local Control Panels, B-3-1, -2, -3, -4 and Master Control Panel, RP-3-1 shall be Ethernet through an Ethernet Switch.

D. Instrumentation

1. The blower manufacturer shall provide the blower instrumentation described in this section. These components shall be mounted within the enclosure except as noted.

   a. Inlet air temperature transmitter
   b. Inlet pressure transmitter
   c. Discharge temperature transmitter
   d. Discharge pressure transmitter
   e. Motor winding RTDs

2. Main Header Pressure Transmitter PDIT-3-1: The blower manufacturer shall provide a pressure transmitter to be field mounted remotely in the main header. The pressure sensitive element shall be 316 stainless steel and shall be calibrated for the header pressure operating ranges. The transmitter shall have a 4-20 mA standard DC isolated floating output. Tolerance shall be less than +/- 2 percent of full scale. The transmitter shall be manufactured by Endress Hauser, or equal.
3. Dissolved Oxygen Transmitters AIT/AE-3-1,-2,-3: The blower manufacturer shall provide dissolved oxygen transmitters, and jet cleaning kits to be field mounted remotely, for each aeration basin. Each dissolved oxygen transmitter shall be a single channel Dissolved Oxygen Analyzer (AIT) with one fluorescence DO Sensor (AE). It shall consist of the monitor mounted where indicated on the drawings, an optical fluorescence dissolved oxygen sensor mounted where indicated, a jet clean system, and mounting hardware for all three. The sensor shall be a type that does not require membranes, cartridges, fill solutions, or replaceable membrane caps as these types of designs are not acceptable. The sensor shall not be damaged by exposure to direct or indirect sunlight nor will exposure to sunlight affect the calibration.

    a. Basis of design equipment: Insite Instrumentation Group, Inc., Model 2000-1 dual channel Dissolved Oxygen Analyzer with two optical DO Sensors and mounting hardware.
    b. Transmitter.

        1) Enclosure: wall-mount, NEMA4X enclosure.
        2) It shall have a digital display controlled by microprocessor circuitry.
        3) All run, programming, and calibration functions shall be accessible without having to open the enclosure.
        4) Unit shall be pre-calibrated at the factory.
        5) Provide 4 relays discrete outputs.
        6) Continuously display dissolved oxygen in ppm with an accuracy of 0.02 ppm.
        7) Continuously display temperature in degrees C or F (user selectable).
        8) Provide an extended temperature, UV treated LCD digital display for continuously showing dissolved oxygen and temperature readout. Programming and diagnostics are also provided through this display.
        9) Provide self-diagnostics for the sensor and analyzer. Analyzer shall have error messages in the operating mode for higher of lower than normal sensor output voltage, temperature input outside the 0-60 degree C range, and unstable instrument circuitry; error messages in the calibrate mode for unstable sensor temperature (after a 5 minute wait), unstable D.O. output of the sensor (after a 5 minute wait), and weak sensor output level.
        10) Provide isolated RS-485 MODBUS RTU serial communication port for dissolved oxygen, temperature, and relay status.
        11) Provide 4-20 MADC optically isolated outputs for both DO and Temperature.
        12) Provide standard back-lit LCD display.
        13) The sensor shall be an optical type sensor that measures the fluorescence and quenching reactions of a ruthenium complex that is immobilized in a sol-gel matrix requiring no consumables and not damaged by exposure to direct or indirect sunlight.

c. The Jet Clean System uses a stream of pressurized air to remove bio growth or other debris from the optical surfaces of the DO sensor. The Dissolved Oxygen Analyzer controls the frequency and duration of the clean cycle through an output relay. The Jet Clean System consists of a compressor pump and mounting hardware. It delivers a sufficient blast of air to clean the debris from the Dissolved Oxygen sensor optics in the aeration basins of this project. The compressed air is delivered by tubing supplied by the blower manufacturer.

4. Thermal Dispersion Flow Meters FIT/FE-3-1,-2,-3: The blower manufacturer shall provide flow meters, to be field mounted remotely, for each aeration basin. Flow meters shall be thermal dispersion type meters with a single insertion point and NEMA 4X enclosure. Input power shall be 120VAC. The flow element shall be constructed of 316 stainless steel and rated for temperatures to 250F. Accuracy shall be +/- 2% of reading, +/- 1% of full scale.

   a. Basis-of Design Product. Subject to compliance with requirements, provide Kurz Instrumentation, Inc., Series 454FTB Single-Point Insertion Thermal Mass Flow Transmitter.
   b. Description: One Remote Single-Chamber Electronics Enclosure mounted on a Single-Chamber Sensor Wire Junction Box, paired with a Dual-Chamber Electronics Enclosure, complete with a 5 conductor shielded cable of sufficient length, and SS I.D Tags on both enclosures. There shall be a ¾" no-flange connection to the process.
   c. Construction: Alloy C-276 all-welded sensor construction
   d. Pressure Rating: 300 psig.
   e. Temperature Rating: -40 to 500 deg F.
   f. Range: 0 – 24,000 sfpm.
   g. Permanent Transmitter/Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 4.5-inch- diameter, or equivalent, dial with fittings connecting to flowmeter element.
   h. Scale: 0-6000 SCFM.
   i. Accuracy: +/-[(1% + .025%/°C) reading + 20 SFPM/°C] Above or below 25°C, all gases.

5. Actuated Butterfly Valves CV-3-1,-2,-3,-4,-5,-6, -7: The blower manufacturer shall provide actuated valves to be field installed remotely, at each aeration basin and at each blower, respectively. The butterfly valves shall be EPDM seated with a lugged cast iron body, ductile iron disc, and stainless steel stem. Valves shall be suitable for air service and temperature requirements up to 250F. The valves shall be manufactured by Bray or equal.

   a. The motor operated valve actuators shall be modulating type, and shall be model IQT as manufactured by Rotork Controls or equal.

E. The entire blower and control system shall be tested as an operation system at the jobsite. The Master Control Panel, RP-3-1 shall be connected to all instruments, electric valves and appurtenances. All start/stop and running sequences and all safety alarm systems shall be tested. The witnessing engineer shall sign the test procedures and results, certifying that the assembled blowers, auxiliaries, control system were field tested together, as a system.

2.8 FACTORY FINISHES

A. Finish: Manufacturer's standard epoxy coated finish.

B. Painting of all equipment that does not come in factory coated shall be in conformance with specification Section 09912.

2.9 SOURCE QUALITY CONTROL

A. Upon completion of assembly, the blower system shall be functionally tested at the place of assembly.

B. At a minimum, the blower and motor skid shall be factory tested for duration not less than four (4) hours.

C. The entire blower system, blow off valve, discharge valve, and control panel, shall be tested as an operational system before shipment. Throughout the entire test, filters cannot be removed and doors and/or panels open/take off to affect performance. The LCP shall be connected to all enclosure instruments, electric valves and appurtenances. All start/stop and running sequences and all safety alarm systems shall be tested.

D. The blower shall be performance tested in accordance with ASME PTC-10-1997 Performance Test Code on Compressors and Exhausters (re-affirmed in 2003). All tests shall be conducted as shown on the performance tables contained in these specifications

E. A calibrated wattmeter certified by the local power company shall measure the electrical shaft power input to the blower system. Measured power shall include wire to air and include all losses associated with electrical shaft power, including but not limited to the control panel, VFD, line reactor, motor, connecting wires, air filter and cooling system.

F. Net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. There shall be no tolerances or measuring uncertainties used in the reporting of the test results (i.e., the test results report + or – zero percent tolerance using measured values).

G. The required tests shall be performed in strict accordance with these specifications and the ASME PTC-10 Codes, modified to permit zero tolerance for flow and power.

   1. The capacity of the blower shall be defined as power Paragraph 4.26 of the ASME PTC-10 Power Test Code. Air flow shall be measured on the discharge side of the compressor at zero percent tolerance.
   2. All test equipment shall be calibrated and certified by an independent test agency no more than 12 months prior to the test date. Certificates shall show the stability of calibration over a period of at least one year per ISO 9001, Paragraph 4.11.

H. The blower test report shall present computations in exact accordance with section 5, 6 and 7 of the ASME PTC-10 Code with the performance curves showing capacity, pressure and horsepower inputs.

I. Test results of the blower package shall be included in the operations and maintenance manual.

J. Noise level

1. The blower Manufacturer shall include all necessary provisions for reducing noise to meet the maximum sound pressure level requirements of this section.
2. The maximum noise level at any point at a distance of 3 feet or more from any blower/motor surface shall not exceed [85] dBA with the blower running at any speed, except during startup and shutdown sequences.
3. The noise level shall be measured during the preliminary equipment tests at the factory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, concrete bases, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance equipment.

B. Examine roughing-in for aeration piping to verify actual locations of pipe.

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

3.2 PRODUCT DELIVERY AND STORAGE

A. All blower equipment shall be enclosed mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during the time between shipment and installation.

B. Securely bolted fiberboard blank flanges shall protect finished surfaces of all exposed flanges.

C. Shipment is not to be made until the blower manufacturer coordinates shipment to the jobsite with the contractor.

D. Equipment shall be stored in strict accordance with blower manufacturer’s instructions.

3.3 CONCRETE BASES

A. Install concrete bases of dimensions indicated for packaged high speed turbo blowers. If dimensions are not indicated concrete base perimeter shall extend a minimum of 8-inches past equipment footprint. Refer to Division 15 Section "Basic Mechanical Materials and Methods."

1. Install dowel rods to connect concrete base extension to existing concrete pump base. Unless otherwise indicated, install dowel rods on 12-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.4 INSTALLATION

A. The blowers, motors, all aeration instrumentation, and appurtenances shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings. All piping shall be supported so as to preclude the possibility of exerting undue forces and movements on the blower flanges.

B. Each blower skid unit shall be mounted on a flat and level concrete pad + or – one degree in accordance with the recommendations of the blower manufacturer.

C. The Contractor shall furnish the required piping, pipe supports, flange gaskets, bolts, nuts and glycol for initial operation in accordance with the manufacturer's recommendations.

D. Furnish a certificate stating that the installation of the equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation and care of each unit.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Ground equipment according to Division 16.

3.6 Connect wiring according to Division 16.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, field-testing and training. Report results in writing. Present at site for minimum person days listed below, travel time excluded.

1. 1 person-days for installation assistance and inspection.
2. 4 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-days for pre-startup training.
4. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until the Owner has reviewed an accepted detailed lesson plan for each training activity.

B. Engage a factory-authorized service representative to perform a performance test

1. Conduct on each packaged high speed turbo blower separately and in two- and three-parallel operation.
2. Perform under actual operating conditions.

3. Test for continuous 2-hour period alone and 1-hour period for each parallel combination without malfunction.
4. Test Log: Record the following:

    a. Total Differential Pressure.
    b. Blower Inlet Pressure.
    c. Blower Discharge Pressure.
    d. Inlet Temperature.
    e. Discharge Temperature.
    f. Standardized Flow.
    g. Horsepower requirements.
    h. Driver motor voltage and amperage measured for each phase.

5. Adjust, realign or modify units and retest in accordance with the above if units fail to meet any specified parameters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged high speed turbo blowers. Refer to Division 1 Section "Closeout Procedures Demonstration and Training."

END OF SECTION 11213

SECTION 11330 - WASTEWATER PRELIMINARY TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following: The Contractor shall furnish, install and place into satisfactory operating condition A Wastewater Preliminary Treatment System, PT-1-1. The system shall consist of the number of 3-plane cylindrical bar screens, vortex grit removal systems, grit washers, and grit pumps as noted in paragraph 1.3.E. for removing floating, particulate, fibrous and grit material from wastewater as shown on the Drawings and described in the Specifications.

B. Related Sections include the following:

1. Division 13 Section “Control Panels” for control panel fabrication.
2. Division 15 Section "Process Piping" for piping installation.

1.3 SYSTEM DESCRIPTION

A. Each 3-plane cylindrical bar screen unit shall consist of a stationary screen basket, rotating rake arm, concentric conveyor/dewatering screw, integral screenings press with drive unit, pivoting support stand, liquid level sensing system, screenings bagger attachment, anchorage, and shall be complete with electrical control panel and motor starter.

B. The vortex grit collection equipment shall be complete with drive assembly with paddles, grit pump, grit fluidizer, grit washer, and necessary anchorage parts.

C. The grit pump shall be complete with self-priming pump, V-belt and sheave drive, belt guard, motor and necessary anchorage parts.

D. Each grit washer unit shall consist of a tangential inlet, inlet baffle, settling and washing chamber, fluidizing manifold, back wash chamber, grit stirrer with drive assembly, organics blow down valve, concentric screw conveyor dewatering screw with drive assembly, and grit bagger attachment, and necessary anchorage parts.

E. General Design Summary:

1. Number of 3-Plane Cylindrical Bar Screens - 1
2. Number of Vortex Grit Removal Systems - 1
3. Number of Grit Washers - 1
4. Number of Grit Pumps - 1

5. Design Average Flow, mgd - 5.00

F. 3-plane Cylindrical Bar Screen Summary:

1. Maximum Hydraulic Capacity per Screen, mgd - 11.00
2. Maximum Upstream Liquid Level, inches - 31.5
3. Maximum Clean Water Headloss, inches - 17
4. Bar Spacing, inches - 1/4
5. Nominal Screening Basket Diameter, inches - 59
6. Maximum Allowable Cleaning Cycle Time, seconds - 11
7. Screening Chamber Width, inches - 62
8. Nominal Screw Conveyor Diameter, inches - 14
9. Minimum Screen Invert to Discharge Height, inches - 106
10. Screen Speed Reducer Minimum Torque Rating, in.-lb - 47,000
11. Screen Speed Reducer Minimum Thrust Rating, lb_f - 10,600
12. Drive Motor Size, hp - 3
13. Electrical Power Characteristics, VAC-Phase-Hertz - 460/3/60
14. Motor and Solenoid Valve Electrical Classification - Class I - Division 1 - Group D
15. Maximum Spray Wash System Flow Rate, gal/min - 30
16. Minimum Spray Wash System Pressure, psig - 60
17. Lower Wash System Number of Nozzles - 14
18. Liquid Level Sensing System Type - Float switch
19. Electrical Enclosure Type - NEMA 4X stainless steel

G. Vortex Grit Chamber Design Summary:

1. Maximum Hydraulic Capacity per Grit Chamber, mgd - 12.0
2. Grit Chamber Inside Diameter, feet - 12.00
3. Grit Hopper Inside Diameter, feet - 5.00
4. Grit Chamber Drive Motor Size, hp - 1
5. Grit Chamber Maximum Operating Speed, rev/min - 20
6. Drive Tube Nominal Diameter, inches - 10
7. Grit Suction Piping Diameter, inches - 4
8. Minimum Grit Hopper Water Fluidizing System Flow, gal/min - 20

H. Pump Design Summary:

1. Minimum Pump Capacity, gal/min - 250
2. Total Dynamic Head, feet - 21.5
3. Static Head, feet - 13.0
4. Minimum Re-Prime Vertical Distance, feet - 9.0
5. Motor Size, hp - 5

I. Grit Washer Design Summary:

1. Maximum Hydraulic Capacity per Grit Washer, gal/min - 400
2. Maximum Grit Capacity, cubic feet/hour - 35
3. Inlet Diameter, inches - 8
4. Grit Stirrer Speed Reducer Minimum Torque Rating, in.-lb - 5,470
5. Grit Stirrer Speed Reducer Minimum Thrust Rating, lb_f - 4,100
6. Grit Stirrer Drive Motor Size, hp - 3/4

7. Outlet Diameter, inches - 10
8. Organics Back Wash Outlet Diameter, inches - 4
9. Minimum Wash Water Rate, gal/min - 10 to 15
10. Minimum Wash Water Supply Pressure, psig - 60
11. Nominal Grit Screw Conveyor Diameter, inches - 12
12. Grit Screw Speed Reducer Minimum Torque Rating, in.-lb - 12,800
13. Grit Screw Speed Reducer Minimum Thrust Rating, lb_f - 5,800
14. Screw Conveyor Drive Motor Size, hp - 1.5

1.4 PERFORMANCE REQUIREMENTS

A. The 3-plane cylindrical bar screen shall be designed to handle the maximum hydraulic capacity noted in paragraph 1.3.F.1. with the maximum upstream liquid level noted in paragraph 1.3.F.2. This maximum upstream liquid depth includes the maximum allowable clean water headloss noted in paragraph 1.3.F.3.

B. The nominal bar spacing noted in paragraph 1.3.F.4. shall be the clear opening between the fixed bar elements only. Screen designs that define the bar spacing as the distance between a fixed bar element and a moving adjacent rake element (step-type screen) will not be acceptable for this project. Screens using perforated plate, traveling filter media, wedge wire or fabric wire will not be acceptable for this project.

C. The average bar screen flow through velocity shall not exceed 3.3 ft/sec (1.0 m/sec) under any flow condition up to the maximum hydraulic capacity noted in paragraph 1.3.F.1. The screen design shall minimize solids deposition in the channel.

D. The 3-plane cylindrical bar screen shall be a rotary raked, cylindrical bar screen with an integral screw conveyor and press. The 3-plane cylindrical bar screen shall use a single drive for screening, conveying, dewatering and compressing screening material.

E. The operation of the rake cleaning mechanism shall be automatically initiated at a preset high liquid level. Screens that operate continuously or via timer only will not be acceptable. The rake shall remove solids from the screenings basket and deposit them into the concentric screw conveyor trough after passing through a cleaning comb, where reverse movement of the rake shall provide positive cleaning of the rake mechanism. The screenings shall be transported up the screw conveyor and through a compression chamber.

F. The screening equipment shall produce dewatered screenings capable of passing the EPA Paint Filter Test as described in method 9095 of EPA Publication SW-486.

G. Due to the high solids loadings in wastewater, the entire screen basket shall be completely cleaned in no more than the maximum allowable time noted in paragraph 1.3.F.6. to ensure minimum headloss and rapid cleaning of the screen. All open spaces of the screen shall be positively cleaned via teeth that pass through the full depth of the bars during each cleaning cycle. Spray wash water or screw flights with brushes will not be an acceptable method of cleaning the screen.

H. The control system shall be designed so that the cleaning characteristics of the screen and spray wash systems can be changed via the programmable controller. Systems that do not offer this feature will not be considered for this project.

I. The grit removal system shall be engineered to meet the following requirements at up to the maximum grit chamber hydraulic capacity noted in paragraph 1.3.G.1:

1. Remove 95% of grit greater than 50-mesh in size.
2. Remove 85% of grit greater than 70-mesh in size.
3. Remove 65% of grit greater than 100-mesh in size.

The efficiency level relates to grit having a specific gravity of 2.65 and to the difference in grit content in the influent channel as compared to that of the effluent in the effluent channel.

J. Self-Priming Grit Pump

1. The self-priming grit pump shall be able to deliver to the grit washer a minimum flow as noted in paragraph 1.3.H.1. at a total dynamic head as noted in paragraph 1.3.H.2. The static head shall be as noted in paragraph 1.3.H.3.
2. All internal passages, impeller vanes, and recirculation ports shall pass a 3-inch spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer, manufacturer's certified drawings showing size and location of the recirculation port shall be submitted for approval along with the manufacturer's certification of solids handling size certified by an officer of the company.
3. Re-prime Performance

    a. Consideration shall be given to the grit slurry services anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg and the siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.
    b. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic re-priming while operating at its rated speed in a completely open system. The pumps being submitted shall not require either a foot valve or an external priming device.
    c. Pump must re-prime at a minimum vertical head as noted in paragraph 1.3.H.4. at the specified speed and impeller diameter. Re-prime lift is defined as the static height of the pump suction above the liquid, while operating with only one half of the liquid remaining in the pump casing. The pump must re-prime and deliver full capacity within five minutes after entering the prime cycle. Re-prime performance must be confirmed with the following test set-up:
        1) A check valve shall be installed down stream from the pump discharge flange. The check valve size shall be equal to (or greater than) the pump discharge diameter.
        2) A length of air release pipe shall be installed between the pump and the discharge check valve. This line shall be open to atmosphere at all times, duplicating the air displacement rate anticipated at the typical pump station fitted with an air release valve.
        3) The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for the re-prime test shall incorporate a 4 foot minimum

horizontal run, a tee with side outlet, and a vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.

4) Impeller clearance shall be set as recommended in the pump service manual.
5) Repeatability of performance shall be demonstrated by testing five consecutive re-prime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
6) Liquid to be used for re-prime test shall be water.
7) Upon request from the engineer, certified re-prime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be supplied prior to shipment.

K. The grit washer shall be designed to receive up to the maximum flow rate noted in paragraph 1.3.I.1. and to convey the maximum grit capacity noted in paragraph 1.3.I.2. The grit washer shall be capable of removing 95% of 150 micron (100 mesh) grit having a specific gravity of 2.65 or larger. The grit washer shall be capable of producing a washed and dewatered grit with less than 10% organics.

1.5 SCREENINGS WASHING

A. Each screen shall be furnished with a dual screenings spray wash system to flush organic material from the screenings prior to compaction and dewatering. The dual screenings washing systems shall be designed to minimize the amount of organic material in the screenings and to maximize solids dryness after compaction and dewatering. The dual screenings washing systems shall include:

1. Lower wash system shall be located immediately prior to the point where the screenings are removed from the screen and enter the screenings transport tube. This wash system shall pre-wash the screenings to remove fecal material and to prevent material from sticking to the screw conveyor flights.
2. Screenings wash system shall be located just prior to the beginning of the compaction zone after maximum maceration of the screenings by the screenings transport screw conveyor. At the maximum wash water flow rate noted in paragraph 1.3.F.15., the screw conveyor shall be designed to prevent screenings from being washed down the screenings transport tube to the basket.

1.6 GRIT WASHING

A. The grit washer tangential inlet and inlet baffle shall create flow patterns to provide optimum grit settling and primary separation of organics from the grit. The grit washer shall clean grit through the injection of wash water in the bottom of the settling chamber so that descending grit moves countercurrent to the wash water flow.

B. Settled grit shall be stirred to loosen and dislodge organic matter in the grit. The operation of the grit transport/dewatering screw conveyor shall be intermittent and automatically initiated at a preset high grit level. The grit shall be transported up the screw conveyor and discharged through a chute located near the end of the grit transport screw conveyor.

C. The control system shall be designed so that the cleaning characteristics of the grit washer and grit transport/dewatering screw can be changed via the programmable controller.

1.7 SCREEN AND GRIT ODOR CONTROL

A. To minimize odors and nuisance insect populations, the 3-plane cylindrical bar screen transport system and compaction/dewatering system shall be completely enclosed.

B. The screen spray wash systems shall be completely enclosed to prevent spray, aerosols, and leakage from coming in contact with the operating floor.

C. The grit washer shall be completely enclosed.

1.8 MATERIALS QUALITY

A. All fabricated components of the 3-plane cylindrical bar screen shall be AISI Type 304 stainless steel including the screen basket, screw conveyor, outer screen housing and support structure.

B. All fabricated components of the vortex grit chamber shall be AISI Type 304 stainless steel.

C. All fabricated components of the grit washer shall be AISI Type 304 stainless steel including the tangential inlet, inlet baffle, settling/washing chamber, fluidizing manifold, back wash chamber, grit stirrer, concentric screw conveyor dewatering screw, and support structure.

D. Materials thicknesses identified in PART 2 - PRODUCTS are the minimum requirements for this project. Materials with increased thicknesses will be acceptable.

E. To ensure spare parts availability, all fabricated components shall be manufactured in the United States and shall comply with the New York Domestic Steel Products Act. To ensure prompt service and to ensure spare parts availability in a timely manner and at a reasonable cost, foreign fabricated materials of construction for the components identified in paragraph 1.9.A., B., and C. will not be acceptable for this project.

1.9 QUALITY ASSURANCE

A. In order to assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these Specifications that all screening, grit removal and grit washing equipment called for under this Section shall be supplied by a single manufacturer. The equipment manufacturer shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.

B. Naming a Manufacturer in paragraph 2.1 does not relieve them from complying with the performance requirements, salient features and the Made in the USA requirements of the Contract Documents The Contract Documents represent the minimum acceptable standards for the screening and grit removal equipment for this project. All equipment shall conform fully in every respect to the requirements of the respective parts and sections of the drawings and specifications. Equipment that is a "standard product" with the manufacturer shall be modified, redesigned from the standard mode, and shall be furnished with special features, accessories, materials of construction or finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of the specification.

1.10 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for equipment. Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams.

B. Product Data: Provide material descriptions, dimensions of components, operating weights, furnished specialties and accessories, and flow range and headloss capacity information:

C. Other Information Submittals:

1. Manufacturer's installation instructions.
2. Warrantees
3. Shop Test Reports

D. Operation and Maintenance Data: The contractor shall submit four (4) copies of Operation and Maintenance manuals for equipment as specified in Section 01782.

E. Field quality-control test reports.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. 3-plane cylindrical bar screen, vortex grit removal system, and grit washer:

a. Lakeside Equipment Corporation, of Bartlett, IL

2.2 3-PLANE CYLINDRICAL BAR SCREEN

A. Screen:

1. The 3-plane cylindrical bar screen shall be designed and built to withstand maximum possible static and hydraulic forces exerted by the liquid to the screen. All structural and functional parts shall be sized for the loads encountered during the screening, conveying and pressing operations. All submerged components and all components of the 3-plane cylindrical bar screen in contact with the screened solids shall be of stainless steel construction.

2. The screen basket shall be of a cylindrical shape that shall be open at the top. The screen bars shall be perpendicular to the centerline of the screen. The basket ring support bars shall have adequately machined slots so that the rake teeth can penetrate the basket ring bars to ensure proper cleaning of the full basket depth.
3. The screen basket shall use graduated depth bars to provide three (3) distinct screening planes (bar heights) on the screen interior to provide superior solids capture and removal from the flow. Designs that utilize a single bar height will not be acceptable for this project. The nominal bar spacing shall be as noted in paragraph 1.3.F.4. Perforated plate, fabric wire, wedge wire or lamella plates will not be acceptable screen media.
4. Each ring shall be fabricated from sections that have been cut from flat cold rolled stainless steel sheet to minimize warping of the rings. Basket ring designs manufactured from rolled bar stock into rings will not be acceptable for this project. Each basket ring section shall be provided with an integral strengthening gusset at each attachment point to the support bars for added basket strength. The stainless steel support bars shall be machined with slots to provide the proper bar spacing as specified in paragraph 1.3.F.4. Each basket ring shall be inserted into the machined slot of the basket support bars and then welded to the support bars to provide a superior strength basket design.
5. The main screen basket upper support ring shall be a minimum of 5/8-inch thick and shall be machined to match the transport tube main support flange to ensure proper alignment of the basket and the rotating rake arm in accordance with paragraph 2.11.F. The main screen basket lower support ring shall be 7/8-inch minimum thickness.
6. The minimum diameter of the screening basket shall be as noted in paragraph 1.3.F.5. The basket diameter shall be matched with a sufficient number of bar spacings to ensure the maximum hydraulic capacity flow rate noted in paragraph 1.3.F.1. is achieved and to provide less than the maximum headloss noted in paragraph 1.3.F.3.
7. The width of the screening channel shall be as noted in paragraph 1.3.F.7.
8. A hinged protective guard fabricated of 12-gauge minimum thick stainless steel or FRP shall be provided to cover the open top of the screen basket. Hinges and mounting hardware shall be stainless steel.
9. Side seal plates shall be provided to enclose the circular screen and the rectangular concrete channel. Side seal plates shall be two-piece fabricated of 10 gauge minimum stainless steel and shall be of sufficient height to prevent bypassing of flow around the screen at the maximum hydraulic capacity flow rate noted in paragraph 1.3.F.1.
10. The screen shall be provided with a pivoting support stand allowing for easy removal of the screen basket from the channel for maintenance purposes. To ensure operator safety during servicing of the screen, supports and support stand shall be fabricated from 1/4-inch minimum stainless steel shapes and plates.
11. A set of stainless steel lower screen basket support brackets fabricated of 1/4-inch sections shall be provided to support the basket in the channel. Support brackets shall allow vertical adjustment of the screen basket so that it does not rest on the channel floor.

B. Rotating Rake and Cleaning Comb:

1. The rotating rake assembly shall penetrate the depth of the bar screen to ensure positive solids removal. Rake shall be cast stainless steel or water-jet cut stainless steel for superior life. Designs using a fabricated rake head or that use a screw conveyor with a brush to clean the screen will not be acceptable for this project. Rake tooth root design shall match the 3-plane design of the basket rings to ensure proper cleaning of the screen bars.
2. The rake shall reverse at least once during the cleaning cycle to pass through the topmost position where it shall be cleaned by a cast stainless steel or water-jet cut stainless steel

hinged cleaning comb installed at the top of the screen basket. Fabricated cleaning comb designs will not be acceptable for this project. The cleaning comb shall be designed to match the rake profile to ensure cleaning of the spaces to the root of each tooth in the 3-plane rake design. Cleaning comb shall be supported at both ends by a nylon bearing and shall pivot and return to the standby position without the use of counterweights.

3. The rotating rake and the screw conveyor shall be fixed to the same shaft and driven by a common drive.
4. A stainless steel backed nylon brush shall be attached to the rake arm and positioned to make contact with the screening trough to sweep material caught on the edges of the trough.

C. Screenings Conveyor and Screenings Dewatering Press:

1. The screenings screw conveyor transport tube nominal diameter shall be as noted in paragraph 1.3.F.8. with a minimum Schedule 10S wall thickness. A minimum of three (3) anti-rotation bars with 1/4-inch minimum thickness shall be welded to the inside of the transport tube along the longitudinal axis from the compaction zone to the beginning of the screenings collection trough. The screenings screw conveyor shall not depend on support from the anti-rotation bars during normal operation.
2. A basket support plate flange shall be a minimum of 3/4-inch and shall be welded to the lower end of the screenings transport tube to attach the screen basket and to provide for attachment of the screenings collection hopper. A 1/2-inch minimum thick drive support flange shall be welded to the upper end of the screenings transport tube for attachment of the drive assembly. After all welding of components to the screenings transport tube have been completed the fabrication shall be placed in a lathe to machine the face of the upper drive flange, to machine the face of the lower basket support plate flange for mating the basket and to machine the lower bearing housing in accordance with paragraph 2.11.F. A 1/2-inch thick minimum drive assembly adaptor stainless steel flange shall be provided to bolt to the upper drive support flange.
3. The dewatering screw shall be designed to transport and dewater the screened material. Screw flights shall be all AISI Type 304 stainless steel construction with a minimum thickness of 3/16-inch with increased 3/8-inch thick minimum thickness in the screenings collection trough and in the compaction and dewatering zone. Designs using a shaftless screw design shall be fabricated of AISI Type 316Ti stainless steel to minimize stress relief after fabrication and shipping. Flight pitch distance shall be a maximum in the screenings collection hopper and shall be reduced along the length of the screenings transport tube to a minimum pitch distance in the compaction zone. Constant pitch screenings screw conveyor designs will not be acceptable for this project.
4. The upper and lower screenings conveyor torque tube shall be fitted with a solid stainless steel stub shaft. The shafts and screenings screw conveyor torque tube shall be accurately machined in accordance with paragraph 2.11.F. to allow a bolted index-fit design for the upper stub shaft and a shrink-fit for the lower stub shaft. The upper screenings conveyor torque tube shall be fitted with a removable stainless steel stub shaft that may be changed for adapting to speed reducers that are produced by various manufacturers. Welding the upper stub shaft to the screening transport screw conveyor torque tube will not be acceptable for this project.
5. The lower end of the screenings conveyor shall be supported by a sealed, water-flushed, self-lubricated lower polymeric composite sleeve bearing with stainless steel wear sleeve. Metallic-based lower bearings will not be acceptable for this project. The lower bearing shall not take any thrust load from the screw conveyor. Flush water shall be furnished with a stainless steel water feed line connected to the lower bearing housing to maintain a

positive pressure in the bearing cavity, which will reduce potential bearing contamination. A minimum of two seals shall be provided each with a UHMW polyethylene seal retainer plate. The stainless steel bearing housing shall be field replaceable and shall be machined in accordance with paragraph 2.11.F. to mate with the screenings collection housing by a bolted connection. Designs in which the bearing housing is welded directly to the screen body will not be acceptable for this project.

6. Rake arm attachment hub outer diameter shall match the outer diameter of the stationary bearing housing to minimize material wrapping around the shaft. A seal plate shall be furnished to mate between the stationary lower bearing support and the rotating arm to prevent material intrusion into the bearing seals. The rake arm attachment hub shall be split to provide compression fit with two (2) bolts for attachment and one (1) bolt for removal. A key and keyway shall be provided to position the rake onto the lower stub shaft.
7. Drainage holes shall be provided along the entire length of the screenings collection trough invert to allow for gravity drainage of wash water without flushing screenings out of the trough. Drainage hole diameter shall be equal to or smaller than the bar spacing noted in paragraph 1.3.F.4. The width of the drainage section shall be based upon a minimum 65-degree arc. The drainage section perforated plate material shall be fabricated from 11 gauge minimum thick stainless steel and shall have a minimum 50% open area for free water drainage.
8. A compaction zone shall be an integral part of the screenings screw conveyor and transport tube design. The compaction zone shall be designed to form a screenings plug of material and to return water released from the screened material back to the wastewater channel through circular holes that are machined into the screenings transport tube. Compaction zone shall be fabricated from 12 gauge minimum thick stainless steel welded to the screenings transport tube to provide a watertight screenings pressate collection chamber. Compaction zone housings that are non-metallic and which require seals to prevent leakage around the screenings transport tube will not be acceptable for this project. Compaction zone housing shall be furnished with a hinged and gasketed access cover held in place with stainless steel latches as well as a removable dewatering section panel inside the dewatering chamber to allow direct access to the screw conveyor should the compaction zone ever become plugged. Designs that require removal of the drive assembly, discharge head or screw conveyor to gain access to the compaction zone will not be acceptable for this project.
9. Water that is released from the screenings shall be returned via a reinforced rubber hose attached to the dewatering section. Drain design shall allow for removal and cleaning of the drain hose should it ever become plugged without removing the drive, discharge head or screw conveyor.
10. Screen minimum invert to discharge height shall be as noted in paragraph 1.3.F.9.

D. Drive Assembly:

1. The rake mechanism and transport screw shall be driven by a direct-connected, hollow-shaft, high-thrust, in-line, cycloidal-helical speed reducer. The cyclo element of the speed reducer shall be designed to take a 500 percent shock load without damage. The speed reducer manufacturer shall be a member of AGMA. Combination gear motor designs will not be acceptable for this project. The speed reducer shall have a minimum torque rating as noted in paragraph 1.3.F.10. and a minimum thrust rating as noted in paragraph 1.3.F.11. at the design output speed.
2. The speed reducer shall be bolted to the drive adaptor flange at upper end of the screenings transport tube.

3. The speed reducer shall be driven by a field replaceable NEMA C-flanged, 1,800 rev/min, ball bearing, continuous-duty, totally enclosed, fan-cooled motor with leads to a large conduit box for outdoor operation. The reducer shall utilize a taper grip bushing to connect to the drive shaft of the screw conveyor. The use of keys and keyways will not be an acceptable connection method for this project.
4. Motor size shall be as noted in paragraph 1.3.F.12., shall be rated for electrical power characteristics as noted in paragraph 1.3.F.13. and shall be rated for an environment as noted in paragraph 1.3.F.14. Explosion-proof motors shall be furnished with thermosensors in the motor windings shall be rated T3C for cutout at 160°C.
5. Chain-drives, belt drives, hydraulic drives or a separate upper bearing for the transport screw will not be acceptable for this project.
6. A proximity sensor for locating the rake position shall be mounted to the outer drive housing with a fabricated stainless steel bracket. Limit switches or other electro-mechanical position sensing devices will not be acceptable for this project.

E. Spray Wash Systems:

1. Three (3) spray systems shall be provided. Each spray wash system shall be furnished with a control solenoid valve, stainless steel piping and fittings, flexible reinforced PVC hose and nozzles. Piping, fittings and valves shall be 3/4-inch diameter minimum. A plant water strainer shall be provided for the incoming plant water supply. The wash water flow requirements shall be as noted in paragraph 1.3.F.15. with a minimum pressure as noted in paragraph 1.3.F.16. The three (3) spray wash systems shall include:

   a. Lower spray wash system shall be located near the upper end of the screenings basket just prior to where screenings enter the screw conveyor transport tube. The lower wash system shall have the minimum of spray nozzles as noted in paragraph 1.3.F.17.
   b. Screenings spray wash system shall be located in the upper section of the transport tube no more than 17 inches from the beginning of the compaction zone to break up and return organic materials to the flow stream and to ensure maximum screenings washing. A minimum of one (1) spray nozzle shall be provided. The screenings spray wash system and screenings screw conveyor shall be designed to prevent washing screenings down the center of the screw conveyor.
   c. The dewatering chamber flush water system shall periodically clean the compaction and dewatering zone via a stainless steel wash nozzle located in the compaction/dewatering chamber. The dewatering chamber flush water system shall not be a substitute for the screenings washing systems described in paragraphs 2.2.E.1.a. and 2.2.E.1.b.

2. The three (3) solenoid valves shall be 3/4-inch minimum, brass body suitable for 120 VAC operation with a rating as noted in paragraph 1.3.F.14. Solenoid valves shall be normally closed and rated for up to 100 psig. Solenoid valves shall be slow close type to minimize water hammer. Solenoid valve electrical connectors shall be a metallic design.
3. Solenoid valves shall be factory installed to a piping manifold to ensure even pressure distribution to each spray wash system. The solenoid valve wiring shall be factory installed to a common junction box on the spray wash manifold for wire nut connection to external power. Conduit and fittings shall be factory installed between the solenoid valves and junction boxes. Junction box, conduit and fittings shall be rated NEMA 4X for non-hazardous locations and NEMA 4/7/9 for an explosion-proof environment as noted in paragraph 1.3.F.14.

4. Water strainer shall be provided suitable for a 3/4-inch connection and a maximum flow rate of 25 gal/min and suitable for a maximum pressure of 100 psig. Water filter shall be a stacked filter element design with washable 80-mesh (200 micron) polyethylene or polypropylene disc elements, polypropylene head and bowl and Buna N gaskets. Y-type strainers will not be acceptable for this project.

2.3 VORTEX GRIT CHAMBER EQUIPMENT

A. General

1. The vortex grit chamber shall have an inside diameter as noted in paragraph 1.3.G.2.
2. The vortex grit chamber grit hopper shall have an inside diameter as noted in paragraph 1.3.G.3.

B. Drive Mechanism

1. The drive mechanism shall consist of a motor, a helical reduction unit, and an enclosed final reduction unit consisting of one pinion and an integral gear/bearing. All components shall be directly coupled.
2. The speed reducer shall be driven by a C-flanged, 1,800 rev/min, ball bearing, continuous-duty, totally-enclosed, fan-cooled motor with leads to a large conduit box for outdoor operation. Motor size shall be as noted in paragraph 1.3.G.4., shall be rated for electrical power characteristics as noted in paragraph 1.3.F.13. and shall be rated for an environment as noted in paragraph 1.3.F.14. Explosion-proof motors shall be furnished with thermosensors in the motor windings shall be rated T3C for cutout at 160°C.
3. The helical reduction unit shall drive the pinion of the final reduction. The helical reduction unit shall have an AFBMA L10 theoretical design life in excess of 100,000 hours.
4. The final reduction pinion shall be made of heat-treated alloy steel and shall be mounted on the output shaft of the intermediate reduction gearbox. The gear teeth shall have a core hardness of 300-350 BHN, and shall be induction hardened to a surface hardness of 52 to 60 Rc.
5. The external tooth gear shall be an external gear/bearing unit such as manufactured by Rotek, Inc. Kaydon, Inc. or equal. Gear teeth shall be AGMA grade 6 or higher. Gear teeth shall have a core hardness of 250 to 300 BHN, and shall be induction hardened to surface hardness of 52 to 60 Rc. The main gear set shall be rated per AGMA Standard 2001-B88 for one million cycles at a continuous torque load. The bearing raceway shall be hardened to 58 to 60 Rc, precision ground and have a minimum 20.5-inch ball path diameter. The bearing shall have a seal to prevent contamination of the bearing raceway. The bearing shall have an AFBMA L10 theoretical design life in excess of 100 years. The bearing shall be oil lubricated.
6. The gear/bearing housing shall be sealed and the bottom opening shall be designed to prevent water from entering the housing in case of flooding by means of an air bell.
7. The fabricated and machined final reduction unit housing shall be manufactured of A36 steel plate or cast iron. All welds shall conform to applicable specifications of the American Welding Society (AWS). After welding, all mounting and mating surfaces shall be machined to insure proper fit and alignment of the drive pinion and mating gear.

C. Drive Tube

1. The drive tube shall be driven by the main spur gear. The drive tube shall have a nominal diameter as noted in paragraph 1.3.G.6. and shall have a minimum wall thickness of 1/4-inches. The drive tube shall be stainless steel construction.

D. Paddle Assembly

1. The paddle assembly shall consist of four (4) fixed propeller blades. The propeller blades shall be affixed to the drive tube by means of a two (2)-piece collar. The collar shall allow adjustment of the propeller assembly in either an upward or downward position to ensure maximum grit removal.
2. The paddle blades shall be tapered with ample rounded leading edges and a fixed pitch of 45 degrees. The paddle assembly shall be stainless steel construction.

E. Floor Plate

1. To minimize the possibility of organic capture, the grit collector shall have a 1/2-inch thick stainless steel floor plate in the grit chamber. The floor plate shall consist of two (2) removable sections to allow access to the grit storage hopper.

F. Inlet Baffle

1. A 1/4-inch thick stainless steel baffle shall be furnished at the inlet channel to optimize the chamber's hydraulic conditions.

G. Grit Suction Piping

1. Grit shall be pumped out of the grit hopper via a Schedule 40 steel pipe with a minimum diameter as noted in paragraph 1.3.G.7.
2. The grit suction piping shall be provided to the grit pump suction inlet complete with a tee and blind flange for clean-out and a 4-inch, 1/4-turn ball valve with stainless steel body, stainless steel ball, and Teflon seats.

H. Grit Hopper Fluidizing System

1. A grit hopper fluidizing system utilizing plant water shall be furnished to free the organics that have settled in the grit well. The water scouring supply line shall include a 1-1/2 inch diameter manual stainless steel ball valve and a 1-1/2 inch diameter brass solenoid valve for water flow control. Solenoid valve shall be slow close design to minimize water hammer.
2. The minimum grit hopper fluidizing system flow rated shall be as noted in paragraph 1.3.G.8.
3. Water strainer shall be provided suitable for a 1-1/2 inch connection and a maximum flow rate of 70 gal/min and suitable for a maximum pressure of 100 psig. Water filter shall be a dual stacked filter design with a washable 80-mesh (200 micron) polyethylene or polypropylene disc element, polypropylene head and bowl and Buna N gaskets. Y-type strainers will not be acceptable for this project.

2.4 SELF-PRIMING GRIT PUMP

A. The grit pump shall be a WEMCO Self-Primer, or equal, self-priming pump. Pumps shall have a 4-inch suction connection, and a 4-inch discharge connection. Pump shall be horizontal, self-priming, centrifugal type, designed specifically for handling a grit slurry.

B. Pump casing shall be 65-45-12 ductile iron with a minimum Brinell hardness of 150 and shall incorporate an integral volute scroll. The casing shall incorporate following features:

1. Mounting feet sized to prevent tipping or binding when the pump is completely disassembled for maintenance.
2. Two (2) 3-3/4 inch diameter case fill/inspection ports with a self-centering port cover shall be incorporated. The ports may be opened after loosening a hand nut/clamp bar assembly. In consideration of safety, hand nut threads must provide slow release of pressure and the clamp bar shall incorporate two recessed areas which securely center it from coming loose prematurely while loosening the hand nut. A Teflon encapsulated Viton O-ring shall be utilized to prevent leakage and adhesion of the fill port cover to the casing.
3. Casing drain plug shall be at least 1-inch NPT to insure complete and rapid draining of the pump volute.

C. The cover plate shall be 65-45-12 ductile iron with a minimum Brinell hardness of 150. The design shall incorporate the following maintenance features:

1. The cover plate must be retained by hand nuts for complete access to pump interior. Cover plate removal shall provide ample clearance for removal of stoppages and allow service to the impeller, seal, wear plate, or check valve without removing the suction or discharge piping.
2. A replaceable wear plate fabricated of Hi-Chrome with a minimum hardness of 650 Brinell must be secured to the cover plate by AISI Type 316 stainless steel studs and hardware.
3. In consideration for safety, a pressure relief valve shall be supplied in the volute. The pressure relief valve shall open at 150 psig.
4. Buna-N O-rings shall seal the cover plate to the pump casing.
5. Two (2) AISI Type 304 stainless steel hand adjustment knobs to assist in removal of the cover plate.
6. A convenience handle shall be mounted to the face of the cover plate.

D. A rotating assembly, which includes impeller, shaft, mechanical shaft seal, AISI Type 316 stainless steel shaft sleeve and seal hardware, lip seals, bearings, seal plate and bearing housing, shall be removable as a single unit without disturbing the pump casing or piping. The design shall incorporate following features:

1. The bearing housing shall be 65-45-12 ductile iron with a minimum Brinell hardness of 150. The seal plate shall be Hi-Chrome with a minimum 650 Brinnell hardness.
2. Separate oil-filled bearing and seal cavities shall be vented to the atmosphere. Cavities must be cooled by the liquid pumped. Three lip (3) seals will maintain the integrity of the atmospheric barrier and isolate the two (2) oil cavities, preventing oil leakage.
3. The bearing cavity shall have an oil level sight gauge and fill/one way vent plug. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition, without removal of the fill plug check valve. The check valve shall vent the cavity, but prevent introduction of moist air to the bearings.

4. The seal cavity shall have an oil level sight gauge and fill/one way vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition without removal of the fill/one way vent plug. The check valve shall vent the cavity but prevent introduction of moist air to the mechanical seal chamber.
5. Double lip seal shall provide an atmospheric path to provide positive protection of the bearings and the capability for either external visual monitoring of drainage or with an optional seal leakage probe.
6. The impeller shall be Hi-Chrome with a minimum hardness of 650 Brinell, two-vane, semi-open, non-clog, with integral pump-out vanes on the back shroud. The impeller shall thread onto the pump shaft and be secured by an impeller locking bolt made of Nitronic 60 with locking threads.
7. The shaft shall be 17-4 PH stainless steel with rolled threads for installation of the impeller. Machining of threads which weaken the structural integrity of the shaft will not be acceptable for this project.
8. The bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal will not be acceptable for this project.
9. The mechanical shaft seal shall be of the oil lubricated type. The stationary and rotating seal faces shall be silicon carbide alloy. Each mating surface shall be lapped to within two light bands flatness (23.3 millionths of an inch) as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the seal plate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be Viton; cage, spring and shaft sleeve are to be 316 stainless steel. The seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.
10. The pusher bolts shall have capability to assist in the removal of the rotating assembly, and the threaded holes shall be sized to accept the same cap screw as used for retaining the rotating assembly.
11. Adjustment of the impeller face clearance (distance between impeller and wear plate) shall be accomplished by external means.
12. Clearances shall be maintained by an external shim-less and tool-less cover plate adjustment using a hand knob design for incremental adjustment of clearances without requiring any tools. Requirement of realignment of belts, couplings, etc., shall not be acceptable. The cover plate shall be capable of being removed without disturbing clearance settings.
13. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the cover plate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment to assist in obtaining optimal efficiency while extending the life of the impeller and wear plate.
14. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, will not be acceptable for this project.
15. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure by blowing out if the internal volute pressure exceeds 180 psig. Removal or installation of the check valve must be accomplished through the cover plate opening, without disturbing the suction piping. Sole function of the check valve shall be

to save energy by eliminating the need to re-prime after each pumping cycle. Pumps requiring a suction check valve to assist re prime will not be acceptable for this project.

16. Spool flanges shall be one-piece ductile iron Grade 65-45-12 fitted to suction and/or discharge ports. The suction and discharge flanges shall have one (1) 1-1/4 inch NPT and one (1) 1/4-inch NPT tapped hole with pipe plugs for mounting gauges or other equipment.

E. Motor size shall be as noted in paragraph 1.3.H.5., shall be rated for electrical power characteristics as noted in paragraph 1.3.F.13. and shall be rated for an environment as noted in paragraph 1.3.F.14. Explosion-proof motors shall be furnished with thermosensors in the motor windings shall be rated T3C for cutout at 160°C.

F. Power transmission from the motor to the pump shall be by means of a set of V-belts and sheaves. Belts and sheaves shall be designed with a minimum 1.5-service factor based on motor horsepower. Sheaves shall be two section units for both drive and driven sheaves and shall consist of a tapered split shaft bushing with three tapped holes to which the sheave is attached by three cap screws. Changing sheaves shall not require a wheel puller. Belts and sheaves shall be covered with a fabricated stainless steel or aluminum belt guard with a hinged expanded metal front panel in accordance with OSHA standards. Belt guard shall be designed with the expanded metal front hinged to the main enclosure for ease of inspection and access. Hinged front panel shall be held in place via stainless steel captive fasteners.

G. Pump and motor shall be provided on a fabricated steel base with a sliding motor base for belt tension adjustment.

2.5 GRIT WASHER

A. General

1. The grit washer shall be circular in design to provide vortex separation of the grit and backwashing of the settled grit bed to maximize organics removal prior to dewatering of the grit.
2. Designs that utilized grit cyclones and classifiers will not be acceptable for this project.

B. Tangential Inlet and Baffle

1. The grit washer shall be designed and built to withstand maximum possible static and hydraulic forces exerted by the liquid to washer. All structural and functional parts shall be sized for the loads encountered during the settling and washing operations. All submerged components and all components in contact with the grit or slurry shall be of AISI Type 304 stainless steel construction.
2. The inlet shall be provided with a stub end and a lap joint flange. The inlet shall be of the diameter noted in paragraph 1.3.I.3.
3. The tangential inlet and baffle shall impart a centrifugal force to the grit and water slurry which in turn shall dissipate the flow energy as it adheres to the inlet chamber walls and is forced downward by the inlet baffle.

C. Settling and Washing Chamber

1. The settling and washing chamber shall be conically shaped to direct grit downward to a lower collection and separation area.
2. Peripheral wash water nozzles shall evenly distribute wash water into the washing chamber.
3. The settling and washing chamber shall include a stainless steel grit stirrer for mixing grit and separating it from the inlet grit and water slurry and to minimize grit build-up on the tank walls. The grit stirrer shall be shall be bolted to a stainless steel drive shaft with 1/2-inch thick minimum stainless steel mating flanges. The grit stirrer shall have an upper and lower stirrer assembly fabricated of stainless steel.
4. The grit stirrer shall be driven by a direct-connected, hollow-shaft, high-thrust, in-line, cycloidal-helical speed reducer. The cyclo element of the speed reducer shall be designed to take a 500 percent shock load without damage. The speed reducer manufacturer shall be a member of AGMA. Combination gear motor designs will not be acceptable for this project. The speed reducer shall have a minimum torque rating as noted in paragraph 1.3.I.4. and a minimum thrust rating as noted in paragraph 1.3.I.5. at the design output speed. The speed reducer shall be bolted to a mounting baseplate supported by structural supports spanning the settling tank.
5. The grit stirrer motor size shall be as noted in paragraph 1.3.I.6., shall be rated for electrical power characteristics as noted in paragraph 1.3.F.13. and shall be rated for an environment as noted in paragraph 1.3.F.14. Explosion-proof motors shall be furnished with thermosensors in the motor windings shall be rated T3C for cutout at 160°C.
6. The settling and washing chamber shall include an effluent weir and outlet. The outlet shall be provided with a stub end and a lap joint flange. The outlet shall be of the diameter noted in paragraph 1.3.I.7.
7. The settling and washing chamber shall include a backwash collection chamber and an organic backwash drain of the diameter noted in paragraph 1.3.I.8. After the wash water nozzles and grit stirrer have fluidized the grit and separated organics from clean grit, the backwash drain valve shall open and flow will enter the backwash collection chamber and discharge through the drain valve. The drain shall include a Sharpe, or equal, stainless steel flanged full-port Figure No. 50116, or equal, quarter-turn ball valve with electric actuator. for automatic operation of the organic backwash cycle
8. Automatic operation of the grit transport and dewatering screw conveyor shall be controlled by a power sensing monitor. As the grit concentration increases, the grit stirrer power monitor will sense an increase in power and initiate a backwash cycle.

D. Grit Fluidizing System Piping and Fittings

1. The grit fluidizing system shall be provided minimum 1-inch and 3/4-inch diameter stainless steel piping and flexible reinforced PVC hose. There shall be a minimum of four (4) grit fluidizing water injection points mounted into the grit washer tank body. The grit fluidizing system shall be designed for a minimum flow rate as noted in paragraph 1.3.I.9. and a minimum pressure as noted in paragraph 1.3.I.10.
2. The grit fluidizing system shall be provided with one (1) water strainer suitable for a 3/4-inch connection and a maximum flow rate of 25 gal/min and suitable for a maximum pressure of 100 psig. Water filter shall be a stacked filter element design with washable 80-mesh (200 micron) polyethylene or polypropylene disc elements, polypropylene head and bowl and Buna N gaskets.
3. The grit fluidizing system shall include a 1-inch brass body solenoid valve for flow control suitable for 120 VAC operation with an electrical classification rating as noted in paragraph 1.3.F.14. Solenoid valves shall be normally closed and rated for up to 100

psig. Solenoid valves shall be slow close type to minimize water hammer. Solenoid valve electrical connectors shall be a metallic design.

4. One (1) flow control ball valve shall be provided. Ball valve shall be 1-inch diameter, 1/4-turn, stainless steel body with stainless steel ball and Teflon seats, and shall have an adjustable handle for flow rate control of the spray wash system.
5. One (1) 2-inch minimum flow meter shall be provided. Flow meter shall be designed to measure a minimum flow range of 3 to 25 gal/min. Flow meter housing shall be fabricated of Trogamid-T, or equal, with a PVDF float, and PVC end connections.
6. Each grit fluidizing system injection point shall include a 3/4-inch stainless steel globe valve for adjusting the flow rate.

E. Grit Conveyor and Dewatering Screw

1. The grit transport and dewatering screw conveyor transport tube nominal diameter shall be as noted in paragraph 1.3.I.11. and shall be fabricated of minimum Schedule 10S stainless steel pipe.
2. A drive support flange shall be welded to the upper end of the grit transport tube for attachment of the drive assembly and machined after fabrication.
3. The grit transport and dewatering screw shall be designed to transport and dewater the grit material. Screw torque tube shall be 3-inch diameter minimum Schedule 40S AISI Type 304 stainless steel pipe. Screw flights shall be all AISI Type 304 stainless steel construction with a minimum thickness of 1/4-inch. Designs using a shaftless screw design shall be fabricated of AISI Type 316Ti stainless steel to minimize stress relief after fabrication and shipping.
4. The upper grit screw conveyor torque tube shall be fitted with a solid stainless steel stub shaft. The shaft and grit screw conveyor torque tube shall be accurately machined in accordance with paragraph 2.11.F. to allow a bolted shrink-fit design. The upper grit screw conveyor torque tube shall be fitted with a removable stainless steel stub shaft that may be changed for adapting to speed reducers that are produced by various manufacturers. Welding the upper and lower stub shafts to the screening transport screw conveyor torque tube will not be acceptable for this project.
5. The lower end of the grit dewatering screw conveyor shall be supported by a sealed, water-flushed, self-lubricated lower polymeric composite sleeve bearing with stainless steel wear sleeve. Metallic-based lower bearings will not be acceptable for this project. The lower bearing shall not take any thrust load from the screw conveyor. Flush water shall be furnished with a stainless steel water feed line connected to the lower bearing housing to maintain a positive pressure in the bearing cavity, which will reduce potential bearing contamination. A minimum of two seals shall be provided each with a UHMW polyethylene seal retainer plate. The stainless steel bearing housing shall be field replaceable and shall be machined in accordance with paragraph 2.11.F. to mate with the screenings collection housing by a bolted connection. Designs in which the bearing housing is welded directly to the screen body will not be acceptable for this project.
6. One (1) tank drain ball valve shall be provided at the lower end of the grit transport screw conveyor housing. Ball valve shall be 2-1/2 inch diameter, 1/4-turn, stainless steel body with stainless steel ball and Teflon seats, and shall have an adjustable handle for flow rate control of the spray wash system.
7. The transport/dewatering screw shall be driven by a direct-connected, hollow-shaft, high-thrust, in-line, cycloidal-helical speed reducer. The cyclo element of the speed reducer shall be designed to take a 500 percent shock load without damage. The speed reducer manufacturer shall be a member of AGMA. Combination gear motor designs will not be acceptable for this project. The speed reducer shall have a minimum torque rating as

noted in paragraph 1.3.I.12. and a minimum thrust rating as noted in paragraph 1.3.I.13. at the design output speed.

8. The speed reducer shall be bolted to the drive adaptor flange at upper end of the screenings transport tube.
9. The speed reducer shall be driven by a field replaceable NEMA C-flanged, 1,800 rev/min, ball bearing, continuous-duty, totally enclosed, fan-cooled motor with leads to a large conduit box for outdoor operation. The reducer shall utilize a taper grip bushing to connect to the drive shaft of the screw conveyor. The use of keys and keyways will not be an acceptable connection method for this project.
10. Motor size shall be as noted in paragraph 1.3.I.14., shall be rated for electrical power characteristics as noted in paragraph 1.3.F.13. and shall be rated for an environment as noted in paragraph 1.3.F.14. Explosion-proof motors shall be furnished with thermosensors in the motor windings shall be rated T3C for cutout at 160°C.

F. Grit Washing System Piping and Fittings

1. The grit screw conveyor shall be provided with a grit washing system. The grit washing system shall include a 1/4-inch stainless steel line with compression fitting that shall be connected into the grit transport and dewatering screw conveyor near the maximum water level.
2. The grit washing feed line shall be furnished with a stainless steel needle valve for flow adjustment.

2.6 CONTROL SYSTEM

A. All controls necessary for the fully automatic operation of the screen and grit removal system shall be provided in accordance with NEMA standards.

B. A position sensor shall be located on the drive unit that shall provide a “home” location for the 3-plane cylindrical bar screen operation during the cleaning cycle.

C. The electrical control system shall provide for automatic control of the screen via a high liquid level using a liquid level control system in connection with an adjustable time clock. The screen shall operate at a high liquid level or a pre-determined time sequence to provide a variable time between cleaning operations.

D. The float switches shall be a hermetically sealed, axially non-position sensitive type, mercury-switch activated and enclosed in a polypropylene housing. The switches shall operate over a narrow switching angle and have a minimum rating of 1 amp at 120 volts. A 20 ft PVC jacketed power cable, weight, grip cord, and stainless steel mounting bracket shall be furnished as part of the switch assembly. The level switching circuit shall be rated intrinsically safe by inclusion of a UL approved switch isolator with relay output. The switch isolator shall be rated for 120-volt service with output contacts rated for 2 amps minimum. A second high-level float switch shall be included for alarm indication.

E. Timers in the PLC control logic shall be used to control the grit fluidizing solenoid valve and the grit pump.

F. The operation of the grit washer grit blow down shall be controlled via a power sensing system on the grit stirrer assembly. As the grit level rises in the grit settling and washing chamber, the

power required to turn the grit stirrer will increase. An adjustable high-level set point shall initiate a grit blow down and washing cycle.

G. The preliminary treatment main control panel, RP-1-1 shall include the following items:

1. Door interlocked fused disconnect
2. Allen-Bradley Micrologix 1500, or latest model, programmable logic controller (PLC) with operator touch screen, relays and timers to monitor equipment-mounted electrical devices and to perform necessary logic functions.

    a. The remote-mounted main control panel will be required to communicate discrete and analog signals to the future Plant Monitoring and Control System. Provide PLC's compatible. Provide necessary software and hardware to provide communications with the Plant Monitoring and Control System.

3. Variable frequency drive (VFD) with line reactor for the screen
4. NEMA starters for the following:

    a. Vortex grit system drive
    b. Grit pump
    c. Grit stirrer
    d. Grit transport and dewatering screw

5. Control power transformer fused primary and secondary with 120 VAC transient voltage surge suppressor (TVSS)
6. Full voltage LED-type pilot lights for each of the following:

    a. Control power ON (White)
    b. Screen

        1) Screen RUN (Green)
        2) Screen HIGH LEVEL (Amber)
        3) Multifunctional overload shutdown/screen FAULT (Red)

    c. Vortex grit system

        1) Vortex grit system drive RUN (Green)
        2) Grit fluidizing system RUN (Green)
        3) Grit pump RUN (Green)

    d. Grit washer

        1) Grit stirrer RUN (Green)
        2) Grit transport and dewatering screw RUN (Green)
        3) Grit HIGH LEVEL (Amber)
        4) Multifunctional overload shutdown/grit system FAULT (Red)
        5) Organics blow-down valve OPEN (Green)

7. Door-mounted elapsed time meters for each screen, vortex grit system, grit pump and grit washer
8. Remote discrete input terminals to receive inputs from the following:

a. pH Monitor: One (1) Low pH alarm.
b. Packaged Booster Station: One (1) Booster Station alarm.

9. Remote analog input terminals to receive inputs from the following:

a. Parshall Flume Flow Meter,: One (1) 4-20mA flow input.

10. Remote dry contact outputs for the following:

a. Screen RUN
b. Screen HIGH WATER LEVEL alarm
c. Common screen MALFUNCTION alarm
d. Vortex grit system RUN
e. Grit fluidizing system RUN
f. Grit pump RUN
g. Grit washer grit stirrer RUN
h. Grit washer grit transport and dewatering screw RUN
i. Organics blow-down valve OPEN
j. Common grit system MALFUNCTION alarm
k. Grit HIGH LEVEL alarm

11. White phenolic nameplates with black lettering
12. 600 VAC terminal block
13. U.L. 508 label
14. Electrical enclosure in accordance with paragraph 1.3.F.19. Enclosure shall be provided with a lockable front cover provided with a full window. All indicating lights, Hand-Off-Auto and Forward-Off-Reverse selector switches and running time meters shall be mounted on a dead front swing out panel located behind the window in the front cover. E-stop and Re-set pushbuttons shall be mounted on the outer lockable door.

H. A local mounted operator selector switch/push button control station, RP-1-2 for the screen shall contain the following items:

1. Hand-Off-Auto selector switches for the following:

a. Screen drive
b. Lower wash system solenoid valve
c. Screenings wash system solenoid valve
d. Dewatering wash system solenoid valve

2. Forward-Off-Reverse selector switch (spring return to center) for screen drive
3. Screen E-stop pushbutton (Red)
4. Screen Cycle/Re-set pushbutton (Black). The CYCLE/RE-SET pushbutton shall allow the control logic to be re-set after the E-STOP pushbutton is pulled out. The CYCLE/RE-SET pushbutton shall also allow the plant operations staff to run the screen through a complete cleaning cycle by holding in the pushbutton for a pre-set time.
5. White phenolic nameplates with black lettering
6. NEMA 4/7/9 cast aluminum explosion-proof 7-hole enclosure.

I. A local mounted operator selector switch/push button control station, RP-1-3 for the vortex grit chamber and grit pump shall contain the following items:

1. Hand-Off-Auto selector switches for the following:

    a. Vortex grit system drive
    b. Grit fluidizing system
    c. Grit pump system

2. Vortex grit system E-stop pushbutton (Red)
3. Vortex grit system Cycle/Re-set pushbutton (Black). The CYCLE/RE-SET pushbutton shall allow the control logic to be re-set after the E-STOP pushbutton is pulled out. The CYCLE/RE-SET pushbutton shall also allow the plant operations staff to run the vortex grit system and grit pump through a complete blowdown cycle by holding in the pushbutton for a pre-set time.
4. White phenolic nameplates with black lettering
5. NEMA 4/7/9 cast aluminum explosion-proof 5-hole enclosure

J. A local mounted operator selector switch/push button control station, RP-1-4 for the grit washer shall contain the following items:

1. Hand-Off-Auto selector switches for the following:

    a. Grit washer grit stirrer
    b. Grit washer grit transport and dewatering screw
    c. Organics blow-down valve

2. Grit Washer E-stop pushbutton (Red)
3. Grit washer Cycle/Re-set pushbutton (Black). The CYCLE/RE-SET pushbutton shall allow the control logic to be re-set after the E-STOP pushbutton is pulled out. The CYCLE/RE-SET pushbutton shall also allow the plant operations staff to run the grit washer through a complete cycle by holding in the pushbutton for a pre-set time.
4. White phenolic nameplates with black lettering
5. NEMA 4/7/9 cast aluminum explosion-proof 5-hole enclosure

K. Serial communication with plant the future Process Monitoring system to be accomplished by means of Ethernet LAN connection.

1. Provide necessary software and hardware to provide communications with the Plant Monitoring and Control System.
2. Provide the Plant Monitoring and Control System Operator Workstation and HMI graphics.
3. Communication of information between the Preliminary Treatment System control panel and the Plant Monitoring and Control System shall be for monitoring purposes only by the Plant Monitoring and Control system.

    a. Provide all operating and alarm monitoring information and displays to the Plant Monitoring and Control System that are available for viewing on the Ultraviolet Disinfection System Operator Interface.

2.7 SCREENINGS AND GRIT BAGGERS

A. The discharge chutes of the screen and grit washer shall be furnished with a bagging device to contain and encase dewatered screenings and grit.

B. The bagging device shall be fabricated of 12 gauge minimum stainless steel.

C. The screenings and grit baggers shall be designed to be fitted with 262 ft of continuous hose complete with two (2) spare hose cartridges.

2.8 ANCHOR BOLTS

A. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Bolts, washers and hex nuts shall be 304 stainless steel unless noted otherwise. Anchor bolts shall be expansion-type or epoxy-type stainless steel.

B. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.9 SPARE PARTS

A. The following spare parts shall be provided:

1. One (1) set of screen rake heads and combs with stainless steel mounting hardware
2. One (1) screen lower bearing element with wear sleeve and seals
3. One (1) complete solenoid valve assembly of each size
4. One (1) solenoid valve re-build kit for each size
5. One (1) set of grit pump seals and O-rings
6. One (1) grit washer grit transport screw lower bearing
7. Three (3) spare fuse sets of each size and type
8. Two (2) spare hose cartridges for bagger attachment

B. Spare parts shall be individually boxed with the project name and part number clearly identified on each individual box. All spare parts shall be shipped in a separate crate and clearly labeled. Spare parts shall be stored indoors by the Contractor in a temperature-controlled environment.

2.10 SHOP SURFACE PREPARATION AND PAINTING

A. All fabricated carbon steel or cast iron components for submerged service shall be solvent-cleaned per SSPC-SP1 followed by a near-white blast cleaning per SSPC-SP10 and given a 3 mil dry film thickness coat of Tnemec 66 Hi-Build Epoxoline Primer.

B. All fabricated carbon steel or cast iron components for non-submerged service shall be solvent-cleaned per SSPC-SP1 followed by a commercial blast cleaning per SSPC-SP6 and given a 3 mil dry film thickness coat of Tnemec 66 Hi-Build Epoxoline Primer.

C. Electric motors, speed reducers, and other self-contained or enclosed components shall be supplied with the manufacturer's standard finish coating.

D. Rust preventative compound shall be applied to all machined, polished, and nonferrous surfaces which are not to be painted.

E. Clean all stainless steel surfaces and provide glass bead blast or chemically treat all external non-wetted stainless steel to a uniform finish.

2.11 SOURCE QUALITY CONTROL

A. All structural stainless steel components shall be fabricated in the United States and shall conform to the requirements of "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" published by the American Institute of Steel Construction.

B. All parts and assemblies shall be fabricated from sheets and plates of AISI Type 304 stainless steel conforming to AISI 304 and ASTM A666, unless noted otherwise. All rolled or extruded shapes shall be fabricated to conform to ASTM A276. All tubular products and fittings shall be fabricated to conform to ASTM A269, A351 and A403.

C. All welding in the factory shall use shielded arc, inert gas, MIG or TIG method. Add filler wire to all welds to provide for a cross section equal to or greater than the parent metal does. All butt welds shall be full penetration type to the interior surface. Provide gas shielding to interior and exterior of the joint.

D. Welding of the screen components shall be in accordance with the latest edition of the American Welding Society (AWS) standards. Field welding of stainless steel will not be permitted.

E. Bolts, nuts and washers shall be AISI 304 stainless steel furnished in accordance with ASTM A193.

F. All surfaces that are specified to be machined shall be designed and fabricated to provide a runout of not more than 0.005 inches and a concentricity to within 0.005 inches.

G. Design and fabrication of structural steel members shall be in accordance with AISC and AWS Standards. The manufacturer shall comply with the American Welding Society (AWS) and the American Institute of Steel Construction (AISC) most current listed standards and qualifications in 2004 D1.1, the criteria per the requirements of Section 6 - Inspection - Structural Welding Code. Evidence of such AWS and AISC compliance shall be submitted with shop drawing submittals as follows:

1. AWS Certified Welding Inspectors (minimum 2 on staff) shall conform to all standards, current or previous as listed in section 6.1.4 AWS QC1, Standard and Guide for Qualification and Certification of Welding Inspectors.
2. AWS Non Destructive Testing Inspectors (Level I, II, III) for Magnetic Particle and Ultra-Sonic testing (minimum 2 on staff) shall conform to all standards, current or previous as listed in and in conformance with The American Society for Non-Destructive Testing (ASNT-TC-1A).

PART 3 - EXECUTION

3.1 FIELD PREPARATION AND PAINTING

A. Finish field preparation and painting shall be performed as specified in Division 9 sections.

B. The Contractor shall touch-up all shipping damage to the paint and stainless steel as soon as the equipment arrives on the job site.

C. The Contractor shall supply paint for field touch-up and field painting.

D. The Contractor shall finish paint electrical motors, speed reducers, and other self-contained or enclosed components with oil-resistance enamel.

E. Prior to assembly the Contractor shall coat all stainless steel bolts and nut threads with a non-seizing compound.

3.2 INSTALLATION

A. The manufacturer shall schedule two (2) trips to the project site for equipment start-up assistance as noted in paragraph 3.2.B. for the Contractor and for operating training as noted in paragraph 3.5.A. for Owner personnel.

B. After the Contractor has installed the 3-plane cylindrical bar screen, vortex grit removal system and grit washer and the equipment is capable of being operated, the equipment manufacturer shall furnish a qualified representative for a minimum of three (3) days (up to 24 hours) to inspect the equipment and to supervise field-testing and start-up for the Contractor.

C. After the equipment has been placed into operation, the manufacturer's representative shall make all final adjustments for proper operation.

3.3 SHOP TESTING

A. Prior to shipment of the equipment the screen and grit washer shall be operated for a minimum of four (4) hours at the fabrication location with the specific drive motor that will be furnished for the project at the actual operating angle of the screen for the project.

B. During the shop test the following parameters shall be recorded:

1. Motor serial number
2. Amperage draw at start-up, after two hours and after four hours during forward operation
3. Amperage draw during reverse operation

C. A certified shop test report shall be submitted to the Engineer.

D. Before final shipment of the grit pump, a Brinell hardness test shall be conducted to certify compliance with the specification. Each individual casting shall be Brinell tested at the manufacturer's plant to ASTM Method E-10 standards. Each casting shall be checked in a minimum of two places, in areas that are representative of casting thickness. Results of the Brinell tests shall be certified by a registered Professional Engineer and submitted for approval.

3.4 FIELD TESTING

A. Prior to final acceptance of the screen, three (3) tests shall be conducted according to the EPA Paint Filter Test as described in method 9095 of EPA Publication SW-486.

B. Should the system fail to produce screenings capable of passing the "EPA Paint Filter Test", the manufacturer shall at its own expense make all necessary modifications to the equipment until such tests can be passed.

3.5 OPERATOR TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment after system is operational. Training will take place while manufacturer's representative is at the job site for inspection. Refer to Division 1 Section "Closeout Procedures" and “Demonstration and Training."

B. Within twelve (12) months after start-up the manufacturer shall provide one (1) trip and one (1) day (up to 8 hours) of follow-up service and operator training. This shall be exclusive of the start-up service work that is specified in paragraph 3.2. and 3.5.A.

END OF SECTION 11330

SECTION 11331 - BAR SCREEN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Bar screen assembly

1.3 SUBMITTALS

A. Shop Drawings: Show fabrication details for the stainless steel bar screen assembly.

B. Welding certificates.

C. Material Certificates: For stainless steel used in fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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

2.2 MATERIALS, GENERAL

A. Bar screen assembly shall be fabricated from Type 304 stainless steel.

B. All fasteners shall be Type 304 stainless steel.

C. Bar screen assembly shall be fabricated by welded construction with welding conforming to current standards of the American Welding Society (AWS), as they relate to the materials involved.

2.3 DRYING RACK

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

B. Drying rack shall be 1-1/2” x 3/16” aluminum dovetail grating with non-serrated surface and mill finish. Rectangular bearing bars shall be 15/16” on-center. Rectangular cross bars shall be 2” on-center and locked in dovetail fashion at right angles and in same plane as the top surface of the bearing bars. Grating shall be capable of supporting a pedestrian load of 100 lbs/sf with a deflection not to exceed ¼”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. All welds shall be thoroughly cleaned, with residue, burrs, and other laitance being removed.

B. Install equipment level and plumb and as shown on the Contract Drawings.

C. Upon completion of installation, carefully inspect each component and verify that all items have been installed in their proper location, adequately anchored and adjust to achieve optimum operation.

3.3 CLEANING

A. After completing installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

END OF SECTION 11331

SECTION 11400 – PRIMARY CLARIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Furnish and install four (4) rectangular sludge collectors for existing primary clarifiers. System shall include:
   1. Chain and flights system
   2. Rotating pipe skimmer (worm gear type)
   3. Controls.

1.3 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details and scaled drawings for rectangular sludge collectors. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Contractor shall be responsible for field measuring existing facilities prior to shop drawing preparation. Field measurements shall be used in preparation of shop drawings.

B. Wiring Diagrams.

C. Product Data: Provide material descriptions and dimensions of components.

D. Other Information Submittals:

   1. Manufacturer’s installation instructions.
   2. Warrantees
   3. A list of the manufacturer's recommended special tools, spare parts and recommended lubricants to be supplied.

E. Operation and Maintenance Manuals: Complete with manufacturer’s instructions for equipment installation, equipment function, start-up procedures, operation, preventative maintenance, servicing and troubleshooting. Submit in accordance with Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. Protect from construction traffic and damage.

1.5 WARRANTY

A. The equipment shall be warranted for a period of one (1) year against defects in workmanship and materials under normal use, operation and service. If the equipment should fail during the warranty period due to a defective part, it shall be replaced and the units restored at no expense to the owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
3. Basis-of-Design Product: The design for each item is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product.

B. Basis-of-Design Product: Subject to compliance with requirements, provide rectangular collectors as manufactured by E&I Corporation (A Division of McNish Corporation) or a comparable product.

2.2 CHAIN AND FLIGHT SYSTEM

A. General: Provide Chain and Flight and Cross Collection equipment at the locations shown on the Contract Drawings. All systems shall have the capability of being lubricated without draining the tank.

B. Collector Chain

1. Collector chain shall be non-metallic EIP720CS, 6.00" pitch, pintle type, glass reinforced polyester. The chain shall have an average weight of 1.5 pounds per foot, a working load of 3200 pounds and an overall strength to weight ratio of not less than 4000:1. The chain link shall be integrally molded in one link to insure square ness and material flow. The link side bar shall be curved and have reinforced surfaces to accept sprockets with chain saver type rims. Test data shall show that the chain elongation does not exceed 1% at its rated working load and also, that the chain has been tested at 5,000 pounds without failure.
2. The connecting pins shall be 7/8" diameter, of reinforced nylon resin and designed to withstand all loads imposed upon the chain without permanent deflection. The pins shall

pass into the chain link and be secured in place by a "Delrin", safety lock retainer and have a T-head designed to prevent rotation.

3. The attachment links shall be of the same design as the main chain link, except that it shall have, as a common molded part, rigid attachments for attaching the flight to the chain. The attachment shall be furnished with four (4) mounting holes to match the flights, using 3/8" diameter bolts.

C. Flights

1. The sludge collector flights shall be channel type, 3 x 8 nominal dimension fiberglass reinforced plastic. The flight shall have, as an integral part, a scraper lip specifically designed to clean the bottom of the tank. The flight shall be manufactured using 45% (minimum) continuous fiberglass (by weight) through its entire length and be in compliance with ASTM-0638-76. The flights shall be accurately drilled and notched by the equipment supplier to accept the chain flight attachments and wear shoes.

D. Filler Blocks

1. Polypropylene filler blocks shall be used to connect the flight to the chain flight attachment. Four (4) 3/8” diameter bolts shall make the connection.

E. Wear Shoes

1. Each flight shall be fitted with floor and return wear shoes. The shoes shall be 1/2" thick, UHMW-PE (Ultra High Molecular Weight Polyethylene). The floor shoes shall be central to the chain flight attachment and the return provided with integrally cast guide lugs to guide the flight between the return runway angles.

F. Collector Sprockets

1. Collector sprockets shall be of the split type and produced from UHMW-PE (Ultra High Molecular Weight Polyethylene). The sprockets halves shall have, chain saver rimes, and be secured to one another with stainless steel bolts through the hub and two stainless steel bolts through the web to ensure the alignment of the assembled sprocket.
2. Head shaft sprockets shall have 23 teeth and a pitch diameter of 22.21", and shall be secured to the head shaft by keys and set screws. Idler and take-up sprockets shall have 19 teeth and a pitch diameter of 18.45". One sprocket on each idler and take-up shaft shall be set-screwed in place; the other sprocket shall run free between two (2) set collars.

G. Set Collars

1. The run free idler sprockets, head and idler shafts shall be held in alignment with split cast nylon 6 set collars. The collar halves shall be held together by two (2) stainless bolts and in place by a stainless steel set screws.

H. Drive Sprocket

1. The drive sprocket shall be Cast Nylon 6 with a Rockwell hardness of R115-120, 11 teeth, and 9.26" pitch diameter. The sprocket shall be mounted to a steel body containing a shear pin and overload trip pin.

I. Overload Limit Switch

1. A NEMA IV limit switch shall be mounted on the drive unit and activated by the shear pin sprocket trip cam in the event of an overload.

J. Driven Sprocket

1. The driven sprocket shall be of the split type and produced from UHMW-PE (Ultra High Molecular Weight Polyethylene). Sprocket halves shall be secured to one another with four stainless steel bolts through the hub and two stainless steel bolts through the web to ensure the alignment of the assembly sprocket. The sprocket shall have 40 teeth and a pitch diameter of 33.25". The sprocket shall be designed to provide proper clearance of the head shaft bearing and flight.

K. Drive Chain

1. The drive chain shall be NH-78, 2.609" pitch, reinforced plastic, with 300 series stainless steel connecting pins. The chain shall have average working load strength of 1750 pounds and a weight of 1.4 pounds per foot.

L. Chain Guard

1. The drive sprocket and chain shall be enclosed in a #14 gauge steel guard.

M. Chain Tightener

1. The drive chain shall be constantly and properly tensioned with a "Snap Idle" assembly. The "Snap Idle" shall float on the drive chain between the drive and the driven sprockets. The "Snap Idle" shall contain no moving parts. All components of the "Snap Idler" shall be stainless steel and UHMW plastic.

N. Shafting

1. All shafting shall be C-1018 cold rolled steel, straight and true, and continuous between bearings, and shall be of ample size to transmit the power required.

O. Collector Shaft Bearings

1. All collector shaft bearings shall be cast iron, peak cap, babbitt lined and self-aligning. The bearings shall mount directly to the tank wall and be fitted with industrial type alemite grease fittings. If required, either the front lower or rear upper collector shaft shall have a take-up bearing assembly. The take-up bearing assembly shall mount directly to the tank wall and provide for 10" of adjustment.

P. Return Rail Angles

1. The flights shall be supported on the return run by fiberglass reinforced plastic angles, 3”x3”x3/8”. The angles shall be manufactured using 50% (minimum) continuous fiberglass (by weight) thru its entire length and be in compliance with ASTM D-3917, D-3918, and D-3647.

Q. Wall Bracket

1. The return rail angle brackets shall be produced from Cast Nylon 6. The bracket shall be one piece design and mount to the tank wall by two (2) 1 /2 “anchor bolts. The bracket shall include an angle for attaching the return rail.

R. Return Rail Wear Strips

1. The wear strips shall be 3/8” thick x 2-5/8” wide UHMW PE (Ultra High Molecular Weight Polyethylene) material and shall be attached to the return rail with stainless steel bolts. The wear strip mounting holes shall be slotted to allow for expansion or contraction.

S. Floor Wear Strips

1. The floor wear strips shall be 3/8" thick x 2 5/8” wide, UHMW PE (Ultra High Molecular Weight Polyethylene) and shall be attached to the floor, with stainless steel screws and plastic inserts. The wear strip mounting holes shall be slotted to allow for expansion or contraction.

T. Drive Unit

1. The drive unit shall be a helical gear reducer running in an oil bath. The reducer shall have a service factor of 1.25 for 24-hour operation. The drive motor shall be a (minimum) NEMA, Design B, totally enclosed, fan cooled. The unit shall operate on 230/460 volts, 3 phase, 60 hertz, and be not less than 1/2 horsepower.

U. Anchors

1. All anchor bolts shall be provided by the manufacturer and shall be Type 316 stainless steel.

2.3 ROTATING PIPE SKIMMER (WORM GEAR TYPE)

A. General: Provide rotating pipe skimmer (worm gear type)equipment at the locations shown on the Contract Drawings.

B. Rotating Pipe

1. Each primary skimmer shall be the same diameter as the existing skimmers and shall be Schedule 10 stainless steel or equivalent FRP pipe with accurately cut slots approximately 3 feet long. There shall be a 2” wide minimum continuous band between adjacent slots. Slots shall be straight and true with the centerline of the pipe. Pipe ends shall be perpendicular, smooth and free from burrs.

C. Wall Brackets

1. The wall bracket shall be made of high-grade cast iron having a recess to receive the packing sleeve and gland and shall have a flat surface for attaching to the tank wall. The wall brackets shall have slotted holes to permit vertical alignment and grease fitting for proper lubrication. The cast iron packing sleeve bolts to the wall bracket and can be adjusted to compress a 1/2" diameter "O" ring gland to make a watertight connection with the skimming pipe. A 1/4" thick neoprene gasket shall be provided as a wall seal for the brackets.
2. The worm gear wall bracket shall have mounting brackets to which two solid journal bearings are mounted which receive the worm and operating shaft.

D. Worm Gear Assembly

1. The worm shall be a cast iron worm and shall be secured to the operating shaft and supported by two-babbitted solid journal bearings fitted with grease fittings. The worm gear shall be made of high-grade cast iron and shall be bolted to a circular steel adjustment band. The adjustment band slips over the slotted skimmer pipe and is secured at final assembly. A steel ring is used with a steel retainer to ensure the proper alignment of the gearing.

E. Operating Handwheel

1. The operating hand wheel shall be made of cast iron and shall be 18 inches in diameter. It shall be connected to the worm gear operating shaft by a pipe extension and shall be located 36 inches above the operating floor.

F. Anchor Bolts

1. Anchor bolts shall be furnished by the equipment manufacturer and shall be stainless steel.

2.4 CONTROLS

A. Each clarifier collection system shall have a dedicated control system. The control system shall be supplied by the manufacturer. It shall provide total automatic machine operation with protection against overload conditions, which might damage the equipment.

1. Control Panel, RP-1-1 shall control PC-2-1collection system.
2. Control Panel, RP-1-2 shall control PC-2-2collection system.
3. Control Panel, RP-1-3 shall control PC-2-3 and -4 collection systems.

B. The control system shall be rated for the following classifications:

1. Main control cabinet NEMA-12, Non-hazardous area

C. Motion Failure Alarm Unit: An external equipment mounted motion failure alarm, (alternately known as “zero speed” or “under-speed” switch) to detect drive failure shall be utilized. Each collector system drive unit shall be equipped with a motion failure alarm unit. The location and mounting details shall be as recommended by the collector system manufacturer. Motion sensor shall be Milltonics MSP 12non contacting type probe with a pre-amplifier and main electronic assembly. The main electronic controller unit shall be Milltronics MFA 4P. It shall operate on 120 volt, single phase, 60 Hz power supply, and shall be housed in a NEMA 4X enclosure. A 0 to 60 second time delay shall be provided for startup of the collector system.

D. Emergency Shutdown: The collector system is to be provided with a cable operated OSHA safety stop switch. The trip switch shall immediately stop collector systems when the switch is actuated.

1. Electronic Motor Overload/Trip: Each collector system motor starter shall incorporate a solid state electronic motor starter with integral motor overload.
2. The starter/overload shall be furnished by the party responsible for the collector system electrical controls.

E. Thermal Protection: An “overload/blockage” indicating light shall be provided. The overload protection shall be sized according to the motor nameplate full load rating. This component shall be equipped with a manual reset and pad-lockable stop button. When the selector switch is on “AUTO” or “MANUAL” mode, the protection circuit shall cut the power off to the motor and to the control circuit of the motor starter, should the following conditions occur:

1. Overheat of the motor;
2. Short circuiting;
3. Single phasing.

F. Jamming Protection: A current metering system shall protect the system against jamming. A continuous current reading (CMT) shall be monitored by an adjustable relay (CMR). The motor starting current being higher than the setting of the CMR, the jamming protection shall be put out of service by a time delay (TCM), for a predetermined adjustable motor start

period, long enough to allow the current to fall below the CMR setting when it reaches its normal full load level. This component shall be equipped with an alarm indicator light and a manual reset push button. Should this system be energized, the "overload/blockage" light shall be activated.

G. Main Control Panel: The following basic components shall be assembled in the system main control panel enclosure and pre-wired to identified terminal blocks. This enclosure shall provide upfront panel door operation. Panel hook up shall be made on site by the contractor. The power supply shall be 480 Volts, 3-phase, 60 Hz. The control panel shall meet the applicable requirements of Section 13520.

1. The PLC shall be an Allen Bradley MicroLogix PLC based control panel.
2. Main circuit breaker type disconnect switch sized for the application shall be front panel mounted c/w operating handle and interlock;
3. Program circuits and relays to start and stop the cleaning and conveying mechanism;
4. Sequence timer shall cause the conveying mechanism to start;
5. Duration timer shall maintain the screw in operation for an adjustable period of time;
6. The control system shall be provided with jamming protection device operating through current monitor control circuit to minimize damage in case of excessive loading;
   a. Indicator light – Jamming & thermal protection alarm
   b. Indicator light – Run mode
   c. Indicator light – Power on
   d. Push-button – Jamming protection reset
   e. Push button, pad-lockable – Stop
   f. Selector switch – Manual/Off/Auto
7. Dry contact outputs rated a minimum of 3 Amps at 120Vac shall be provided to connect to the plant control system for the following status points. Contacts shall close when status points are true.
   a. Power On
   b. Collector system in Auto
   c. Collector system Run Status
   d. Collector system Fault Alarm
8. Provide a dry contact output for "Running" indication and "Malfunction" indication.
9. Provide "Auto Run" terminals for automatic operation and control by the Centrifuge, CF-6-1
10. Provide provision to accept a shutdown contact from the washer compactor.

2.5 PAINTING

1. Chain and Flight System: All structural steel, except stainless steel, shall be commercially sandblasted and shop primed with 3 to 5 mils (dry) Tnemec #66-1211 or approved equal. Bearing surfaces and shafts shall be grease coated.
2. Scum Skimming Equipment: All metal parts except stainless steel shall be, at minimum, shop primed with 3 to 5 mils (dry) Tnemec #66-1211 or equal.
3. Final painting to comply with Specification Section 099100.

2.6 SPARE PARTS

A. The following spare parts shall be provided:

1.	Carrying Chain	40 Ft.
2.	Flight Attachment Links	6
3.	Flights	4

4. Floor Wear Shoes 10
5. Return Rail Wear Shoes 10
6. Filler Blocks 8
7. Flight Hardware 4 sets
8. Drive Chain 10 Ft.
9. Any Specialty Tools required for assembling/disassembling the system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all equipment in accordance with the drawings, approved shop drawings, and the manufacturer's installation instructions. Install level and plumb, with clearances for service and maintenance.

B. Pipe all submersed grease fittings to an accessible location above the grating acceptable to Owner.

C. Align, adjust, and connect in accordance with the manufacturer's instructions and leave in proper working condition.

D. Installation shall include furnishing the required oil and grease for initial operation. The grades for oil and grease shall be in accordance with the manufacturer’s recommendations.

3.2 FIELD TESTING

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that equipment units are secure on mountings and supporting devices and that connection to pipes and electrical components are complete.
3. Verify that cleaning and adjusting are complete.
4. Perform a field test for the clarifier collector equipment and confirm operation of equipment.

3.3 FIELD QUALITY CONTROL

A. A qualified representative of the manufacturer shall inspect and approve the installation as part of the equipment commissioning.

B. Retain a qualified field service technician of the manufacturer for a minimum period of one (1) day to perform the following services:
1. Equipment Calibration:
   a. Assist with performance of equipment set up and calibrations.
2. Equipment Installation:
   a. Assist with start-up and adjusting of completed installation.
3. Training:

a. Instruct plant personnel in the operating and maintenance of the equipment provided under this item.
b. All procedures shall be covered including preventative maintenance, method of controlling equipment, and troubleshooting.

3.4 FIELD PAINTING

A. All equipment shall be field painted as specified in Section 09912.

END OF SECTION 11400

SECTION 11435 – SLUDGE DEWATERING CENTRIFUGE

PART 1 - GENERAL

1.1 WORK OF THIS SECTION

A. This Section covers the work necessary to provide one centrifuge, including centrifuge control panel(s) and all appurtenances as specified herein.

1.2 RELATED DOCUMENTS

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

1.3 EQUIPMENT NUMBERS

A. Centrifuge CS-6-1 and all associated controls and appurtenances.

1.4 GENERAL

A. Unit Responsibility: A single centrifuge manufacturer shall be responsible for supplying the centrifuge equipment, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors, adjustable speed drives, control panels, adjustable frequency drive (AFD) panels, shafting, safety guards, speed reducers, and spare parts) and for the design, assembly, delivery, installation supervision, startup, and testing of the centrifuge equipment. The centrifuge manufacturer shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions. The centrifuge equipment shall be produced and assembled by the manufacturer at a facility owned and operated by the manufacturer and under the direct supervision and control of the manufacturer.

B. Units provided under this proposal shall be of a standard model only and shall meet the reference requirements described herein. All proposed units shall be manufactured for this project and process the sludge material as specified herein. Proposals that include custom units or existing but unused standard size units shall not be acceptable.

C. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

D. The centrifuge manufacturer shall have a service center located within the continental United States that performs as a center for parts replacement as well as performs rebuild services for the model of centrifuge proposed.

E. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this project.

F. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

G. Related Sections include the following:

1. Division 3 Section "Reinforced Concrete" for base installation.
2. Division 13 Section “Control Panels” for control panel fabrication.
3. Division 15 Section "Process Piping" for piping installation.

1.5 QUALITY ASSURANCE

A. Pilot Testing and Report.

1. Prior to acceptance of the sludge dewatering centrifuge, a pilot test shall be performed with a trailer mounted complete centrifuge system, with a minimum bowl diameter of 18 inches , to perform pilot testing at the project site for a minimum of 3 days , not including assembly and disassembly time.
2. The system shall include the required quantity of the manufacturer’s suggested polymer, polymer feed pump, sludge feed pump, and connections for sludge and/or centrate piping/hoses and electrical connections necessary for a complete working unit.
3. The purpose of this testing is to demonstrate that the unit will operate and meet all of the performance requirements as specified and operating parameters used in the suppliers life cycle cost report. The General Contractor shall submit a detailed testing protocol and obtain written approval by the Engineer prior to completion of the field testing. Failure to complete the field testing or meet all of the performance requirements shall be grounds for rejection of the proposed manufacturer and model.
4. All temporary piping, power and control wiring, utilities, etc. from the plant to the centrifuge shall be provided by the General Contractor.

B. Factory Testing and Report.

1. After acceptance of the sludge dewatering centrifuge Post Pilot Testing Action Submittals and after manufacturing, a factory test shall be performed on the centrifuge and the control panel(s).
2. The Owner reserves the right to witness the tests specified herein and to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuges and associated equipment. Owner’s travel expenses will be borne by the Owner.

C. Onsite Testing and Startup Services and Report.

1. Onsite Testing and Startup Services and Report shall be performed upon final completion of the sludge dewatering centrifuge installation.
2. The timing and scheduling for testing shall be coordinated with and be dependent upon the Owner’s schedule and quantity of sludge available for testing.

1.6 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Anti-Friction Bearing Manufacturers Association (AFBMA).
2. American Gear Manufacturers Association (AGMA).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
5. American Welding Society (AWS).
6. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
7. British Standards Institute (BSI): BS 5490.
8. German Industrial Standards (DIN).
9. Institute of Electrical and Electronics Engineers (IEEE).
10. Instrument Society of American (ISA).
11. National Electric Code (NEC).
12. Occupational Safety and Health Act (OSHA).

1.7 ACTION SUBMITTALS

A. Submittals shall be made in accordance with Section 01330 - Submittal Procedures. In addition, the specific information listed below shall be provided.

B. Pre-Pilot Testing Action Submittal

1. The General Contractor shall submit a detailed testing protocol and obtain written approval by the Engineer prior to completion of the field testing. Failure to complete the field testing or meet all of the performance requirements shall be grounds for rejection of the proposed equipment.
2. Submittal shall also include trailer mounted Pilot Testing equipment information, including:

    a. Make, model, size, weight, and horsepower of each equipment assembly and panels.
    b. Solids processing capacities at various feed percentages.
    c. Maximum solids feed percentage allowable.
    d. Name and manufacturer of polymer(s) to be used during the Pre-Pilot Testing including results of bench and/or laboratory testing utilized in the selection of the polymer(s).
    e. Calculations for minimum G-volume at nameplate rpm.
    f. Manufacturer’s catalog information, descriptive literature, specifications, and identification of materials of construction for the centrifuge, drive motor, backdrive motor, adjustable speed drives, control panel, AFD panel, power supply, lubrication system, and flexible connectors.
    g. List of five centrifuge model reference installations operating five years including location, sludge stream, number of units, starting date of operation, and reference contact information.
    h. Preliminary equipment lists.
    i. Preliminary process control description.

j. General trailer arrangement layout drawing.
k. List of all required process/utility piping connections and sizes.
l. Location of Service/Maintenance and Support Facilities and Abilities:

1) Provide the addresses of all existing U.S. or other service offices. At each location, provide the number of personnel currently engaged full-time in the following categories:

a) Field service (engineering, sales/customer service, and spare parts).
b) Indicate the years of experience of each field service technician on solid bowl centrifuges.
c) Indicate the approximate response time for on-site service at the Arlington WWTP Facility.
d) Indicate how long the service office closest to the Arlington WWTP Facility has been in operation.
e) Indicate the addresses of the closest service location to the Arlington WWTP Facility and spare parts warehouses in the U.S. or elsewhere, and the extent of inventory.
f) Indicate the ability to repair a machine within 5 calendar days. Identify which repairs normally take longer than 5 days and the normal time to complete the repair.
g) Indicate the location of facilities and ability to rebalance the machine. Indicate cost and time to rebalance the machine.
h) Identify if there is a standard program for exchanging major pieces of the machine as part of preventive or emergency maintenance and repair.
i) Indicate training capabilities. Provide up to five references (name, municipality, and telephone number) for the proposed model, and qualifications of specific training personnel.
j) Indicate ability to provide a refurbished scroll within 10 working days of request. Provide three references of where you have provided a refurbished scroll in this time period.

C. Post Pilot Testing Action Submittals

1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

a. Make, model, size, weight, and horsepower of each equipment assembly and panels.
b. Solids processing capacities at various feed percentages
c. Maximum solids feed percentage allowable
d. Calculations for minimum G-volume at nameplate rpm
e. Manufacturer’s catalog information, descriptive literature, specifications, and identification of materials of construction for the centrifuge, drive motor, backdrive motor, adjustable speed drives, control panel, AFD panel, power supply, lubrication system, and flexible connectors..
f. List of five centrifuge model reference installations operating five years including location, sludge stream, number of units, starting date of operation, and reference contact information
g. Preliminary P&IDs

h. Preliminary equipment lists
i. Preliminary process control description
j. 20-year life cycle cost analysis.
k. General arrangement mechanical drawing in AutoCAD.

2. Shop Drawings:

a. Update all information provided in the submittal for official review and approval
b. Data on the characteristics and performance of the units to indicate ability to meet the system performance specified herein, including back drive gear box rated torque capacity and torque capacity required to meet performance requirements.
c. Bill of materials listing major system components, special tools, and spare parts.
d. Outside utility requirements such as air, water, power, drain, etc., for each component.
e. Calculated AFBMA L-10 bearing life and type of lubrication recommended for all equipment.
f. Design data for the following:

1) Main drive motor sizing.
2) Backdrive motor sizing.
3) Main drive sheave and belt sizing.
4) Adjustable frequency drive sizing.
5) Main bearings.
6) Maximum measured sound power levels at 3 feet, all sides of equipment.
7) Heat transfer to room from centrifuge, control panel, and AFD panel.

g. Certificate(s) demonstrating that the centrifuge production and assembly facilities are currently ISO 9001 certified.
h. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
i. Sequential description of operation under various modes of control, describing the complete control circuit and equipment operation and logic, including interlocks and permissives.
j. Description of all automatic shutdown features and interfaces with the plant instrumentation and control systems, in both word and schematic form. Standard Instrument Society of America symbols shall be used on all schematics.
k. Control and AFD Panel interconnection diagrams showing wiring interconnections between all centrifuge system components and between centrifuge system components and remote components provided by others.
l. Control and AFD Panel elevation Drawings showing construction and placement of operator interface devices and other elements.
m. Power and control wiring diagrams including terminals and numbers.
n. Shop and field painting systems proposed: Include Manufacturer’s descriptive technical catalog literature and specifications, and hazardous communication data sheets.

3. Coordination Drawings: Scaled and dimensioned drawings on D-size sheets, indicating the installation of the centrifuge equipment and appurtenances, other new work within the area of installation and existing building and building related utilities. Including, but not limiting:

a. Shaftless screw conveyors.
b. Polymer system.
c. Control panel.
d. Work by other contracts in the drawings.

4. Samples: Submit the following items with the Shop Drawings:

a. Scroll abrasive resistant tile, quantity of two.

1.8 INFORMATIONAL SUBMITTALS

A. Factory Quality Control Submittals:

1. Manufacturer's Certificate of Compliance.
2. Factory test results, reports, and certifications. Include:

a. Functional Test Reports and Certificates.
b. Vibration Test Reports and Certificates.
c. Noise Test Reports and Certificates.
d. For each ac motor, provide a certified copy of a test report for an identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B. The test report shall show full-load efficiency and power factor meeting or exceeding the specified minimum guaranteed values. Motors not as specified will be rejected.
e. Certified Scratch Abrasion Test results of the abrasion protection tiles.

3. Submit certified copies of mill test results for the stainless steel castings and abrasion-resistant materials. The test reports shall certify that the materials supplied are in accordance with the applicable standards and shall include:

a. The actual material analysis.
b. Applicable standards.
c. Date of manufacture.
d. Place of manufacture.
e. Manufacturer's name.
f. Markings on the materials to denote the batch number.
g. Mechanical property test for parts of the rotating assembly subject to stress.

4. Test results of the control panels and AFD panels for proper operation, construction, electrical connection, and function.
5. Shipping, storage and protection, and handling instructions.
6. Manufacturer's written/printed installation instructions.
7. Routine maintenance requirements prior to plant startup.

B. Operation and Maintenance Manual with Maintenance Summary Form shall be provided in accordance with Section 1 requirements, and the following requirements:

1. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this Section.
2. Set of complete as-reviewed Shop Drawing submittals.

3. As-built electric and instrumentation and control wiring diagrams and equipment drawings.
4. Index of all equipment suppliers listing current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.
5. Detailed operational procedures including step-by-step startup, normal operation, shutdown, and troubleshooting procedures.
6. Detailed preventative maintenance requirements and recommended schedule.
7. Shop Manual that includes full breakdown, torque, etc.

C. Equipment Testing Procedure Submittals: Centrifuge manufacturer shall submit post installation test procedures for the following tests for review, comment, and approval at least 30 days in advance of the notice to conduct the testing :

1. Functional (clean water) Testing.
2. Pre-Performance (sludge) Testing.
3. Performance (sludge) Testing.

D. Field Quality Control Submittals:

1. Obtain Engineer's review and approval of the information listed below prior to project completion. Centrifuge manufacturer shall submit test reports within 20 days after completing field testing.
2. Field test results, reports, and certifications. Include:

a. Functional Test Report and Certificates.
b. Manufacturer's Certificate of Equipment Installation Services.
c. Pre-Performance Test Report and Certificates.
d. Performance Test Report and Certificates.
e. Vibration Test Certificates.

E. Warranty: Special warranty specified in this Section.

1.9 EXTRA MATERIALS

A. Spare Parts and Special Tools:

Item	**Quantity**
Plate Dams	One complete set
Sheaves	One complete set
Drive Belts	One complete set
Main Bearings	One complete set
Scroll Conveyor Bearings	One complete set
Thrust Bearings, Seals, and Lock Washers	One complete set

Gaskets, O-rings, and Seals	One complete set
Speed Proximity Sensors	One complete set
Scroll Conveyor Tiles	20, Twenty
Replacement Indicating Lamps	One complete set
Spare Pre-Programmed PLC Memory Card	One

B. Tools and Accessories: Provide manufacturer's recommended special tools and accessories required to assemble and disassemble installed centrifuges, including the minimum following items:

1. Bowl lifter, including spreader beam, shackles, and ratchet straps, suitable for bowl removal.
2. Bowl truck.
3. Conveyor lifter.
4. Straps for lifting of machine top case.
5. Straps for lifting of drive motor assembly.
6. Straps for lifting of gearbox.
7. Tools for removal/installation of conveyor and thrust bearings.
8. Tools for plate dam adjustment/replacement.
9. Lifting eyes for hoisting of main drive pillow block bearings.

C. Special Tools: Provide the following specialized tools.

1. VJ-ADV 6930 Video Borescope, as manufactured by RF System Lab; Phone Number: 231 943 1171.
2. Or approved equal.

D. Lubricants: All necessary lubricants shall be provided for the initial startup of the centrifuge equipment. Lubricants and filters shall be provided and changed by the manufacturer as frequent as required during the period between successfully completed functional testing and equipment acceptance, up to a maximum period of 12 months. New lubricants and filters shall be furnished and installed by manufacturer at Substantial Completion. After acceptance and substantial completion, the Owner will be responsible for changing the lubricants according to the schedule provided by the manufacturer.

1.10 SAFETY REQUIREMENTS

A. All equipment furnished shall be designed and manufactured with due regard to safety of operation, accessibility, and durability of parts, and shall comply with all applicable Occupational Health and Safety Act, federal, state, and local safety regulations.

1.11 GUARANTEE

A. Provide Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as a guarantee. The guarantee shall provide for correction, or removal and replacement of Work provided under this Specification section (including but not limited to the centrifuge,

drive motors, scroll drive, control panel, hydraulic/AFD panel, and equipment found defective during a warranty period of 1 year from date of startup.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a Centrisys, Inc, Model CS-21-HC sludge dewatering centrifuge.

2.2 GENERAL

A. Each centrifuge system shall consist of a solid bowl, horizontal, continuous feed, scroll type unit, and shall be specifically designed to meet the performance requirements for the sludge types specified herein. Each unit shall be capable of continuous operations with a minimum of maintenance.

B. Each centrifuge system shall be equipped with:

1. Adjustable speed electric main drive motor assembly.
2. Belt guards.
3. Hydraulic backdrive.
4. Forced oil or automatic grease lubrication system for the rotating assembly's main bearings.
5. Vibration isolators.
6. Flexible connectors, necessary for all mechanical and electrical connections.
7. Feed, Polymer, Centrate and Cake Solids sampling provisions.
8. Control and AFD panel and instrumentation and controls specified herein.
9. Main drive adjustable frequency drives.
10. Discharge chute diverter gate.
11. Centrate and solids chutes.
12. 304 SS Solids diverter gate.
13. Type 316 anchor bolts of sufficient size and quantity.

C. All equipment shall be suitable and rated for the electrical classification required as shown in the Area Classification Table on the Drawing and the Area Classification envelopes shown on the Drawings.

D. Anchor bolt size, quantity, and location shall be designed by the Manufacturer and shall take into account all loads including vibration. The design calculations shall be signed and stamped by a structural engineer registered in New York State.

2.3 MANUFACTURER

A. The centrifuge manufacturer shall have at least 10 years' experience in the design, application, and supply of centrifuges for dewatering of sludge from municipal water treatment plants.

Centrifuge manufacturer's production and assembly facilities shall be ISO 9001 certified and units shall be manufactured or substantially transformed within the United States.

B. The centrifuge manufacturer shall have provided centrifuges at other facilities with the same bowl diameter as necessary to meet the performance requirements stated herein. A minimum of five municipal WTP dewatering reference installations in North America with units representative of those to be supplied, with each unit operational for a minimum of 5 years, including at least one New York State approved centrifuge system. Submit list of reference installations including model number, location, sludge stream and characteristics, number of units, starting date of operation, and reference contact information.

C. Modifications to Standard Equipment Model Offerings:

1. Only an equipment supplier's standard model offerings shall be acceptable for this project. Any modifications to an existing offering that is not part of the manufacturer's standard design and capacity rating shall not be acceptable.

2.4 SERVICE CONDITIONS

A. The centrifuges, control panels, and AFD panels, and appurtenances shall be suitable for exposure to continuous 95 percent relative humidity conditions, for operation in ambient air temperature from 40 to 104 degrees F, for exposure to intermittent water or sludge splash and spill conditions, and for continuous operation at a site elevation of 300 feet above sea level. Equipment shall be rated for the area classification in which it is located. Refer to the Drawings for delineation of area classification.

B. Design Feed Sludge: This is the sludge that will be available during performance testing to meet the performance requirements specified herein. The sludge will be resulting from settling of municipal wastewater. The characteristics of the sludge are summarized in the table below:

Parameter	**Value**
Sludge Feed Concentration, % Total Dry Solids Exclusive of Polymer	3%

C. The sludge to be processed will be fed to each centrifuge from a dedicated pump (provided by others). Polymer solution will be pumped by a dedicated polymer feed pump and injected at the centrifuge feed tube (provided by others)

2.5 PERFORMANCE REQUIREMENTS

A. The centrifuges shall continuously receive, condition, and dewater the feed sludges specified herein, and continuously discharge the dewatered solids. Each unit shall be able to operate continuously on demand; shall be suitable for dewatering the specified sludges continuously for up to 24 hours per day, 7 days per week; and shall operate without spillage of sludge beyond the nominal solids discharge chute and conveyor envelope or spillage of centrate beyond the liquid (centrate) discharge chute and piping envelope. Normal centrifuge operation is estimated to be less than 10 hours per day; seven days per week.

B. Manufacturer shall guarantee that the centrifuge equipment shall be capable of the minimum performance requirements specified below for Design Feed Sludge, to be confirmed via the field performance testing specified herein while operating with that sludge stream.

C. Performance Requirements:

Parameter	**Design Basis Performance Requirements**
Max. Feed Hydraulic Loading Rates(1), gpm	170
Max. Feed Solids Loading Rate(1), lbs/hr, Total Dry Solids (DS) Basis	3300
Sludge Feed Concentration, % Total Dry Solids Exclusive of Polymer, Min. – Max.	2.7% avg. 1.5% min. 4.8% max.
Minimum Dewatered Cake Concentration, % Total Dry Solids	28%
Minimum Total Solids Capture, %	95
Maximum Polymer Dose, lbs. Active per Dry Ton of Feed Solids	17
Notes: (1) The range of feed hydraulic loading rates are calculated based on the total dry solids dry mass loading rate at the expected 1.5 to 4.8% total dry solids concentrations, and are exclusive of polymer solution and carrier water.	

D. Solids Capture:

$$\%\,\text{Capture}: \frac{T}{F} \text{ x } \frac{F\text{-}C}{T\text{-}C} \text{ x } 100$$

Where:
T = Cake total solids concentration (mg/L).
F = Feed sludge total solids concentration, excluding any dilution due to polymer solution addition (mg/L).
C = Centrate total suspended solids concentration, excluding any dilution due to polymer solution addition and centrifuge purge water (mg/L).

2.6 EQUIPMENT DESCRIPTION

A. The centrifuges shall be of the high-speed, dry solids, solid bowl horizontal, continuous feed, scroll conveyor type specifically configured for dewatering only applications and intended to produce a dewatered cake with a higher solids content than that produced with conventional centrifuges. No disc type or nozzle bowl type or basket type centrifuges will be allowed. The centrifuges shall be designed to limit air leakage into or from the body of the centrifuges by providing gaskets on the casing flange and labyrinth-type seals on both hub ends. The centrifuge equipment shall be designed and built to operate continuously. An adjustable frequency drive (AFD) main drive system shall be provided to drive each centrifuge rotating assembly. A hydraulic backdrive system shall be supplied with each centrifuge to provide speed variation between the conveyor and the centrifuge bowl to maximize solids retention time within the unit under varying feed characteristic conditions. The centrifuges shall be designed to be mounted on a steel frame allowing discharge into a discharge chute directly beneath the centrifuge bowl.

2.7 MATERIALS

A. Materials of Construction: Unless otherwise specified, materials shall conform to the following:

1. Bowl: ANSI SC-2205 duplex stainless steel centrifugal castings. Static castings shall not be accepted.
2. Bowl Wear Strips: Stainless steel, Type 316, and/or replaceable ribbed bowl liner or bowl strips (stainless steel, Type 316, minimum 3 mm thickness). Grooved bowls in lieu of wear strips will not be acceptable.
3. Scroll Conveyor: ANSI SC-2205 duplex stainless steel.
4. Scroll Conveyor Tips: Sintered Tungsten Carbide tiles(1) and flame sprayed tungsten carbide hard surfacing.
5. Feed Tube: Stainless steel, Type 316.
6. Base: Fabricated carbon steel or cast steel with replaceable stainless steel cladding on all surfaces in contact with process material.
7. Upper Case: Stainless steel, Type 316.
8. Bottom Case: For all surfaces in contact with the process material, from the liquid to solids discharge shall be stainless steel or fabricated carbon steel with stainless steel cladding or cast steel with stainless steel cladding.
9. Centrifuge Cover: The centrifuge cover shall be manufactured from 304 stainless steel. Fiberglass or carbon steel covers shall be unacceptable.
10. Main Centrifuge Bearings: Forced oil or automatic grease lubricated L 10 life of 100,000 hours minimum.
11. Scroll Conveyor Bearings: Grease lubricated, L 10 life of 100,000 hours minimum.
12. Feed Compartment: Duplex stainless steel.
13. Feed Compartment Liner: Either constructed of corrosion resistant, hardened material or equipped with field replaceable Adiprene, ceramic or Urethane liner or Flame Sprayed Coast 53C, or equal, including axial walls.
14. Sludge Feed Nozzles: Replaceable Solid Sintered Tungsten Carbide(1).
15. Solids Discharge Nozzles: Replaceable Solid Sintered Tungsten Carbide(1).
16. Case Protection, Solids Discharge End: Field Replaceable Adiprene, Urethane, or Type 316 stainless steel liner, or equal.
17. Fasteners (Wetted): Minimum Type 316 stainless steel.

18. Anchor Bolts, Nuts and Washers: Stainless steel, Type 316, minimum 3/4 inch in diameter for all anchor bolts under the centrifuge frame.

(1) All sintered tungsten carbide abrasion resistant materials shall be tested in accordance with the ASTM G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests with volume loss less than 3 cubic millimeters.

2.8 BOWL

A. The bowl shall be designed to withstand, with an adequate factor of safety, all forces encountered during operation. The bowl shall be supported on each end by pillow block bearings, each of which shall be forced oil or automatic grease lubricated.

1. Bowl Length to Diameter Ratio: minimum of 4.3:1
2. Minimum Bowl Diameter – Nominal 22 inches.
3.
4. G-volume: Calculated using the formula shown below:

   a. G-volume calculated by the following formula:
      G-volume = $K\omega 2Db\ Lc\ (Db2 - Dd2)$
      Where: K = constant equal to 4.83 x 10-8
      ω = operating speed, rpm
      Db = bowl diameter, inches
      Dd = cake discharge diameter, inches
      Lc = length of bowl cylinder, inches

   b. Provide values for each variable for the given centrifuge unit.
   c. G-volume shall include only the cylindrical section and not cone section.

5. Normal Operating Speed: Minimum 2,500 rpm to maximum 3,250 rpm
6. The minimum bowl wall thickness shall be 0.7 inches. All surfaces shall be examined for cracks, shrinkage, porosity, or other defects by means of a liquid penetrant test.
7. Pool depth level must be readily adjustable via weir plates (dams) located at the large diameter end of the bowl where liquid is discharged.
8. Solids shall be conveyed through a conical section of the bowl and discharged from the small diameter end of the bowl through multiple solids discharge ports spaced evenly around the bowl end. Solids discharge ports shall be protected against abrasion by field replaceable, weight balanced, mechanically attached wear nozzles manufactured of Sintered Tungsten Carbide.
9. Centrifugally cast bowls shall be 100 percent dye penetrant inspected. Casting certificates for each component will be required. Rolled and welded or statically cast bowls shall not be allowed.
10. A replaceable ribbed liner from two wraps beyond the feed zone (towards the liquid end), or minimum of eight evenly spaced longitudinal bowl strips the entire length of the bowl, to trap solids and form a layer to protect the bowl from wear shall be provided.
11. The conical section shall be 15 degrees. No other angles shall be acceptable.
12. Material to be processed shall be introduced to the bowl through a compartment which shall evenly distribute the feed. The feed compartment shall be protected against abrasion.

2.9 SCROLL CONVEYOR

A. Each centrifuge shall include a horizontal cylindrical-conical scroll conveyor supported by anti-friction bearings and equipped with helical flights independently mounted concentrically within the centrifuge bowl. Bearings shall have externally greased fittings.

B. Conveyor shall include solids feed ports protected against abrasion by field replaceable, weight balanced, mechanically attached wear nozzles manufactured of Sintered Tungsten Carbide.

C. The conveyor edge and face of the flights shall be protected against abrasion by a series of welded-on sintered tungsten carbide tile assemblies, with coverage from two wraps beyond the feed zone (towards the liquids discharge end) through to the solids discharge end. Each tile assembly shall be weight correct, and consist of a solid sintered tungsten carbide wear part attached to a stainless steel backup holder. Spray hard surfacing applied to a backup plate is not allowed. Each assembly shall be individually replaceable, and shall include the ability to monitor wear by means of visual inspection. The tile assemblies shall extend a minimum of 0.3 inches beyond the radial edge of the conveyor flight. The remaining scroll conveyor edge and face shall be protected from abrasion by flame sprayed hard surfacing containing a minimum of 40 percent tungsten carbide particles.

D. After attachment of the abrasion protection tiles on the back up plate flighting, each tile shall be individually torque tested at a minimum shear stress of 5,000 psi, by the means of a torque wrench, or other equivalent method. No total detachment, visible or residual deformation, or carbon cracking shall be noticed after the test. If not so, the tile shall be removed and a new one attached in its place and the torque test repeated. The manufacturer shall keep and submit a record of this test.

E. All sintered tungsten carbide tiles shall be able to meet ASTM G65 Test Procedure A with a volume loss as specified in Article Factory Tests.

2.10 CASE

A. Each centrifuge shall be enclosed in a fabricated case, the purpose of which shall be to contain and direct the solids and liquid discharge from the centrifuge, to act as a protective guard, and to provide complete enclosure for noise reduction and odor control. The casing assembly shall be provided with a Type 304/316 stainless steel upper case per manufacturer’s standard, specifically designed for rigidity and noise reduction, and Type 304/316 stainless cladding on wetted parts in the lower casing. A FRP upper case is not acceptable. The case top shall be bolted in place. Lifting eyes shall be provided for lifting of the case top.

B. A flanged and gasketed seal shall be provided between the upper and lower case components. Flange bolts shall be stainless steel.

2.11 FRAME

A. Each centrifuge shall be supported individually on a fabricated carbon steel or combination cast iron and steel base which shall in turn be mounted on vibration isolators. The centrifuge frame shall not be artificially weighted to dampen vibration.

B. The vibration isolators shall be provided to isolate the centrifuge from the building structure. The number, capacity, and vibration constant of the isolators shall be selected by the manufacturer for the load and impact resulting from operation of the centrifuge provided.

C. The bottom portion of the frame shall be provided with machined outlets for the attachment of the solids and centrate flexible connectors.

D. Lifting eyes or solid lifting bars shall be provided for lifting of the frame.

2.12 MAIN DRIVE SYSTEM

A. For each centrifuge system, the bowl drive system shall consist of an electric main drive motor with adjustable frequency drive and V-belt drive system complete with necessary vibration isolators for the individual support of the motor and centrifuge. The belt drive system shall consist of multiple V-belts as required to provide full load capacity and to withstand the full starting torque of the system.

2.13 BACKDRIVE SYSTEMS

A. Provide a hydraulic backdrive system for each centrifuge. Backdrives utilizing adjustable frequency drive (AFD) backdrive systems are not acceptable as an alternate.

B. Hydraulic Backdrive.

1. Provide a hydraulic backdrive system for each centrifuge, as manufactured by Viscotherm. The differential speed between the centrifuge bowl and scroll conveyor shall be produced by a hydraulic system which shall independently drive the scroll conveyor.
2. The system shall use a hydraulic pumping group and hydraulic motor. Torque-based adjustment shall be a function of input to the driven unit. The maximum torque input and rate of change of scroll differential speed shall be adjustable.

2.14 FASTENERS

A. All internal fasteners furnished with the centrifuges which are subject to contact with sludge, centrate, or vapors of wash water and wastewater shall be a minimum Type 316 stainless steel.

2.15 BEARINGS

A. The entire rotating assembly of each centrifuge shall be supported by two main bearings. Each main bearing shall be forced oil or automatic grease lubricated ball or cylindrical roller type bearings. Main bearings shall be housed in one piece pillow blocks with dowel pins for proper alignment. Provide each pillow block bearing with a threaded female connection to permit the use of a lifting eye to facilitate inspection and maintenance.

B. Scroll conveyor bearings shall be anti-friction ball or roller type bearings sealed from process contamination. Bearings shall have external grease fitting for lubrication. Permanently lubricated bearings shall not be allowed.

C. Bearings shall have an AFBMA or SKF new life bearing theory L-10 life of 100,000 hours minimum.

2.16 FORCED OIL LUBRICATION SYSTEM

A. If the lubrication of centrifuge main bearings is by means of a forced feed oil system, the system shall consist of:

1. Oil reservoir including drain leg and plug valve.
2. Oil pump of adequate capacity with motor sized by centrifuge manufacturer.
3. Oil pump motor starter.
4. Oil to water heat exchanger, Type 316 stainless steel.
5. Pressure gauge.
6. Water in oil detector.
7. Temperature regulating valve on cooling water supply.
8. Solenoid valve on cooling water supply, automatically controlled from the centrifuge control panel, fail open.
9. Two oil return flow-indicator switches, one for each pillow block bearing.
10. Three resistance temperature detectors (RTD), one in the oil supply to the main bearings and one in each of the two main bearings.
11. Relief valve.
12. Two reservoir sight level gauges and two temperature gauges.
13. Oil filter and cooling water strainer, 100 mesh.
14. Oil filter high pressure loss switch, to indicate required filter change.
15. Oil temperature indicator and regulator.

B. If the lubrication of centrifuge main bearings is provided by means of a high efficiency air-oil lubrication system for each centrifuge, it shall consist of:

1. Oil reservoir with built in controller and pump assembly
2. Pressure gauge for oil and air.
3. All necessary items assembled on mounting panel and stand.
4. Level and pressure monitoring with common alarm.
5. Solenoid valve on air supply, automatically controlled from the centrifuge control panel, fail closed.
6. Three oil flow-indicator sensors, one for each lube point on pillow block bearing and mounted on pillow block.
7. Relief valve set to 30 Bar.
8. Water separator filter/ included.
9. Compressed (instrument) air supplied by plant at 4cfm max, (compressor optional)
10. Use clear plastic high pressure tubing to connect air and oil to centrifuge
11. Lube system shall not require cooling water.

C. Each lubrication system shall be interlocked with the associated centrifuge main drive motor such that low oil pressure, low oil flow, and/or high oil temperature will de-energize the centrifuge main drive motor. In all cases, the starter for the oil circulating pump motor controls shall be interlocked with the main drive motor so that oil is circulating whenever the centrifuge is running and a delayed trip so as to continue pumping oil while the centrifuge coasts to a stop. The oil pump shall also be independently operable.

D. Each oil system shall be skid-mounted and supplied fully assembled. All lube oil piping internal to the lube oil skid and on the centrifuge itself shall be Type 316 stainless steel. Piping between the lube oil skid and the centrifuge shall be flexible rubber hose. Fittings shall be compression type.

E. Lubrication oil heat exchanger shall meet its cooling requirement using cooling water supplied at a temperature of 80 degrees F when ambient temperature is 104 degrees F. Provide self-contained regulating valve to automatically control cooling water flowrate as required to maintain lubricating oil temperature. Cooling water supplied will be plant effluent reclaimed water.

2.17 GUARDS

A. Fabricated guards shall be provided for all gear boxes, pulleys, and belt drives.

1. Guards shall be 11 gauge minimum thickness Type 304 stainless steel.
2. The guards shall meet OSHA standards and completely enclose the rotating parts of drive system and shall be designed to minimize vibration and noise.
3. Guards, except for the main drive motor, shall have 1-inch diameter holes coincident with the shafts of all equipment to allow the shaft speed to be checked.
4. Fasteners shall be externally accessible.

2.18 FEED TUBE

A. Sludge shall be fed to the centrifuge by means of a removable feed tube suitable to minimize turbulence. The feed connection to the centrifuge shall be a suitably sized 150-pound ASME flange connection. The maximum inlet pressure required at the centrifuge inlet flange shall be 10 psig at maximum pump flow gpm as indicated in the performance requirements (when based on water with the viscosity of 1 Centipoise). The flow includes a maximum sludge flow plus polymer solution and carrier water. The feed tube shall also include a suitably sized NPT connection for polymer.

2.19 FLEXIBLE CONNECTIONS

A. All mechanical and electrical connections to the centrifuge equipment, including, but not necessarily limited to, the feed sludge, polymer, centrate and dewatered sludge cake connections, cooling water supply and return piping, sample line, vents, and electrical raceways shall be equipped with flexible connections. All flexible connections shall isolate centrifuge vibrations from fixed, rigid external connections. No exterior loads shall be transferred to a centrifuge by external connections to the machine. Centrate and dewatered sludge cake flexible connections shall be flanged and fabricated from neoprene, with Type 316 stainless steel bolts with Type 316 stainless steel retainer plates at each end. Piping flexible connectors shall be metal-reinforced elastomer with flanged connections. Tubing flexible connectors shall be metal-reinforced hose with Type 316 stainless steel hose clamps. Flexible electrical connections shall be flexible metal, liquid tight conduit meeting the following:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

2.20 DISCHARGE DIVERTER GATE

A. Provide a stainless steel diverter gate with an automatic actuator mounted and a process water connection with a control solenoid valve. The diverter gate shall be connected to the centrifuge discharge chute. The diverter actuator and the process solenoid shall be controlled by the centrifuge control panel.

2.21 SAMPLE CONNECTIONS

A. Provide sampling connection for centrifuge feed sludge after polymer addition and before it enters the bowl.

2.22 SOLIDS DISCHARGE CHUTES:

A. Chutes shall be of 304 stainless steel construction and supplied by the Centrifuge Supplier and costs shall be included within this specification. Owner reserves right to eliminate the chutes from this scope of supply, in which case the Solids Discharge Chutes will be provided by the General Contractor. Any scope of supply changes shall be made prior to shop drawing approval.

2.23 CENTRATE CHUTES.

A. Chutes shall be of 304 stainless steel construction and supplied by the Centrifuge Supplier and costs shall be included within this specification. Owner reserves right to eliminate the chutes from this scope of supply, in which case the Centrate Chutes will be provided by the General Contractor. Any scope of supply changes shall be made prior to shop drawing approval.

2.24 NOISE

A. Centrifuge shall be designed such that when running at the normal operating speed, the average noise level measured at 3 feet around the periphery of the complete centrifuge assembly shall not exceed 90 dBA, when tested at the manufacturing facility, without feed and with inlet and discharge connections sealed.

2.25 ELECTRICAL

A. General:

1. Conform with Division 26, Electrical.
2. Provide all necessary electrical components and wiring for a complete, functional system.
3. All motor adjustable frequency drives for each centrifuge system shall be provided in associated AFD panel provided as part of this Section.
4. Control panel and AFD panel and interior components shall be rated for continuous operation in 40 degrees C (104 degrees F) ambient conditions.

B. Wiring: Size conductors and conduits for power circuits to the main and backdrive motors. Factory prewire (size, furnish, install, and connect) all skid mounted equipment control

conductors and instrumentation cables to skid mounted terminal junction boxes for connection to the associated control panel and AFD panel by Division 16, Electrical. The electrical wiring requirements and proper documentation shall be included as part of the package system scope of supply. All conductors shall be stranded copper, and all wiring shall meet the requirements of NFPA 70, the 2011 National Electrical Code. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in 600 volt twisted shielded pair cable. Analog circuits shall not be mixed with power or discrete control circuits.

C. Terminal Junction Boxes: All skid-mounted devices, except for motor leads, shall be prewired to skid-mounted terminal junction boxes (TJBs). Separate TJBs shall be provided for (a) 120V power and (b) 4 to 20 mA analog and 24V dc discrete signals. Size, furnish, and install NEMA 4X, Type 316 stainless steel TJBs on the centrifuge skid.

D. Main Drive Motors:

1. Provide squirrel-cage ac induction motors. Motors should be selected to allow for easy repairs in the future, preferably with wear parts that have Imperial sizes as opposed to Metric.
2. Motor shall meet the following specific requirements:

    a. Motor Horsepower: 75 HP design basis.
    b. Synchronous Speed: 3600 rpm.
    c. Voltage Rating: 460V, three-phase.
    d. Enclosure Type: TEFC.
    e. Mounting: Horizontal.
    f. Inverter duty rated motor.

3. Provide motor modifications as follows:

    a. With the motor at ambient temperature (COLD), it shall be capable of making two complete starts in succession with coasting to rest between starts within a 1-hour time period. With the motor running (HOT), it shall be capable of at least one restart within 1 hour after any shutdown. The motor insulation temperature classification shall not be exceeded.
    b. The motor shall be of the quiet type design. The noise level shall not exceed 85 dBA sound pressure measured at 3 feet from the motor in all directions.
    c. A motor thermal protection system consisting of six (two per phase) three-wire 100 ohm platinum resistance temperature detectors (RTDs) or bi-metallic thermostat. Bring the RTD leads out to a Type 316 stainless steel NEMA Type 4X junction box. Provide temperature monitoring and overtemperature relay at the main drive AFD enclosure.
    d. Provide motor bearing temperature protection on each motor bearing. Provide 100 ohm three-wire platinum resistance temperature detectors (RTDs). Bring the RTD leads out to terminal blocks in a threaded cast aluminum junction box. Provide temperature monitoring and overtemperature relay at the main drive AFD enclosure.

E. Main Drive AFDs: Each main drive motor shall be controlled by an adjustable frequency drive.

1. The system shall be sized in accordance with manufacturer’s design requirements.
2. The motor shall be capable of delivering full load torque across a 10:1 turndown ratio.

3. Drive system shall be capable of flying restart.

F. Hydraulic Backdrive

1. Provide a hydraulic motor and pump unit as a complete hydraulic drive (HD) system. Motor shall be a slow speed, high torque hydraulic motor with a constant displacement. Hydraulic motor shall be a positive displacement radial piston motor capable of providing the torque, speed, and power required to drive the scroll.

G. Dried Sludge Cake Conveyors:

1. Provide full voltage forward/reversing motor control contactors for two shaftless screw dried sludge cake conveyors:

   a. CNV-6-1 – 7.5 hp, 460V, three-phase, TEFC.
   b. CNV-6-2 – 7.5 hp, 460V, three-phase, TEFC.

2. Provide power and control relay for energizing/de-energizing process water flush solenoid valves for conveyors, one valve for each conveyor.
3. Emergency Shutdown: Each conveyor shall be furnished with an emergency trip cord and safety switch. The conveyor is to be provided with a cable operated OSHA safety stop switch with continuous cable run on both sides. The trip switch shall immediately stop all conveyors when the switch is actuated. The switch shall be RS2 type by Conveyor Components Corporation or approved equal.

   a. Electronic Motor Overload/Trip: Each conveyor motor starter shall incorporate a solid state electronic motor starter with integral motor overload.

H. Provide a Centrifuge VFD control panel and PLC control panel for the centrifuge.

Panel Nos.	**Name**	**NEMA Enclosure**	**Material**
RP-6-1A RP-6-1B	VFD control panel PLC control panel	12, typical	Type 304/316 Stainless Steel, typical

1. The Centrifuge VFD control panel, RP-6-1A shall be a freestanding enclosure, to house the centrifuge motor controls and VFD equipment, including:

   a. A main circuit breaker with a through the door lockable handle.
   b. VFD controls for main drive.
   c. Hydraulic controls for backdrive.
   d. Control for lube oil pump, if required by the manufacturer.
   e. E-stop pushbutton.
   f. Power transformer to supply centrifuge controls equipment, instruments, and control power.

2. Adjustable frequency drives shall be sized in accordance with NEC and Division 16, Electrical.
3. The main circuit breaker shall be a 65,000 symmetrical amp thermal magnetic breaker sized in accordance with centrifuge system requirements.
4. Power Supply: 480 volt, three-phase, three-wire, 60 Hz.

I. The PLC control panel, RP-6-1B shall be a freestanding enclosure, to house the centrifuge PLC based controls equipment, with no components energized with greater than 120 volt power.

2.26 CONTROLS

A. General:

1. Instrumentation component qualities shall be in accordance with components specified in Section 13520 - Control Panels.
2. Provide centrifuge controls equipment in a dedicated compartment of the Control and VFD Panel specified herein, in Article Electrical.
3. The controls for all components of each centrifuge shall be provided by a dedicated programmable logic controller (PLC), mounted in each of the respective control panels. The PLC shall provide all control and monitoring functions as required for the operation and monitoring of the centrifuge including, but not limited to, timing, interlocks, startup sequencing, normal and emergency shutdowns, and permissive functions required for safe operation of each centrifuge.

    a. Programming Standards: All PLC programming for the centrifuge system shall not be proprietary in nature.
    b. Critical field alarm instruments and contacts will be wired for failsafe operation where an open circuit will alarm. PLC communications and faults shall be monitored.
    c. All indicating lights shall be in accordance with Section 13520 - Control Panels, with equipment tag numbering as specified herein and as shown on the Drawings.

4. Provide Power Loss Ride through System backup power for all PLC and instrument components of the centrifuge control system. Size UPS to supply power for a minimum of 20 minutes.
5. PLC Manufacturer and Products: As specified in Section 13520 - Control Panels.
6. Provide Application software for all digital, programmable components of the centrifuge systems as specified in Section 13520 - Control Panels.
7. Provide Ethernet TCP/IP 100 Mbps network communications module to support communications between the PLC and the Owner’s future Plant Control System network.
8. Provide each control panel with an external air conditioning device, to sustain the control panel in ambient air temperature conditions up to 115 degrees F. Air conditioning device shall be powered by a single 120V, 60-Hz circuit. Provide thermostat to control operation of the air conditioning device, so that device only provides cooling when panel interior temperature exceeds a preset and adjustable limit. The purpose of this device shall be to sustain the panel in the event that the building air conditioning system is out of service.
9. Provide programming and communication hardware for interfacing with two remote thickened sludge pump AFD control panels for automatic/manual lead/lag operation:

    a. P-6-1.
    b. P-6-2.

10. Provide programming and communication hardware for interfacing with a polymer feed panel.
11. Provide power, programming logic and communication hardware for stop/start and flushing operation of two remote shaftless screw dried sludge cake conveyors:

a. CNV-6-1.
b. CNV-6-2.

B. Control Panel Functions:

1. Operator Interface Unit (OIU):

a. Provide a panel-mounted OIU on each centrifuge control panel.
b. OIU Manufacturer and Product: As specified in Section 13560 - Operator Interface.
c. The OIU for each centrifuge shall provide the primary method for an operator to monitor the status of the centrifuge and to affect its operation by command or directive entry. The OIU shall provide the graphics-based interface between the operator and the centrifuge controller. The graphics and their layout/presentation shall be manufacturer's standard.
d. The OIU shall provide all displays and control screens needed to safely and efficiently monitor and control the associated centrifuge system.
e. The OIU shall provide for selection of the following:

1) Centrifuge Control Mode: LOCAL/REMOTE.
2) Backdrive Control Mode: TORQUE/DIFFERENTIAL (in Local mode).
3) Centrifuge Start (in Local mode).
4) Centrifuge Stop (in both LOCAL and REMOTE modes).
5) Centrifuge Clean-In-Place (CIP) initiation (In Local mode).

f. Display (at a minimum):

1) Alarms.
2) Status and control of each system component.
3) Bowl speed.
4) Backdrive gear shaft speed, if gearbox is supplied.
5) Main drive motor amperage (rms value).
6) Differential Speed: Scroll versus bowl.
7) Bearing temperatures.
8) Backdrive torque.
9) Vibration.
10) Centrifuge Control Mode: LOCAL/REMOTE.
11) Backdrive Control Mode: TORQUE/DIFFERENTIAL.
12) The specific shutdown condition.
13) Sludge and polymer flow rates.
14) All inputs from and outputs to the future plant SCADA system.

g. The OIU shall have operator adjustable parameters for backdrive control. There shall be a minimum of 5 sets of backdrive control parameters stored for the operator to use for different sludge conditions. In addition there should be one set of backdrive control parameters for use during cleaning or flush cycles. Backdrive control should be automatically changed to cleaning parameters in auto shutdown of the centrifuge or in CIP mode and return to the previous parameter set afterwards.

h. The OIU shall contain historical trending of data to include bearing temperatures, hydraulic pressure or backdrive torque, sludge flow, vibration, and bowl speed. Trending data shall be retained for a minimum of 1 week.

2. Controller Sequencing: Each centrifuge PLC shall contain all programming necessary to safely start and stop the associated centrifuge, in the Local mode. The following minimum sequences and control shall be provided.

a. Local/Remote: In the Local mode, centrifuge control shall only be available through the centrifuge control panel. All outputs to the future plant SCADA system shall still be available in Local mode.

b. Start: This command shall instruct the centrifuge control system to begin its start sequence. The centrifuge shall not be allowed to start more than the stated number of times per hour (two if cold, one if hot). The centrifuge control system shall confirm the successful initiation and/or completion of each step in the startup sequence before continuing with the next step in the sequence.

1) The start sequence can only begin when the centrifuge feed pump and polymer feed pump are not running (OFF status).
2) Provided all interlocks are in the normal state, the centrifuge control system shall bring the bowl and scroll up to speed and signal when proper conditions have been attained to begin feeding polymer and sludge.
3) Initiate start of polymer feed pump.
4) Initiate start of centrifuge feed pump (after a preset time delay).
5) Initiate opening of the dewatered sludge diverter slide gate, to discharge to the centrate piping.
6) Upon reaching an operator entered torque set point, initiate closing of the dewatered sludge diverter slide gate.
7) If the start sequence is interrupted for any reason, including, but not limited to equipment failure, interlock failure, or manual (operator initiated) interrupt, the centrifuge controller shall generate a FAIL TO START alarm. Stop the centrifuge and polymer feed pumps, and allow the machine to coast to a standstill.
8) If the start sequence is successful, discontinue monitoring interlock status of polymer feed, sludge feed, and cake conveyance.

c. Normal Stop: This command shall instruct the centrifuge control system to begin its normal stop sequence. The centrifuge control system shall confirm the successful initiation and/or completion of each step in the stop sequence. If any step in the sequence fails, the centrifuge controller shall generate an alarm specifying the failed step.

1) Stop the centrifuge feed pump and polymer feed pump (disable ENABLE commands).
2) Maintain a preset differential speed to clear the remaining cake from the bowl.
3) After a set adjustable time for removal of resident solids or upon reaching an operator entered falling backdrive torque set point, initiate opening the flush water valve and initiate opening of the dewatered sludge diverter slide gate, to discharge to the centrate piping.

4) After a predetermined (adjustable) time period, close the flush water valve and initiate closing the dewatered sludge transfer screw slide gate. The machine shall then coast to a standstill.

d. The control system shall cause a “Shutdown” of the centrifuge and alert this condition to the future plant SCADA system in the event that any of the following interlocks are triggered. These automatic shutdown interlocks shall include, but are not limited to:

1) Backdrive controller malfunction.
2) Left/right bearing HIGH HIGH temperature alarms.
3) Backdrive malfunction.
4) HIGH HIGH torque.
5) HIGH HIGH vibration.
6) In the event that shutdown is caused by any of the above conditions, the control system shall require operator intervention to determine the cause of the shutdown and for restarting the system.

e. The control system may also cause an automatic “Shutdown” sequence of the centrifuge and alert this condition to the future plant SCADA system in the event that any of the following interlocks are triggered. These automatic shutdown interlocks shall include, but are not limited to:

1) Backdrive HIGH temperature alarm.
2) Drive motor over temperature.
3) Drive motor overload.

f. During normal operation an excessive solids build-up shall be detected by the centrifuge control system as a higher than normal torque requirement or by sensing excessive vibration. Should the torque or vibration exceed a preset point, the HIGH torque or vibration switch shall close, sending a signal to the centrifuge control system which shall initiate shutdown of the sludge and polymer feeds. When the torque or vibration falls to an acceptable limit, operator may reinitiate start of sludge and polymer feeds upon determining that the solids build-up is no longer a problem. The high torque control shall be not more than twice the normal operating torque or pressure. The controls shall also allow operation at a set differential speed allowed to vary within the normal operating limits. Controls shall include adjustable timers and or a count of HIGH torque or vibration events in order to initiate an automatic “Normal Stop” in the event of repeated torque or vibration excursions.

g. In the event that the above clearing action fails to remedy the high torque or vibration situation and the torque or vibration continues to increase, the centrifuge control system shall respond by issuing a torque or vibration HIGH HIGH alarm at the control panel and similar signal to the future plant SCADA system in addition to initiating a “Controlled Shutdown”.

h. Controlled Shutdown: Controlled Shutdown shall require reset action at the control panel before the unit can be restarted.

1) This command shall de-energize the centrifuge main drive motor. The centrifuge shall be allowed to coast to a standstill. If available, the backdrive

shall remain active until the bowl has coasted to a standstill, controlled to clear as much solids as possible from the bowl.

2) The sludge and polymer feeds shall be stopped (disable ENABLE commands).

3) Initiate the bowl flush water valve open for flushing and subsequently initiate close after an adjustable time period.

i. Emergency Stop: Emergency Stop initiated via E-stop pushbutton at the centrifuge control panel or from the future plant SCADA system shall stop the centrifuge and all associated equipment instantaneously with no flush water.

1) This command shall de-energize the centrifuge system.

2) The sludge and polymer feeds shall be stopped (disable ENABLE commands).

j. Provide clean-in-place (CIP) function to clean solids out of the bowl. In a CIP cycle a "CIP Start" pushbutton is pressed, the flush water valve OPEN is initiated, the backdrive energized and begin to rotate in the reverse (if required by the manufacturer's particular design) direction at a low speed for a predetermined time. At the end of the set time, the backdrive shall toggle direction, causing a water "sloshing" effect within the centrifuge bowl and conveyor. The process shall continue until the predetermined overall times ends, a "CIP Stop" key is depressed, or a fault occurs. Any shutdown fault shall terminate the CIP cycle.

3. Controller Interface (Data Exchange with the future plant SCADA system): Provide provisions to make available and receive in contiguous registers the following data to and from the plant control system, through the centrifuge PLC Ethernet network communication module.

a. Provide for discrete outputs to the future plant control system:

1) Centrifuge LOCAL/REMOTE status.
2) Centrifuge READY status.
3) Centrifuge RUNNING status.
4) Lubrication System RUNNING status.
5) Backdrive TORQUE/DIFFERENTIAL control mode status.
6) Sludge feed ENABLE signal.
7) Polymer feed ENABLE signal.
8) Bowl flush water valve OPEN/CLOSE command.
9) Chute flush water valve OPEN/CLOSE command.
10) Emergency Stop alarm
11) FAILED TO START alarm.
12) HIGH vibration (warning) alarm.
13) HIGH-HIGH vibration (shutdown) alarm.
14) HIGH torque (warning) alarm.
15) HIGH-HIGH torque (overload) alarm.
16) Main bearing HIGH temperature alarm.
17) Bowl motor HIGH temperature alarm.
18) Scroll motor HIGH temperature alarm.
19) Bowl motor AFD FAIL alarm.
20) Scroll motor AFD FAIL alarm.

21) Lube oil system alarm.
22) Centrifuge common alarm.
23) Bowl motor winding temperature.
24) Bowl motor bearing temperature.
25) Scroll motor bearing temperature.
26) Quantity of six spare discrete outputs.

b. Provide for analog outputs to the future plant control system:

1) Bowl speed.
2) Scroll gearbox shaft speed.
3) Bowl/scroll differential speed.
4) Backdrive torque.
5) Bowl motor amperage (rms value).
6) Solids-side main bearing vibration value.
7) Liquids-side main bearing vibration value.
8) Solids-side main bearing temperature.
9) Liquids-side main bearing temperature.
10) Bowl motor winding temperature.
11) Bowl motor bearing temperature.
12) Scroll motor bearing temperature.
13) Quantity of three spare analog outputs.

c. Provide for discrete inputs to the future plant control system:

1) Emergency stop command.
2) Centrifuge START command.
3) Centrifuge SHUTDOWN command.
4) Centrifuge CIP START command.
5) Backdrive control mode (TORQUE/DIFFERENTIAL).
6) Centrifuge feed pump ON status.
7) Polymer feed pump ON status.
8) Dewatered sludge transfer screw slide gate OPEN status.
9) Bowl flush water valve OPEN/CLOSE status.
10) Chute flush water valve OPEN/CLOSE status.
11) Quantity of six spare discrete inputs.

d. Provide for analog inputs to the future plant control system:

1) Backdrive torque set point (in TORQUE control mode).
2) Differential speed set point (in DIFFERENTIAL control mode).
3) Bowl speed set point.
4) Quantity of three spare analog inputs.

e. Polymer pump START/STOP and flow control loop will be controlled by the future plant SCADA system. The centrifuge PLC shall communicate ENABLE (start) signal for polymer pump as specified for centrifuge startup and shutdown functions.

f. Sludge feed pump START/STOP and flow control loop will be controlled by the future plant SCADA system. The centrifuge PLC shall communicate ENABLE

(start) signal for sludge feed pump as specified for centrifuge startup and shutdown functions.

2.27 ACCESSORIES

A. Equipment Identification Plates: Provide a 16 gauge stainless steel identification plate for all equipment, valves, appurtenances, and instruments with equipment/component numbers, securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 inch die-stamped equipment identification numbers indicated in this Specification and as shown on the Drawings.

B. Lifting Lugs and Slings: Equipment and each component thereof weighing over 50 pounds shall be provided with lifting lugs or lifting slings for easy handling.

2.28 PAINTING

A. The paint system shall be a powder coating as the preferred alternative. Alternatively, a catalyzed epoxy primer with a top coating of aliphatic acrylic urethane applied in accordance with manufacturer’s typical paint specifications may be allowed. This section shall include motors and third party items as well.

B. All carbon steel and cast iron shall be properly prepared and cleaned in accordance with the best standard practices. Minimum surface preparation shall include solvent cleaning, SSPC SP 1 followed by abrasive blasting to near white metal, SSPC SP 10. Or other surface preparation methods will be considered, provided that the method results in the minimum surface profile required by the paint manufacturer. Apply a powder coat finish that provides the same or greater degree of protection as 3 mils minimum dry film thickness of lead-free catalyzed epoxy polyamide metal primer and one finish coat of aliphatic acrylic urethane, 3 mils minimum dry film thickness. Prepare all surfaces and apply all paint and powder coats in accordance with the manufacturer's written directions. The color shall be the manufacturers standard. Provide 2 gallons of touch up paint if epoxy coat is used.

2.29 CENTRIFUGE FACTORY TESTS

A. The Owner reserves the right to witness the tests specified herein and to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuges and associated equipment. Owner’s travel expenses will be borne by the Owner.

B. Perform manufacturer’s standard functional tests on each centrifuge system as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.
2. Manufacturer’s Test Representative shall certify test results.
3. Perform tests on all components and actually furnished.
4. Vibration measurement with bowl empty.
5. Vibration measurement with bowl filled with water.
6. Operation of machine for minimum of 4 hours with water.
7. Motor starting amperage.

8. Notify Engineer of the test schedule not less than 45 days in advance.
9. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

C. Noise Test: Measure free field sound pressure levels of centrifuge running at the normal operating speed with bowl empty.

D. Scratch Abrasion Test:

1. A representative sample of each batch of the sintered tungsten carbide tiles to be used on the wearing face of the conveyor shall be subjected to a dry sand rubber wheel abrasion test. This test shall be conducted in accordance with the current ASTM G65 Procedure A. The test shall be conducted with the following requirements:

   a. Wheel Load: 30 pounds.
   b. Grit: AFS 50/70.
   c. Grit Flow Rate: 250 to 350 grams per minute.
   d. Shape of Sand Curtain: Streamlined.
   e. Test Duration: 6,000 revolutions.
   f. Rubber Wheel: Chlorobutyl rubber with a Durometer A of 58-62.
   g. Wheel Speed: 200 rpm (plus or minus 10 rpm).
   h. Wheel Diameter: 8.50 to 9 inches.
   i. Linear Abrasion Distance: 14,138 feet.
   j. Sand Nozzle: Special fabricated design.

2. Test one tile from each lot of tiles used in manufacturing the centrifuges, or four tiles total, whichever requires the greater number of tiles to be tested. The following laboratories are equipped to conduct these tests in accordance with the ASTM Standards and can provide certification of the results:

   a. Colorado School of Mines, Golden, Colorado 80401.
   b. Falex Corp., Aurora, Illinois 60505.
   c. FMC Corp., 1205 Coleman Avenue, Santa Clara, California.

3. The volume loss of the proposed wear resistant material shall not exceed 3 cubic millimeters per tile during the 30-minute test period. Any material that exceeds 3.0 cubic millimeters loss in 30 minutes will not be allowed.

2.30 PANEL FACTORY TESTS

A. The Owner reserves the right to witness the tests specified herein and to inspect the fabrication procedures at any time during the fabrication stage(s) of any or all centrifuge panels and associated equipment. Owner’s travel expenses will be borne by the Owner.

B. Notify the Owner as specified below and Owner will travel to the factory and inspect and witness the panel factory testing.

C. Perform manufacturer’s standard functional tests on each centrifuge control panel as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.

2. Manufacturer's Test Representative shall certify test results.
3. Perform tests on panels actually furnished with each associated centrifuge at the manufacturer's facility.
4. Test panel for proper construction, electrical connection, and function.
5. Check all alarms, shutdown conditions, and automatic sequences to verify proper function.
6. Simulate interlocks and signals from other connected equipment in order to demonstrate specified operator interface functions and controls.
7. Notify Engineer of the test schedule not less than 45 days in advance.
8. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in conformance with the manufacturer's written instructions, with supervision and inspection performed by manufacturer's representative.

B. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for the load criteria specified in Section 01600 - Product Requirements.

C. Accurately place anchor bolts per the drawings furnished by the manufacturer in accordance with Section 05500, Miscellaneous Metal.

D. Manufacturer shall provide a trailer mounted unit to the General Contractor to allow the facility to process sludge during new centrifuge installation and start-up. Costs for this rental unit shall be borne by the General Contractor.

3.2 PILOT TESTING

A. A pilot test shall be provided by the General Contractor utilizing a portable unit of the same make, with a minimum of 18 inch bowl diameter and characteristics of that proposed for the project. This test shall be performed by the proposed system manufacturer's representative. The purpose of this testing is to demonstrate that the unit will operate and meet all of the performance requirements as specified and operating parameters used in the suppliers life cycle cost.

1. The General Contractor shall submit a detailed testing protocol and obtain written approval by the Engineer prior to start of the pilot testing. Failure to complete the pilot testing or meet all of the performance requirements shall be grounds for rejection of the manufacturer.

B. The General Contractor shall supply a trailer mounted complete centrifuge system, to perform pilot testing at the project site for a minimum of 5 days. The system shall include polymer feed pump, sludge feed pump, and connections for sludge and/or centrate piping/hoses and electrical connections necessary for a complete and operating unit.

1. The General Contractor shall provide all required electrical, utility and process connections and hoses, cables, conduit and wires as required to operate the pilot test unit in a safe and code compliant manner for the duration of the pilot testing.

C. The Owner shall be responsible for providing sludge with a 2 to 4 percent dry solids content for use during the pilot test.

D. The General Contractor shall start up and operate the centrifuge on the sludge stream specified herein, for a period of 8 hours per day for 5 days, with no interruptions allowed during the 8 hour period.

E. The General Contractor shall follow a testing protocol as described in Article 3.4 Onsite Testing and Startup Services, paragraph D. Performance Test, subparagraphs 5 through 11, for pilot testing. A report summarizing the findings shall be supplied within 5 days of completion of the pilot testing.

F. Failure to complete the pilot testing or meet all of the performance requirements shall be grounds for rejection of the proposed equipment.

G. Prepare and submit Test Reports.

3.3 SOURCE QUALITY CONTROL

A. Centrifuge Factory Tests

1. A factory test shall be provided by the manufacturer utilizing the unit that will be shipped and installed at the project site.
2. The Owner reserves the right to witness the tests specified herein and to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuges and associated equipment. Owner's travel expenses will be borne by the Owner.
3. Perform manufacturer's standard functional tests on each centrifuge system as follows:

    a. Gather and furnish test information necessary to show conformance to specified requirements.
    b. Manufacturer's Test Representative shall certify test results.
    c. Perform tests on all components and actually furnished.
    d. Vibration measurement with bowl empty.
    e. Vibration measurement with bowl filled with water.
    f. Operation of machine for minimum of 4 hours with water.
    g. Motor starting amperage.
    h. Notify Engineer of the test schedule not less than 45 days in advance.
    i. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

4. Noise Test: Measure free field sound pressure levels of centrifuge running at the normal operating speed with bowl empty.
5. Scratch Abrasion Test:

    a. A representative sample of each batch of the sintered tungsten carbide tiles to be used on the wearing face of the conveyor shall be subjected to a dry sand rubber wheel abrasion test. This test shall be conducted in accordance with the current

ASTM G65 Procedure A. The test shall be conducted with the following requirements:

1) Wheel Load: 30 pounds.
2) Grit: AFS 50/70.
3) Grit Flow Rate: 250 to 350 grams per minute.
4) Shape of Sand Curtain: Streamlined.
5) Test Duration: 6,000 revolutions.
6) Rubber Wheel: Chlorobutyl rubber with a Durometer A of 58-62.
7) Wheel Speed: 200 rpm (plus or minus 10 rpm).
8) Wheel Diameter: 8.50 to 9 inches.
9) Linear Abrasion Distance: 14,138 feet.
10) Sand Nozzle: Special fabricated design.

b. Test one tile from each lot of tiles used in manufacturing the centrifuges, or four tiles total, whichever requires the greater number of tiles to be tested. The following laboratories are equipped to conduct these tests in accordance with the ASTM Standards and can provide certification of the results:

1) Colorado School of Mines, Golden, Colorado 80401.
2) Falex Corp., Aurora, Illinois 60505.
3) FMC Corp., 1205 Coleman Avenue, Santa Clara, California.

c. The volume loss of the proposed wear resistant material shall not exceed 3 cubic millimeters per tile during the 30-minute test period. Any material that exceeds 3.0 cubic millimeters loss in 30 minutes will not be allowed.

6. Prepare and submit Test Reports.

B. Panel Factory Tests

1. The Owner reserves the right to witness the tests specified herein and to inspect the fabrication procedures at any time during the fabrication stage(s) of any or all centrifuge panels and associated equipment. Owner's travel expenses will be borne by the Owner.
2. Notify the Owner as specified below and Owner will travel to the factory and inspect and witness the panel factory testing.
3. Perform manufacturer's standard functional tests on each centrifuge control panel as follows:

a. Gather and furnish test information necessary to show conformance to specified requirements.
b. Manufacturer's Test Representative shall certify test results.
c. Perform tests on panels actually furnished with each associated centrifuge at the manufacturer's facility.
d. Test panel for proper construction, electrical connection, and function.
e. Check all alarms, shutdown conditions, and automatic sequences to verify proper function.
f. Simulate interlocks and signals from other connected equipment in order to demonstrate specified operator interface functions and controls.
g. Notify Engineer of the test schedule not less than 45 days in advance.
h. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

4. Prepare and submit Test Reports.

3.4 ONSITE TESTING AND STARTUP SERVICES

A. The timing and scheduling for testing shall be coordinated with and be dependent upon the Owner's schedule and quantity of sludge available for testing.

B. Functional Test (and clean water test):

1. Test is part of the start-up procedure; to be performed after installation of the unit.
2. Prior to startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance of all components by means of a functional test conducted by the manufacturer's representative, assisted by the General Contractor and Owner, and as approved by the Engineer.
3. Functional testing shall be conducted after the installation of the centrifuge and all appurtenances.
4. Perform on the completed centrifuge system without sludge feed prior to startup.
5. Each unit shall be submitted to complete normal start and normal stop cycles. Each unit shall then be submitted to a 2 hour running test. At the beginning and end of the test, and at periodic intervals between, all thermometers shall be observed and recorded. The belt tension shall be adjusted at the start of the test, checked and readjusted if necessary at the end of the test. All safety devices and the differential speed control for the backdrive unit shall be checked for satisfactory operation. Instrumentation and control systems shall be checked for conformance with the specifications.
6. After approximately 1 hour of runtime without sludge feed, each centrifuge shall be measured for proper vibration. Vibration velocities shall not exceed 7 mm/sec RMS at the main bearings. If units exhibit vibration in excess of the limits specified, manufacturer shall adjust or modify the unit as necessary. After adjustment and/or modification, unit shall be retested to prove conformance.
7. As part of the test, each centrifuge shall be operated with water feed for a minimum of 30 minutes. At the beginning and end of the 30 minute water test, observe and record all thermometers, pressure gauges, and flow indicator readings.
8. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment, and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
9. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.
10. Submit test log to Engineer upon completion of each test.
11. Complete and sign Manufacturer's Certificate of Equipment Installation Services, as specified in Section 01400 – Quality Requirements.
12. Complete successful functional testing prior to pre-performance testing.

C. Pre-Performance Test:

1. Test is part of the start-up procedure; to be performed after functional test is completed and acceptable.
2. Manufacturer's representative, assisted by the General Contractor and Owner, shall conduct testing to demonstrate continuous, reliable operation, not performance, while dewatering the Design Feed Sludge.

3. Centrifuge manufacturer shall notify Owner in writing at least 14 days prior to when the Pre-Performance Test will occur. Prior to any testing, the centrifuge manufacturer shall have provided complete Operation and Maintenance Manuals and conducted Pre-Startup classroom training on the centrifuges. Field training may occur during the Pre-Performance Test. The Functional Test shall be successful before the Pre-Performance Test may be conducted.
4. Pre-Performance Test shall include operation of the centrifuges for a period of 5 working days (one 5 day week with 12 hour working days) without shutdown due to equipment or system failures.
5. Stoppages due to any failure of provided equipment and instrumentation, such as the centrifuge control and AFD panel, shall not exceed 30 minutes, and such stoppages shall not number more than three over the 5 day period for all centrifuges. A greater number of stoppages or a stoppage longer than 30 minutes shall be deemed a failure of the Pre-Performance Test and the test will stop. Stoppages caused by the Owner may occur without causing failure of the test.
6. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment, and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
7. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.
8. If, in the opinion of the Engineer, the Pre-Performance Test is successful and meets the requirements specified herein, the Engineer will recommend to the Owner, by letter, the acceptance of the Pre-Performance Test and that the centrifuges may begin the Performance Test, providing other requirements for the Performance Test to begin are satisfied.
9. Should the centrifuge be unable to achieve the Pre-Performance Test requirements as a result of failure(s) of the equipment or systems provided by the centrifuge manufacturer, the centrifuge manufacturer shall perform whatever equipment modifications are deemed necessary such that the equipment can achieve the performance specified, at no cost to the Owner. All modifications (provided such replacements do not violate the terms of as specified in 1.03(C) of these specifications) shall be documented and submitted to the Engineer. Following completion of the equipment modifications, the Pre-Performance Test shall be run again in its entirety.

D. Performance Test:

1. Test is part of the start-up procedure; to be performed after the pre-performance test has been completed and is the final test of the start-up procedure.
2. Performance testing shall be done to demonstrate the actual system operating conditions and verify that the centrifuges meet or exceed the minimum performance requirements specified in Article Performance Requirements while dewatering the Design Feed Sludge stream specified in Article Service Conditions. Performance testing shall be performed at the solids loading rates specified in Article Performance Requirements.
3. Centrifuge manufacturer shall notify the Owner in writing at least 14 days prior to when the Performance Test will occur. Performance Test shall not proceed until after the Pre-Performance Test is successfully concluded.
4. Manufacturer's representative, assisted by the General Contractor and Owner, shall startup and operate each centrifuge on the sludge stream specified herein, for a period of 8 hours per day for 2 days, with no interruptions allowed during the 8 hour period. All centrifuge operations and associated manufacturer's field services required to adjust

machine settings shall be performed prior to and exclusive of the above specified performance test duration.

5. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
6. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.
7. Steady state operation at the specified sludge feed solids rates shall be maintained throughout the test and all hourly quantities shall be the average during the test period. The centrifuge shall maintain acceptable performance while dewatering feed sludge with properties within plus or minus 10 percent of the specified criteria listed in Article Service Conditions.
8. During each performance test, take measurements and collect all required samples for analysis in order to make the following determinations:

    a. Sludge Feed Rate: gpm.
    b. Sludge Feed Concentration: The total dry solids concentration of the feed sludge entering the centrifuge (percent TS).
    c. Dewatered Cake Concentration: The total dry solids concentration of the dewatered sludge cake discharged from the centrifuge (percent TS). Take two duplicate samples per sample interval.
    d. Centrate Concentration: The total suspended solids concentration of the centrate discharged from the centrifuge (percent TSS).
    e. Solids Capture: Percent.
    f. Feed Hydraulic Loading Rate (Exclusive of Polymer): gpm.
    g. Feed Solids Loading Rate (Exclusive of Polymer): lbs/hr of total dry solids.
    h. Polymer Feed Rate: gpm.
    i. Polymer Dose: Pounds active per dry ton of feed solids.

9. Collect samples at approximate 1 hour intervals.
10. Variations in sludge feed characteristics

    a. Make compensating calculations for the effects if feed sludge characteristics are not within the ranges specified herein. Provide supporting data to be considered by the Engineer in determining conformance with the specified design conditions. The Engineer will be sole judge of conformance with performance testing requirements.
    b. If retesting to document compliance is required due solely to feed sludge characteristics outside of the specified range, The Owner may waive retesting or may compensate the Supplier for reasonable costs to witness retesting at the Owner's sole option.

11. Performance will be based upon the arithmetic average of the test results obtained during the test period. The Owner reserves the right to discard obviously high or low erroneous test results. As specified below, laboratory testing will be performed by the Owner. Turnaround time for cake concentration samples are approximately 24 hours. Performance results shall be based on the laboratory standard methods results.
12. Prepare a formal test report including all laboratory analysis reports, all measured flows, the mass balance calculations, and the percent capture. Six copies of the final report shall be submitted to the Engineer within 20 days after completion of the test.

13. In the event that a centrifuge does not meet the requirements of the specifications during the performance test, the representative of the manufacturer shall make such changes in the equipment and methods of operation as deemed necessary and as approved by the Engineer. Following the adjustments, make a second test run similar to the first run. In the event that the centrifuge still does not achieve specified performance during the second test, then the equipment will be subject to rejection.
14. The centrifuge manufacturer shall retain responsibility for the centrifuges until the acceptance test has been successfully completed. However, after initial startup the Owner shall have the right to use the centrifuge as needed to process sludge.
15. If, after a maximum of two test runs, in the opinion of the Engineer, a centrifuge meets the performance requirements specified herein, the Engineer will recommend the acceptance of the centrifuge. If, in the opinion of the Engineer, the performance test results do not meet the requirements specified herein, the Engineer will notify the centrifuge manufacturer and the Owner of the non-acceptable performance.
16. The cost of all laboratory tests necessary to confirm the sludge characteristics for the initial performance test on a centrifuge will be borne by the Owner. All laboratory tests for performance testing will be performed by the Owner in conformance with the applicable portions of standard methods.
17. Emulsion polymer used shall be as recommended by the centrifuge manufacturer. Polymer costs for initial testing and for one retest will be borne by the Owner.
18. The cost of power, water, feed sludge, and disposal will be borne by the Owner.
19. Field Motor Tests: At the time of equipment delivery to the jobsite and after installation prior to startup, the General Contractor or manufacturer's representative shall megger test (500-volt megger) each motor phase-to-phase and phase-to-ground in the presence of the Engineer. Values of resistance less than 1 megohm will not be acceptable.

E. Prepare and submit Test Reports.

F. Manufacturer's Field Services:

1. Manufacturer's Authorized Representative: Present at Work site or classroom designated by the Owner, for the minimum person-days listed below, travel time excluded. A minimum of four trips shall be required.
2. Minimum services to include:

    a. 4 person-days for installation assistance, inspection, and certification of installation.
    b. 3 person-days for functional testing.
    c. 3 person-days for pre-startup classroom or jobsite training.
    d. 5 person-days for pre-performance testing.
    e. 5 person-days for performance testing and operator training during facility startup.
    f. Manufacturer shall video-record all classroom training sessions and provide original video-recordings and three copies of recordings on CD or DVD.

3. The periods stated above are minimums only and the manufacturer is required to be onsite for all of the functions listed above to the extent that is required to complete those functions to the satisfaction of the Owner and Engineer.

END OF SECTION 11435

SECTION 11436 – LIQUID POLYMER BLENDING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Liquid Polymer blending system, PLY-6-1

B. Related Sections include the following:

1. Division 11 Section “Sludge Dewatering Centrifuge” for coordination with sludge dewatering centrifuge installation.
2. Division 13 Section “Control Panels” for control panel fabrication.
3. Division 15 Section "Process Piping" for piping installation.
4. Division 16 Sections for coordination with electrical specifications.

1.3 SCOPE

A. Provide all labor, materials, tools and equipment required to furnish and install, in good workmanlike manner, a liquid polymer blending and feed system and controls as shown in the Contract Drawings and as specified herein. Equipment units shall be complete and operational and function as specified. All products and controls shall be supplied by a single equipment vendor, responsible for the successful performance of the system.

B. Major components of the liquid polymer system to be supplied under this section shall include, but not be limited to, the following:

1. Liquid Polymer Blending Equipment

a. Local Control Panel
b. Metering Pump.
c. Calibration Column.
d. Loss of Polymer Flow Switch.
e. Polymer Flow Measurement.
f. Polymer Check Valve.
g. Differential Pressure Switch.
h. Solenoid Valve.
i. Water Flow Measurement.
j. Liquid Filled SS Pressure Gauges.
k. Variable Orifice Water Control Valve.

l. Mixing Chamber.
m. Pressure Relief Valve.

2. Start-up and training services

1.4 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Product literature.
2. Complete description.
3. Dimensional drawings as required for the installation.
4. Complete mechanical assembly drawings.
5. Required clearances.
6. Weights.
7. Certified Performance curves.
8. Wiring Diagrams: Power, signal, and control wiring.
9. Layout drawing for all equipment showing installation details.
10. Affidavits of compliance with referenced standards and codes.
11. Manufacturers' Warranty.
12. Complete local control panel data including:

    a. Electrical diagram.
    b. Panel elevation drawing.
    c. Control panel bill of materials.
    d. Component technical data sheets.

13. Installation instructions.

B. Factory quality-control test reports.

C. Submit manufacturer’s standard operations and maintenance manuals prior to equipment startup. At a minimum the O & M manual shall include:

1. System operation
2. Calibration procedures
3. Trouble Shooting
4. Routine maintenance procedures
5. Listing of common spare parts
6. Appendices containing O & M manuals of ancillary equipment suppliers
7. Project bill of materials including mechanical and electrical components utilized.

D. Field test reports.

1.5 QUALITY ASSURANCE

A. Manufacturers' Qualifications: All equipment furnished under this section shall be furnished by a single vendor who shall assume complete responsibility for the design and performance of the equipment. The manufacturer shall have a minimum of five (5) years experience in producing

packaged systems and shall produce evidence of at least five (5) installations of similar size in satisfactory operation in the United States.

B. Reference Standards: Comply with all applicable provisions and recommendations of the following or equivalent IEC standards, except as otherwise shown or specified.

1. National Electrical Code (NEC): Labeled and listed as defined in NPFA - 70
2. National Electrical Manufacturers Association (NEMA): Motors and electrical accessories shall comply with NEMA standards.
3. Occupational Safety and Health Act (OSHA)
4. American Society of Testing and Materials (ASTM)
5. American Welding Society (AWS)
6. American Institute of Steel Construction (AISC)

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling of Equipment:

1. Inspect all equipment and materials against reviewed shop drawings at the time of delivery.
2. Equipment and materials damaged or not meeting the requirements of the reviewed shop drawings shall be immediately returned for replacement or repair.
3. The equipment shall be stored, protected from the weather, in accordance with the supplier’s recommendations.

B. Storage:

1. Carefully prepare for storage and label all equipment and materials after they have been inspected.
2. Store materials to permit easy access for inspection and identification. Support all material off of the ground and protect steel members and packaged material from corrosion and deterioration as per manufacturers' instructions.
3. All equipment shall be protected from damage from weather related problems such as, but not limited to, freezing, sunlight, water, wind, and any other effects. Any equipment in storage for more than two months shall be inspected, serviced or otherwise conditioned and approved for service by the equipment manufacture’s service person or appointed agent. Such approval shall comply with the long-term service reference in the manufacturer’s service manual for the exact same model and type of equipment.
4. All spare parts shall be packaged and stored in weatherproof containers suitable for such purposes. The packages shall be clearly marked and identified by part number and description caption. All packages shall be inventoried on a list that is legible and identified for this section of the specification and the list shall be given to the owner’s agent.

1.7 WARRANTY

A. The polymer system shall be covered by a one (1) conventional warranty. The system shall be warranted to be free from defects in workmanship and materials for a period of one year from date of delivery or significant startup, whichever is later. All pumps, blowers, optional and

customized equipment carry the warranty of the original manufacturer. The full warranty shall be valid regardless of whether potable or non-potable dilution water is used.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. The Basis-of-design polymer blending system shall be Model DynaBlend L6-3000-10P Liquid polymer blending system as manufactured by Fluid Dynamics of North Wales, PA.

2.2 DESIGN REQUIREMENTS

A. Dilution Water Flow Range (gallons per hour) 300 to 3000

B. Polymer Pump Range, Neat (gallons per hour) 1.0 to 10.0

C. Target Design Capacity:

1. Neat Concentrated Polymer, 44% active (pounds per hour): 5.23
2. Delivered Solution Polymer, 0.25% active (pounds per hour): 2100

D. Utility Services Available

1. Power

a. Voltage: 115-volts/1-Phase

2.3 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, and manufacturer's instructions and recommendations, unless exceptions are noted by the engineer.

B. Each component shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation on a factory fabricated skid mounted frame. The installation shall include all components specified herein or indicated on the drawings, and all additional materials or construction required by the design of the system.

C. All materials shall be designed to withstand any stresses that occur during typical delivery, installation and operation. Equipment shall be of corrosion resistant materials, as specified herein.

2.4 POLYMER PREPARATION SYSTEM COMPONENTS

A. Polymer Feed Package

1. Liquid Polymer Feed:

    a. Provide an integrally mounted, progressive cavity pump to meter liquid polymers to the wetting device. The pump shall be constructed of stainless steel and Viton, provided with Teflon and gore membrane packing. Pumps with mechanical seals shall not be acceptable. The metering pump shall be as manufactured by Moyno or approved equal.
    b. The liquid polymer pump shall be provided with a 480V/3PH/60Hz constant speed 1/2 H.P., 1750 RPM motor coupled to an in line gear reducer.
    c. An integrally mounted 4000 ML graduated cylinder shall be provided with necessary valves for start-up calibration. The calibration column shall be rigidly mounted to the system's skid.

B. Equipment:

1. General System Requirements:

    a. Each polymer feed systems shall be a skid mounted assembly consisting of one metering pump, mixing chamber, and all piping, valves, and controls capable of delivering required minimum and maximum gallons per hour of polymer solution as shown on attached schedule. Included with each polymer feed system shall be a pressure relief valve, back pressure valve, and calibration chamber.
    b. Each polymer feed system shall consist of an integrated equipment package system which shall meter, dilute, activate, mix, and feed liquid polymer and water. Polymer shall not be exposed to a rotating centrifugal pump turbine or other machinery that would cause excessive shear.
    c. Feed systems shall include a progressing cavity feed pump to provide the capability of pumping emulsion type liquid polymers, with maximum apparent viscosities of up to 40,000 centipoise. At no time shall liquid polymer or polymer solution be exposed to excessive shear, so as to degrade the effectiveness of the polymer molecular chains.
    d. Polymer feed system shall be furnished with an integrally mounted control panel.
    e. Provide SCR drive for "neat" pump to accept 4 to 20 mA signal.
    f. Each polymer feed system shall be equipped with Type 304 stainless steel side frame and stainless steel base with nonskid feet, which shall fit within the available existing building area, as shown on the contract drawings.

2. Mixing Requirements:

    a. Polymer mixing system shall be specifically designed to invert, disperse, and activate in solution emulsion polymers which may vary in specific gravity from 0.98 to 1.18 and vary in viscosity from 80 to 6,000 cp.
    b. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy. Polymer activation efficiency shall be consistent over the entire dilution water range.

3. Pump:

    a. To prepare the desired polymer solution concentration from liquid polymer, the system shall meter liquid polymer with a progressive cavity metering pump at a constant rate to a high energy, non-damaging liquid polymer activation chamber.

b. The metering pump shall have an output range of 0.25 to 10 gph neat polymer.

4. Dilution Water System

a. Polymer feed system shall have a solenoid valve for automatic OPEN/CLOSE control of dilution water supply. Solenoid valves shall be NEMA 4X with 120V ac coil. Solenoids shall be internally controlled.
b. Dilution water system shall contain primary dilution and post dilution assemblies. Dilution system shall have a flow indicator equipped with integral rate-adjusting valves. Total water flow rate into unit shall be adjustable as shown in the attached schedule.
c. All components in the system shall be designed for at least 100 psig working pressure.
d. Polymer feed system shall have a manufacturer's standard dilution water pressure differential type flow element and low flow switch. Flow switch and element assembly shall be installed as per manufacturer's recommendation.

5. Local Control Panel: The Basis-of-Design polymer blending system controls shall be the DynaBlend Control Level 6 Option.

a. The project label for the polymer control panel is RP-6-2.
b. A control panel shall be supplied to control the polymer blending system as described in the system cycle of operation. All components shall meet IEC specifications, as applicable. Panel design shall meet UL-508, and NFPA 79.
c. Major components of the control panel shall include, but not be limited to, the following items:

1) NEMA 4X enclosure.
2) Fused disconnect.
3) Touch screen operator interface.
4) Emergency stop button.
5) PLC.
6) Control relays.
7) Control power transformer.
8) Level controllers.
9) Motor starters.
10) Fuse blocks and fuses.
11) Terminal blocks.

d. The control panel shall be the polymer system manufacturer's standard enclosure rated NEMA 4X, FRP mounted on the skid assembly and pre-wired to the required skid mounted components.
e. A main power, door mounted fused disconnect switch shall be provided.
f. An emergency stop push button with red knob shall be provided labeled "EMERGENCY STOP". The button shall be Allen Bradley 800H series rated NEMA 4X and IP66.
g. All relays, motor starters, breakers, timers, transformers, SCR controllers and appurtenances required for manual and fully automatic operation shall be provided.
h. Terminal blocks with number tabs shall be provided for connection of all external wiring to the panels, excluding the main power supply connection. Control wiring

terminal blocks shall be sized for 12 AWG copper wires, except for grounding terminal blocks, which shall be sized for 14 AWG wires.

i. Main power supply shall be terminated directly to the disconnect switch. The disconnect switch shall allow for connection of at least 8 AWG wires.

j. All interior connecting wiring and wiring to terminals for external connection shall be in accordance with NFPA 79. Whereby, circuits rated to 10 Amps circuits are of 16 AWG, circuits rated to 15 Amps circuits are of 14 AWG, and circuits rated to 20 Amps circuits are of 12 AWG. All wiring shall be insulated for not less than 600 volts with a moisture and heat-resistant material and flame retardant nonmetallic covering. All wiring shall be grouped or cabled and firmly attached to the panel through wire raceways.

k. All instruments and devices shall be separately fused to protect the equipment.

l. Auxiliary relays and timers shall have 120 VAC, 60 Hz continuous duty coils and 10 ampere, 120 VAC contacts.

m. The control panel shall be provided with an Allen Bradley CompactLogix Series PLC, controlling all functions of the system.

n. The programmable logic controller shall provide for manual or fully automatic operation of the entire polymer system.

o. Provide a touch screen operator interface. The operator inter face shall provide access to all system operational functions and settings. The screen shall be at minimum 6" diagonal color, of NEMA 4X design. The touch screen operator interface, at a minimum, shall provide the following screens:

1) Auto Process: To display equipment run status, timer countdown status, valve status, and tank level.
2) Manual Operation: To allow access to manual control and function of individual system components.
3) Settings: Screen showing operator input settings and calculated auto process parameters. Allowing access to factory settings screens.
4) Calibration Screen: To automatically run the volumetric feeder or metering pump for an exact calibration time, allowing the operator to simply input the test results.
5) AlarmsScreens to display alarm conditions:
6) The follow alarm screens are to be included; emergency stop, power failure, illegal state, system common alarm, tank level alarm, and motor overload condition.
7) Totalizer: Screen to display re-settable batch counter total, total polymer consumed, and non-resettable continuous batch counter.

p. The polymer system local control panel shall provide a minimum of two discrete inputs and two analog inputs for remote control by the sludge dewatering centrifuge, CF-6-1, control panel

q. The polymer system local control panel shall provide a normally contact closure for remote indication of alarms.

2.5 SKID AND FRAME

A. All components of the solution feed system including pump, drive, post dilution assembly, and local control panel shall be pre-plumbed and pre-wired on a 304 stainless steel skid.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install all equipment in accordance with the drawings, approved shop drawings, and the manufacturer's installation instructions. Install level and plumb, with clearances for service and maintenance.

B. Align, adjust, and lubricate in accordance with the manufacturer's instructions and leave in proper working condition.

C. All final electrical connections shall be made by Electrical Contractor.

3.2 Factory Tests: Manufacturer shall factory-test equipment components to detect any defects and demonstrate that they will function satisfactorily under the conditions specified. Testing shall include testing of all mixers, pumps, motors and related equipment. This shall include performance of a mechanical run testing at full pressure and full speed.

3.3 FIELD QUALITY CONTROL

A. A qualified representative of the manufacturer shall inspect and approve the installation as part of the equipment commissioning. The installing contractor shall submit a written certification of approval of the installation signed by the manufacturer’s representative and indicating that the manufacturer’s representative confirms a complete and satisfactory installation.

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that equipment units are secure on mountings and supporting devices and that connection to pipes, ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Verify operation of all controls.
5. Submit certified test report on the operation of the gravity dewatering system.
6. Provide equipment calibrations.

3.4 START-UP AND TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to provide a start-up.

B. Operator Training: To be performed by a factory service technician:

1. Training:

a. Instruct plant personnel in the operating and maintenance of the equipment provided under this item.
b. All procedures shall be covered including preventative maintenance, method of controlling equipment, and troubleshooting.

C. Start-up and Training shall occur coincidentally with Start-up and Training of the Sludge Dewatering Centrifuge.

END OF SECTION 11436

SECTION 11437 - SHAFTLESS SCREW CONVEYORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following: The Contractor shall furnish, install and place into satisfactory operating condition two shaftless screw conveyors for transporting dewatered sludge from the centrifuge to the garage bay as shown on the Drawings and described in the Specifications. The equipment designations are:

1. Conveyor CNV-6-1.
2. Conveyor CNV-6-2.

B. Related Sections include the following:

1. Division 13 Section “Sludge Dewatering Centrifuge” for controls coordination.

1.3 GENERAL

A. Fabricate and assemble all equipment under this section in full conformity with this specification and as shown in the contract drawings.

B. Furnish equipment complete with all supports; all mechanical equipment required for proper operation, including complete drive units; all steel and other metal construction specified herein; and all additional materials or fabrication as required by the supplier's design.

C. Structural Integrity, Process Specification: For optimum quality control, spirals furnished with the shaftless conveyor(s) shall be produced from hot-rolled micro-alloy steel bar which is cold formed into the final specified diameter, pitch, hardness and strength. To eliminate irregular OD and pitch tolerances cold-forming process must be a single-stage process utilizing a “captured winding” technology. The diameter and pitch is formed simultaneously with a computerized numerically controlled (CNC) machine built specifically to form spirals. Spirals manufactured with an uncontrolled “loose” pitch pull two-stage process in which the pitch is pulled by connection to a winch or crane will not be accepted.

1.4 PERFORMANCE REQUIREMENTS

A. Design the shaftless screw conveyor system to meet the performance and design requirements per the attached “Table A”. Conveyor selection design standards to be based on the operational experience of the manufacturer with shaftless screw conveyors, and not shafted screw conveyors.

B. Conveyor rotational speeds shall not be greater than herein specified, unless availability of the reducer ratio requires slight adjustment (+- 2 rpm) or if shown by the conveyor manufacturer calculations to be required to meet design load. Deviations from specified speed cannot be utilized to reduce the conveyor trough and spiral size.

C. Screw Conveyors with shafts and intermediate hanger bearings will not be acceptable for this application.

TABLE - A **CONVEYOR Performance & Design**		
Conveyor Position	**CNV-6-1**	**CNV-6-2**
PERFORMANCE		
Material conveyed	Sludge	Sludge
Density, average, lbs/cu.ft.	65	65
Volume, ft3/hr.	60	60
Screw speed, rpm +-2	20	20
Trough fill rate @ Design load, %	30	30
SYSTEM DESIGN		
Length, approx. ft (to be determined in field)	(14)+/-	(36)+/-
Degrees Incline, approx.	11	15
Feed Inlet From	Centrifuge	CNV-1
Discharge outlet to	CNV-2	Truck/bin
No. Discharges:	1	1
Discharge Type (axial or vertical)	Vertical	Vertical
CEMA Conveyor Trough diam. In.	10	10
Trough thickness, min.	10 ga.	10 ga.
Minimum lid thickness	12 ga.	12 ga.
Lid length, inches max.	48	48
Chute thickness, min.	10 ga.	10 ga.
Spiral OD, Nom. in.	9	14
Spiral, outer size, in.	2.5 x 0.75	2.5 x 0.75
Spiral pitch (full or 2/3)	Full	Full
Spiral insert size, in.	0.75 x 0.5	0.75 x 0.5
Liner type	Polystone M	Polystone M
Liner length, ft, max	4	4
Liner thickness, inch, min.	0.375	0.375
Location of drives	pulling	pulling
Drive Hp, min.	2	5
Motion failure probes, # per conv	1	1
NEMA rating at probe	4	4

1.5 QUALITY ASSURANCE

A. Unit Responsibility: A single manufacturer shall be responsible for supplying the equipment, complete with all accessories and appurtenances. The manufacturer shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and

as necessary to place the equipment in operation in conformance with the specified performance, features, and functions. The equipment shall be produced and assembled by the manufacturer at a facility owned and operated by the manufacturer and under the direct supervision and control of the manufacturer.

B. The manufacturer shall have at least ten (10) years demonstrable experience in the design and manufacture of waste water conveyor systems and ten (10) years demonstrable experience in the design and manufacture of shaftless conveyor systems. The manufacturer shall have at least twenty-five (25) full-scale shaftless conveyor systems operating successfully for at least five (5) years in North America at municipal wastewater treatment plants that were designed and furnished under the Supplier's own name. Equipment bought and re-sold; or supplied under a license or marketing agreement shall not be considered for meeting the experience clause.

1.6 SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for equipment. Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Wiring Diagrams.

C. Product Data:
1. Provide material descriptions, dimensions of components, operating weights, furnished specialties and accessories, and other additional information:
2. Descriptive literature regarding the conveying equipment to be supplied.
3. Reference information and certifications as required under subsection 1.5, B.
4. Detailed specifications for the Equipment proposed.
5. Manufacturer's certification, signed by a corporate officer, confirming that the proposed Equipment fully complies with these specifications.
6. General arrangement drawing(s) for the proposed Equipment.
7. Cut sheets for electric motors and ancillary items manufactured by others.
8. Conveyor torque requirement calculations.
9. Torque calculations for the gear reducer and reducer motor.
10. Horsepower calculations for the drive motor(s).
11. Utilize spiral strength calculations for spring (spiral) compression and elongation showing the supplied spiral meets or exceeds spring effect intent herein described.
12. Complete schematic diagrams for electrical control interconnection to others panels.
13. Operations & Maintenance Manual.

D. Coordination Drawings: Scaled and dimensioned drawings on D-size sheets, indicating the installation of the equipment, supports and appurtenances, other new work within the area of installation and existing building and building related utilities. Including, but not limiting:

a. Shaftless screw conveyors.
b. Centrifuge.
c. Work by other contracts in the area.

E. Other Information Submittals:

a. Manufacturer's installation instructions.
b. Warrantees
c. Shop Test Reports
d. Operation and Maintenance Data: The contractor shall submit four (4) copies of Operation and Maintenance manuals for equipment.
e. Field quality-control test reports.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products indoors or in weather protected area until installation. Protect from construction traffic and damage.

1.8 SPARE PARTS

A. One (1) Motion failure probe.

B. One (1) Packing gland set, for each conveyor supplied.

1.9 WARRANTEE

A. The manufacturer shall warranty the equipment furnished under this section to be free from defects in material and workmanship for a period of twelve (12) months after the equipment was first placed into operation at the jobsite or eighteen (18) months after the equipment was first delivered to site, whichever date occurs first. Any warranted material defects found to exist shall be corrected replaced at no cost to the Owner.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Basis-of-Design Product: Subject to compliance with requirements, provide shaftless screw conveyor(s) type as manufactured by Custom Conveyor Corporation, Rogers, Minnesota.

B. GENERAL

1. The shaftless screw conveyor equipment shall include the following:
   a. Troughs, Liners and Covers.
   b. Spiral Flighting.
   c. Chutes.
   d. End Shaft.
   e. Electric Motor and Gear Reducer.
   f. Mounting and Support Structure.
   g. Safety Accessories.
2. Power supply. Power supply to the equipment will be 460 volts, 60 Hz, 3 ph.
3. Fabrication. All welds to be continuous unless otherwise specified. Facing surfaces of field-welded components shall be beveled and match marked.
4. Edge Grinding. Sharp corners of all cut and sheared edges shall be made smooth.

5. Fasteners. All bolts, nuts, washers, and other fasteners shall be stainless steel.
6. Surface Preparation
   a. All iron and mild steel surfaces to be painted shall be dry abrasive blasted in accordance with SSPC-SP6, and in accordance with the painting section of these specifications. Surfaces shall be painted or hot dip galvanized within 24 hours to prevent rusting and surface discoloration.
   b. Stainless steel shall be cleaned with mild abrasive wheels and/or nonferrous blast media to remove heavy scale and welding carbon and/or passivated with stainless steel cleaner then rinsed.
7. Painting. After surface preparation, ferrous metal surfaces, if any, except for the spiral flighting shall receive a minimum of one (1) coat of epoxy primer. Provide a total minimum dry film thickness of 3 mils prior to shipment to jobsite. Primer shall be compatible with the paint system specified for the equipment under “Painting” section of these specifications. Finish coats shall be applied at the jobsite by the General Contractor.
   a. The spiral shall be furnished with one coat of shop primer only.
   b. Electric motors, gear reducers, electrical control panels, and other purchased sub-components shall be furnished with the manufacturer’s standard finish.
   c. Stainless steel surfaces do not require painting.
8. Materials of Construction:
   a. U Trough, lids, end plates and flanges : 304 stainless steel.
   b. Hardware: 304 stainless steel.
   c. Supports: 304 stainless steel.
   d. Drive shafts: 1045 steel.
   e. Liners: UHMW PE .
   f. Spiral: HTMAS.

C. SHAFTLESS SCREW CONVEYOR CONSTRUCTION

1. Spiral Flighting

   a. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft or hanger bearings.
   b. Spiral flights shall be cold-formed high strength chrome alloy steel with a minimum hardness of 220 Brinnell. The spiral flights shall be designed with adequate stability to prevent distortion and jumping in the trough. A second, inner spiral, concentric with the outside spiral shall also be provided. The torsional rating of the auger flighting shall exceed the torque rating of the drive motor at 150% of its nameplate horsepower. The "spring effect" of the spiral shall not exceed + 0.16” per foot of length at maximum load conditions. The minimum outer spiral thickness shall be 0.75” for spiral diameters up to 14” and 1” for spirals diameters exceeding 14”.
   c. The spiral flighting shall be formed in sections from one continuous flat bar and shall be concentric to within +0.125”. Sectional flighting formed from plate shall not be permitted.
   d. Spirals should conform to CEMA 300-34 for US standard conveyors. European standard metric sizes will not be allowed due to availability for competitive spare parts.
   e. Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled in the field and

shall be made in accordance with the supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.

2. Field welds at the jobsite by the Contractor for installation may be necessary when any overall conveyor length presents shipping or handling constraints.
3. A gland packing ring consisting of two teflon fiber packing rings shall seal the drive shaft at its penetration through the end plate.
4. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate.
5. Hold Down Provisions: In order to avoid excessive wear and increased maintenance the conveyors shall be designed without the use of steel hold down bars. For pushing drive conveyors hold-down guide liners mounted in the trough sides above the design load fill level shall be accepted that do not interfere with the flow of conveyed product.
6. Horizontal and Inclined Troughs: Troughs shall be U-shaped and to the dimensional standards of CEMA 300 and enclosure classification IIE.
7. A flanged drain outlet shall be provided with each conveyor to facilitate cleaning. The drain outlet shall be piped to a drain as shown on the drawings, with adequate cleaning facilities. Drain flushing connections are to be provided if and where specified by the contract drawings. The Contractor shall furnish all labor and materials to connect the conveyor flush water and/or drains with the plant water and drain system.
8. Each trough shall be equipped with inlet and/or discharge openings as shown on the contract drawings. If required, each inlet and discharge opening shall be flanged suitable for interconnection to other devices. Any interconnecting devices such as chutes and hoppers shall be fabricated from the same grade of material as the troughs and with a gauge thickness to suit the application requirements.
9. Bolted covers shall be furnished for any portion of each trough that is not covered by the filling chute. Covers shall be manufactured in maximum four (4) foot length section to allow for easy access and ease of liner replacement. To prevent unsafe access to the conveyors, quick opening covers will not be allowed unless they are also bolted to prevent access during operation. Each conveyor shall be fixed with the appropriate warning labels to call for lock out – tag out of the electrical system before the covers are removed. If required, inspection hatches or sample ports with finger guards will be supplied as indicated on the contract drawings.

10. Wear Liner

    a. Liner - The inside trough surfaces of shaftless conveyors shall be lined with a layer of ultra-high molecular weight polyethylene UHMW-PE. The wear liner shall be Polystone M by Custom. The liner shall be supplied in 4’ foot long sections to provide ease of replacement. The liner shall be held in place with stainless steel clips; no fasteners will be allowed. Liner thickness shall be at a minimum 3/8”.

11. Conveyor Supports

    a. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the contract drawings and as required by the supplier's design of 304 stainless steel structural angle, minimum 0.25” thick. The supports shall be shop fabricated from structural steel shapes and plates, and shall be assembled and fitted to the conveyor prior to its delivery to the jobsite. Supports and conveyor

segments shall be match marked and shipped to the jobsite for assembly by the contraction others. The manufacturer shall allow for 1 inch of grout beneath each support foot pad for the Contractor to compensate for uneven floor elevation. At a minimum, each conveyor shall be provided with supports at the inlet and discharge end, with intermediate supports as required.

b. All shop welding shall conform to the latest standards of the American Welding Society (AWS). The supports shall be designed to avoid interference with other equipment or equipment supports.

D. LUBRICANTS

1. Furnish lubricants of the type and quantity as recommended by the conveyor manufacturer for one-year of operation.

E. DRIVE UNITS

1. Each spiral conveyor shall be driven by a constant-speed gear reducer motor drive unit mounted to a bellhousing adapter flange mounted to the end plate of the conveyor.
2. The adapter flange shall allow the leakage of any material from the conveyor trough to atmosphere rather than into the gear reducer/ motor drive unit. Direct coupling of the gear reducer/motor drive unit to the end flange of the conveyor will not be acceptable.
3. The drive unit shall be rigidly supported so there is no visible "wobble" movement under any operating condition. In the event of a prolonged power failure or emergency system shutdown the drive system shall be designed, at a minimum, to start the conveyor from a dead stop with the trough filled at 2 X the design load for loads designed up to 67% fill rate and 1.5 X for loads designed exceeding 67% fill rate.
4. All motors shall be of energy efficient design meeting or exceeding NEMA MG1- table 12-10 and EP Act guidelines. The motors shall be 230/460 volt, 60 Hz, 3 phase conforming to the General Equipment specifications, except as modified herein. Each motor shall be 40oC ambient rated, 3300 feet (1000m) altitude or lower operation, with a maximum temperature rise of 80 degree C by resistance at 1.0 service factor (95 degree C rise at 1.15 s.f.) The motors have Class B insulation with Design B speed/torque characteristics in accordance with NEMA MG1-12.35 and 12.38, and be C face type, with NEMA frame sizes.
5. Constant speed motors shall have a 1.15 service factor and a TEFC enclosure.
6. Gear Reducers

   a. All gears shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the fully loaded startup condition and shall have an AFBMA B-10 life of 30,000 hours.
   b. The reducer will be air-cooled unit with no auxiliary cooling requirement. The gear reducer shall be sized with a torque service factor of 1.5 times the absorbed power or 1.1 times the motor nameplate, at the driven shaft speed, whichever is greater.

F. HOPPERS, DISCHARGE BOOTS, & GATES

1. Furnish inlet and discharge hoppers of the same gauge and construction material as the conveyor troughs, at locations as shown on the drawings. Flanges shall be a minimum 5 mm thick.

2. The inlet hopper size, shape and flange dimensions of CNV-6-1 shall be coordinated with the sludge dewatering centrifuge.
3. Furnish single-ply flanged discharge boots at locations as shown on the drawings. The flexible boots shall be neoprene impregnated canvas, EPDM rubber hose, neoprene, Linatrile by Linatex Corporation, or approved equal.

G. ELECTRICAL EQUIPMENT

1. All electrical equipment shall conform to applicable standard of the National Electrical Manufactures Association (NEMA) and the National Electrical Code (NEC). Both power and control equipment shall be insulated for not less than 600 volts even though operating voltages may be lower.
2. All motors shall be totally enclosed, fan cooled (TEFC), designed in accordance with the detailed motor specifications and suitable for operation with a 480 volt, 3 phase, 60 Hz. Power supply.

H. CONTROL SYSTEM

1. The conveyor control system shall be supplied by the conveyor manufacturer. It shall provide total automatic machine operation with protection against overload conditions, which might damage the equipment. The following factory supplied panels will be provided:

   a. PANEL RP-6-4 for Conveyor CNV-6-1
   b. PANEL RP-6-5 for Conveyor CNV-6-2

2. The control system shall be rated for the following classifications:

   a. Main control cabinet NEMA-12, Non-hazardous area

3. Motion Failure Alarm Unit: An external conveyor mounted motion failure alarm, (alternately known as “zero speed” or “under-speed” switch) to detect spiral or drive shaft failure shall be utilized. Each conveyor drive unit shall be equipped with a motion failure alarm unit. The location and mounting details shall be as recommended by the conveyor manufacturer. Motion sensor shall be Milltonics MSP 12 non-contacting type probe with a pre-amplifier and main electronic assembly. The main electronic controller unit shall be Milltronics MFA 4P. It shall operate on 120 volt, single phase, 60 Hz power supply, and shall be housed in a NEMA 4X enclosure. A 0 to 60 second time delay shall be provided for startup of the conveyor.
4. Emergency Shutdown: Each conveyor shall be furnished with an emergency trip cord and safety switch. The conveyor is to be provided with a cable operated OSHA safety stop switch with continuous cable run on both sides. The trip switch shall immediately stop all conveyors when the switch is actuated. The switch shall be RS2 type by Conveyor Components Corporation or approved equal.
5. Electronic Motor Overload/Trip: Each conveyor motor starter shall incorporate a solid state electronic motor starter with integral motor overload.
6. The starter/overload shall be furnished by the party responsible for the conveyor electrical controls.
7. Sequence of Operation: The conveyor will automatically start upon receipt of a signal from the Centrifuge, CF-6-1 control panel RP-6-1 or when the manual start button is energized. The operating cycle length shall be adjustable to provide for complete material

evacuation from the inlet zone(s). Should the power requirement of the conveying process exceed the preset point on the current monitor relay, a heavy load protection system shall automatically stop the rotation of the screw. The unit will then trip on overload, an alarm light will be lit and the conveyor will be turned off.

8. Thermal Protection: An “overload/blockage” indicating light shall be provided. The overload protection shall be sized according to the motor nameplate full load rating. This component shall be equipped with a manual reset and pad-lockable stop button. When the selector switch is on “AUTO” or “MANUAL” mode, the protection circuit shall cut the power off to the motor and to the control circuit of the motor starter, should the following conditions occur:

    a. Overheat of the motor;
    b. Short circuiting;
    c. Single phasing.

9. Jamming Protection: A current metering system shall protect the spiral screw against jamming. A continuous current reading (CMT) shall be monitored by an adjustable relay (CMR). The motor starting current being higher than the setting of the CMR, the jamming protection shall be put out of service by a time delay (TCM), for a predetermined adjustable motor start period, long enough to allow the current to fall below the CMR setting when it reaches its normal full load level. This component shall be equipped with an alarm indicator light and a manual reset push button. Should this system be energized, the “overload/blockage” light shall be activated.

10. Control Panels: The following basic components shall be assembled in the system control panel enclosure and pre-wired to identified terminal blocks. This enclosure shall provide upfront panel door operation. Panel hook up shall be made on site by the contractor. The power supply shall be 480 Volts, 3-phase, 60 Hz. The control panel shall meet the applicable requirements of Section 13520.

    a. The PLC shall be an Allen Bradley MicroLogix PLC based control panel with a 6” Allen Bradley Panelview Plus color touch screen.
    b. Main circuit breaker type disconnect switch sized for the application shall be front panel mounted c/w operating handle and interlock;
    c. Reversing Magnetic Contactor sized for the application c/w adequate overload protection;
    d. Program circuits and relays to start and stop the cleaning and conveying mechanism;
    e. Sequence timer shall cause the conveying mechanism to start;
    f. Duration timer shall maintain the screw in operation for an adjustable period of time;
    g. The control system shall be provided with jamming protection device operating through current monitor control circuit to minimize damage in case of excessive loading;
    h. Indicator light – Jamming & thermal protection alarm
    i. Indicator light – Run mode
    j. Indicator light – Power on
    k. Push-button – Jamming protection reset
    l. Push button, pad-lockable – Stop
    m. Selector switch – Manual/Off/Auto

n. Dry contact outputs rated a minimum of 3 Amps at 120Vac shall be provided to connect to the plant control system for the following status points. Contacts shall close when status points are true.
o. Power On
p. Conveyor in Auto
q. Conveyor Run Status
r. Conveyor Fault Alarm
s. Provide a dry contact output for “Running” indication and “Malfunction” indication.
t. Provide “Auto Run” terminals for automatic operation and control by the Centrifuge, CF-6-1
u. Provide provision to accept a shutdown contact from the washer compactor.
v. Local Control Station: The Conveyor shall be supplied with a local control station located near the unit. The following components shall be assembled and pre-wired to identified terminal blocks.
w. “AUTO / OFF / MANUAL” Operation selector switch c/w spring loaded return from "MANUAL" to “OFF”.
x. “EMERGENCY STOP” Push button, pad-lockable.

PART 3 - EXECUTION

A. INSTALLATION

1. Install equipment in conformance with the manufacturer’s written instructions, with supervision and inspection performed by manufacturer’s representative.
2. Equipment anchoring and mounting shall be in accordance with manufacturer’s requirements for the load criteria specified in Section 01600 - Product Requirements.
3. Accurately place anchor bolts per the drawings furnished by the manufacturer in accordance with Section 05500, Miscellaneous Metal.

B. MANUFACTURER'S FIELD SERVICES

1. The conveyor system supplier shall furnish the services at site of a factory-trained representative for a period of two days total in no more than one trip to the jobsite. Service shall be provided as necessary after the Contractor has installed the equipment. These services shall be furnished for the purposes of;
   a. The equipment manufacturer’s inspection of the equipment following installation by others, and to certify that the equipment has been properly installed and is ready to operate, to train the Owner’s personnel in the operation, maintenance of the equipment, and to observe and supervise the initial operation of the equipment.
2. Field services at the jobsite shall be performed during normal daylight working hours from Monday – Friday; legal holidays excepted.
3. The Contractor shall coordinate the manufacturer’s technical services in a timely professional manner. At a minimum, two weeks notice must be given to the manufacturer for travel planning purposes unless previously agreed by manufacturer. To avoid project delays, every effort should be made to coordinate inspection, training and start up of the equipment in one trip. If the manufacturer is asked to make trips in excess to the stated contract document requirements due to lack of coordination, planning or efforts of the contractor, then the contractor is responsible for additional costs incurred by the manufacturer.

4. After inspection of the installed equipment the Supplier shall furnish a written report certifying that the equipment has been properly installed and lubricated, is in accurate alignment, is free from any undue stress imposed by connecting piping or anchorage, has been operated under full load conditions and that it operates satisfactorily.

C. FIELD TESTING

1. Prior to final acceptance of the screen, three (3) tests shall be conducted according to the EPA Paint Filter Test as described in method 9095 of EPA Publication SW 486.
2. Should the system fail to produce screenings capable of passing the "EPA Paint Filter Test", the manufacturer shall at its own expense make all necessary modifications to the equipment until such tests can be passed.
3. Field testing shall be coordinated with sludge dewatering centrifuge field testing and start-up.

D. OPERATOR TRAINING

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment after system is operational. Training will take place while manufacturer's representative is at the job site for inspection. Refer to Division 1 Section "Closeout Procedures" and "Demonstration and Training."
2. Within twelve (12) months after start-up the manufacturer shall provide one (1) trip and one (1) day (up to 8 hours) of follow-up service and operator training. This shall be exclusive of the start-up service work.

END OF SECTION 11437

SECTION 11445 – CENTRATE SURGE TANK/PUMP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for the centrate pumping station, PS-6-1:

1. Polyethylene tank.
2. Duplex Submersible pumps and controls.

B. Related Sections include the following:

1. Division 13 Sections for controls and instrumentation.
2. Division 16 Sections for electric power, wiring and cables, devices, grounding, and lightning protection.

1.3 PERFORMANCE REQUIREMENTS

A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than 125 psig.

B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.4 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Shop Drawings: Show fabrication and installation details for each sewage pumping station. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Product Certificates: For sewage pumps, signed by product manufacturer.

D. Field quality-control test reports.

E. Maintenance Data: For sewage pumping stations to include in maintenance manuals.

F. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged pumping stations and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. HI Compliance: Comply with HI 1.1-1.5 for sewage pumps.

F. NEMA Compliance: Comply with NEMA MG 1 for electric motors.

G. UL Compliance: Comply with UL 778 for sewage pumps.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 SURGE TANK

A. Description: Factory fabricated tank with overflow pipe connection, and separate cover.

1. Basis of Design: ChemTainer Flat Bottom Cylindrical Tank, AA or AX Series.

B. Tank: Fabricate watertight, with sidewall opening with PVC bulkhead fitting for overflow pipe connection.

1. Material: Polyethylene or Cross Linked Polyethylene.
2. Anchor Flange: Same material as or compatible with sump, cast in or attached to tank bottom, in location and of size required to anchor basin to concrete slab.

C. Cover: Hinged removable cover fabricated with same material as tank. Cut slotted openings; for access to pumps, connections, floats and power cables.

D. Capacities and Characteristics:

1. Capacity: 500 gallons.
2. Diameter: 52 inches.
3. Depth: 60 inches.
4. Wall Thickness: 3/8 inch, minimum.
5. Sidewall Outlet:

a. Discharge Pipe Size: 6” IPS
b. Bottom of Sump to Centerline: 54 inches.
c. Type: PVC slip for gluing.

2.3 SUBMERSIBLE SEWAGE PUMPS

A. General:

1. Sewage Pumps: Two submersible type sewage pumps, with guide rail, quick-disconnect system at each pump station suitable for NEC class 1, division 1 group C, D hazardous locations. Non-clog pumps shall be capable of passing solids of 3-inch minimum diameter. Motors shall be hermetically sealed with moisture-sensing probe.

2. Available Manufacturers:

a. ITT Flygt Corporation.

3. Casing: Grey cast iron, ASTM A-48, all fasteners exposed to pumped liquids shall be stainless steel
4. Impeller: Grey cast iron, ASTM A-48, Class 35B, or bronze, statically and dynamically balanced, keyed or threaded to shaft
5. Pump And Motor Shaft: AISI type 431 stainless steel, with lubricated bearings.
6. Motor: Watertight, hermetically sealed, NEMA B design, induction type, waterproof power cable of length required.

a. Moisture Sensing Probe: Internal moisture sensor and moisture alarm.

7. Include the following for each pump

a. Guide Rails: Vertical pipes or structural members, made of stainless steel attached to baseplate and upper guide brackets.
b. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
c. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
d. Guide plate: Stainless steel
e. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.

f. Lifting Cable or chain: Stainless steel; attached to pump and cover at access hatch.
g. Level float switch bracket.

8. Control: Manufacturer's standard panel for a duplex pump station pump, project label Control Panel RP-6-3.

a. Panels with external dimensions and instruments arrangement to provide for neat and orderly installation of conductors, materials and equipment. Adjust actual panel sizes to accommodate internal and external components.
b. Provide transformers, controls, relays, starters, float switches, cabling and all other devices for the installation of a complete and operating system.
c. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
d. Fabricate panels; install instruments, wire, and plumb at the factory.
e. Instrumentation and Controls and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

B. Non-Clog pump:

1. Basis of design equipment: ITT Flygt Corporation, model CP3102.180 MT
2. Design Conditions, Typical of P-6-3-1, P-6-3-2:

	Min.	Avg.	Max.
Capacity (gpm)	100	275	550
Total Dynamic Head (ft.)	50	40	23
Pump Efficiency (%)		42	
Shut-off Head (ft.)	57		

3. Maximum operating pressure: 125 psig.
4. Impeller Size: 7-1/2 inches.
5. Impeller Throughlet: 3”
6. Outlet Size: 4 inch discharge flange
7. Speed: 1715 rpm.
8. Electrical Characteristics:

a. Motor Horsepower: 5 hp.
b. Volts: 460 V
c. Phases: Three
d. Frequency: 60 Hertz.
e. Pump motors shall be inverter duty and be compatible with requirements of motor variable frequency drive and solid-state starter manufacturers.
f. Provide a NEMA Design B motor with Class H insulation and temperature rise in accordance with NEMA standards. Shall have ample capacity to drive the pump under continuous operation without overloading the motor service factor rating at any point on the pump curve.

2.4 MISCELLANEOUS MATERIALS

A. Structural Support Steel: Type 304L, Division 5 Sections Miscellaneous Metal.

B. Grout: ASTM C 1107, Grade B, nonshrink cement grout.

1. Design Mix: 5000-psi, 28-day compressive strength.

C. Concrete: Refer to Division 3 Section "Cast-in-Place Concrete."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect sewage pumps according to HI 1.6, "Centrifugal Pump Tests." Include test recordings that substantiate correct performance of pumps at design head, capacity, speed, and horsepower.

B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before sewage pumping station installation.

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

3.2 IDENTIFICATION

A. Install identifying labels permanently attached to equipment.

B. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.

3.3 INSTALLATION

A. Pumping station components where indicated, according to specific equipment and piping arrangement indicated.

B. Fill voids between chamber sidewalls, sleeves, and piping and make watertight seal with grout.

3.4 CONNECTIONS

A. Sanitary sewer piping installation requirements are specified in Division 15 Section "Process Piping." Drawings indicate general arrangement of piping.

B. Electrical power and wiring are specified in Division 16 Sections.

C. Instrumentation is specified in Division 13 Sections.

3.5 PAINTING

A. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.

B. Paint field-welded areas to match factory coating.

3.6 FIELD QUALITY CONTROL

A. Perform the following field quality-control tests and inspections and prepare test reports:

1. Schedule tests and inspections by authorities having jurisdiction with at least 48 hours advance notice.
2. Pump Stations: Perform air test according to ASTM C 1244.
3. After installing sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
4. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
5. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
7. Leaks and loss in test pressure constitute defects that must be repaired.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Adjust pump, accessory, and control settings, and safety and alarm devices.

3.8 CLEANING

A. Clean dirt and debris from wet wells, pumps, and piping.

B. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finishes to match original finishes.

C. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove dirt and construction debris and repair damaged finishes.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pumping stations. Refer to Division 1 Section "Closeout Procedures" and "Demonstration and Training."

END OF SECTION 15445

SECTION 13125 - METAL BUILDING ROOFING & SIDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal building systems that consist of integrated sets of mutually dependent components including roof panels**,** wall panels**,** soffit panels, and accessories.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for concrete foundations, slabs, and anchor-bolt installation.
2. Division 8 Section "Steel Doors and Frames."
3. Division 9 painting Sections for finish painting of shop-primed structural framing.

1.3 DEFINITIONS

A. Terminology Standard: Refer to MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

A. General: Provide a complete, integrated set of mutually dependent components and assemblies that form a system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include metal roof and siding panels**,** and accessories complying with requirements indicated.

B. Roof Slope: Per plans.

C. Roof System: Manufacturer's standard vertical-rib, standing-seam metal roof panels.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Engineer metal building systems according to procedures in MBMA's "Metal Building Systems Manual."
2. Design Loads: As required by “New York State Building Code.”

3. Roof Snow Loads: Include vertical loads induced by the weight of snow, as determined by 50-year, mean-recurrence-interval ground snow load at Project site of 55 psf. Allow for unbalanced and drift loads.
4. Wind Loads: Include horizontal loads induced by a basic wind speed corresponding to a 50-year, mean-recurrence interval at Project site.
5. Collateral Loads: Include additional dead loads other than the weight of metal building system for permanent items such as sprinklers, mechanical systems, electrical systems, and ceilings.
6. Auxiliary Loads: Include dynamic live loads, such as those generated by cranes and materials-handling equipment indicated on Drawings.
7. Load Combinations: Design metal building systems to withstand the most critical effects of load factors and load combinations as required by MBMA's "Metal Building Systems Manual and the New York State Building Code.”
8. Deflection Limits: Engineer assemblies to withstand design loads with deflections no greater than the following:

    a. Metal Roof Panels: Vertical deflection of 1/180 of the span.
    b. Metal Wall Panels: Horizontal deflection of 1/180 of the span.

B. Thermal Movements: Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

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

C. Air Infiltration for Metal Roof Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at negative test-pressure difference of 1.57 lbf/sq. ft.

D. Air Infiltration for Metal Wall Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at static-air-pressure difference of 6.24 lbf/sq. ft.

E. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at test-pressure difference of 2.86 lbf/sq. ft.

F. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at a minimum differential pressure of 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. and not more than 12 lbf/sq. ft.

G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 60.

1.6 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of the following metal building system components:

1. Wall panels.
2. Metal roof panels.
3. Flashing and trim.
4. Accessories.

B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.

1. Metal Roof and Siding Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

   a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.
   b. Show wall-mounted items including doors, windows, louvers, and lighting fixtures.
   c. Show translucent panels.

2. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches :

   a. Flashing and trim.
   b. Gutters.
   c. Downspouts.
   d. Louvers.

C. Samples for Initial Selection: For each type of building component with factory-applied color finish.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below.

1. Metal Roof Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
2. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: Nominal 12-inch- long Samples for each type of accessory.

E. Product Certificates: For each type of metal building system, signed by product manufacturer.

F. Manufacturer Certificate: Signed by manufacturer certifying that products comply with requirements.

G. Qualification Data: For Erector, manufacturer, professional engineer, land surveyor and testing agency.

H. Maintenance Data: For metal panel finishes to include in maintenance manuals.

I. Warranties: Special warranties specified in this Section.

1.7 QUALITY ASSURANCE

A. Erector Qualifications: An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

B. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.

1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

C. Source Limitations: Obtain metal building system components, including structural metal panel assemblies, through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal building system and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Engineer, except with Engineer’s approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.

E. Preinstallation Roof Assembly Conference: Conduct conference at Project site. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

1. Examine purlin and rafter conditions for compliance with requirements, including flatness and attachment to structural members.
2. Review structural limitations of purlins and rafters during and after roofing.
3. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
4. Review temporary protection requirements for metal roof panel assembly during and after installation.
5. Review roof observation and repair procedures after metal roof panel installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness and with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements:

1. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.10 COORDINATION

A. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam, metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Alliance Steel, Inc.
2. American Buildings Company.
3. American Steel Building Company, Inc.; Division of NCI Building Systems, LLP.
4. Butler Manufacturing Company.
5. Ceco Building Systems; Division of Robertson-Ceco Corporation.
6. Crown Metal Buildings, Inc.
7. Garco Building Systems.
8. United Structures of America, Inc.

2.2 MATERIALS FOR FIELD-ASSEMBLED METAL PANELS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80, with G90 coating designation.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 50 or 80; with Class AZ50 coating designation.
3. Surface: Smooth, flat finish.
4. Exposed Finishes: Apply the following coil coating:

a. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight), with a minimum total dry film thickness of 1.5 mil. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions, except as modified below:

1) Humidity Resistance: 2000 hours.
2) Salt-Spray Resistance: 2000 hours

2.3 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
   1. Fasteners for Metal Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with nylon or polypropylene washer.
   2. Fasteners for Metal Roof Panels: Self-drilling Type 410 stainless-steel or self-tapping Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal panels.
   3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
   4. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

D. Metal Panel Sealants:

   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
   2. Joint Sealant: ASTM C 920; one-part elastomeric polyurethane, polysulfide, or silicone-rubber sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.4 FABRICATION, GENERAL

A. General: Design components and field connections required for erection to permit easy assembly.

   1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
   2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."

C. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.5 METAL ROOF PANELS

A. Vertical-Rib, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) steel sheet, 0.0269 inch thick.

   a. Exterior Finish: Fluoropolymer.
   b. Color: As selected by Engineer from manufacturer's full range.

2. Clips: Manufacturer's standard, fixed type; fabricated from zinc-coated (galvanized) steel sheet.
3. Joint Type: Panels snapped together.
4. Panel Coverage: 16 inches.
5. Panel Height: 2 inches.
6. Uplift Rating: UL 60.

B. Metal Siding Panels

2.6 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal roof panels.

1. Finish: Match finish and color of metal roof panels.

2.7 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers,

closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet .
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1 inch standoff; fabricated from extruded polystyrene.

C. Flashing and Trim: Formed from minimum 0.0159-inch- thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, false chimney tops and fillers.
2. Opening Trim: Minimum 0.0269-inch thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

D. Gutters: Formed from minimum 0.0159-inch- thick, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters; spaced 36 inches o.c.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

E. Downspouts: Formed from 0.0159-inch- thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters; spaced 10 feet o.c.

F. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating roof panel, with predrilled holes and clamps or hooks for anchoring.

1. Metal-Type Guard: Consisting of aluminum or stainless-steel rods or bars held in place by supports clamped to vertical ribs of standing-seam roof.

a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1) LMCurbs; S-5! SnoFence.
2) Riddell & Company, Inc.; Snobar.
3) Snow Management Systems; Vermont Snowguard.

G. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.8 FINISHES, GENERAL

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

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Erector, listing conditions detrimental to performance of work.

3.2 METAL PANEL INSTALLATION, GENERAL

A. Examination: Examine primary and secondary framing to verify that structural panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before metal panel installation.

B. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports, unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

C. Lap-Seam Metal Panels: Install screw fasteners with power tools having controlled torque adjusted to compress neoprene washer tightly without damage to washer, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

E. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

3.3 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations.

1. Install ridge and hip caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Field-Assembled, Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels for fasteners.
6. Provide metal closures at peaks, rake edges, rake walls, and each side of ridge and hip caps.

C. Field-Assembled, Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels; on side laps of ribbed or fluted metal panels; and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.4 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.5 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying

rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. High-Strength, Field-Bolted Connections: Connections shall be inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1 and the following inspection procedures, at inspector's option:
   a. Radiographic Inspection: ASTM E 94.

B. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract Documents.

3.7 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 13125

SECTION 13520 – CONTROL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section covers requirements for Control Panels and equipment and is in addition to requirements in Section 13500, “Process Monitoring and Control System”.

B. Related Sections include the following:

1. Other Division 13 Specification Sections.
2. Division 15 Specification Sections.
3. Division 16 Specification Sections including containing instrument wiring, conductors and conduit.

C. The control panels fabricated under this Section consist of:

1. Main Control Panel MCP-1, by the Wastewater Facilities General Contractor; located at the Main Plant Control Room.
2. Sludge Pumping Station Control Panel, RP-5-1, by the Wastewater Facilities General Contractor; located at the Sludge Pumping Station.
3. Incinerator Process Control Panel ICP-1, by the Wastewater Facilities General Contractor; located at the Incinerator Control Room.

1.3 SUBMITTALS

A. General: Refer to Section 13500, “Process Monitoring and Control System” for submittal requirements.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown on panel Drawing.
2. Materials: Adhesive backed, laminated plastic.
3. Letters: 1/2-inch white on black background, unless otherwise noted.

B. Nametags: Device identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch imposed.
4. Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.2 NON-HAZARDOUS PANEL ENCLOSURE FABRICATION

A. General:

1. Available Manufacturers: Hoffman Engineering Co.
2. Panels with external dimensions and instruments arrangement to provide for neat and orderly installation of conductors, materials and equipment. Adjust actual panel sizes to accommodate internal and external components.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
4. Fabricate panels; install instruments, wire, and plumb at the factory.
5. All panels shall bear UL label stating “LISTED ENCLOSED INDUSTRIAL CONTROL PANELS.”
6. Instrumentation and Controls and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

B. Panel Construction Ratings:

1. UL 508A, 508, Type 12; NEMA/EEMAC Type 12: Designed for indoor use; providing a degree of protection against circulating dust, lint, fibers, falling dirt, and flyings; dripping and light splashing of non-corrosive liquids.
2. UL 508A, 508, Type 4; NEMA/EEMAC Type 4: Designed for outdoor or indoor use; providing a degree of protection against windblown dust and rain, splashing water, and hose directed water; undamaged by the formation of ice on the enclosure.

C. Temperature Control:

1. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
2. Ventilated Panels: Furnish with stamped sheet metal louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel. Provide ventilation fans where required to provide adequate cooling. Create positive internal pressure within panel. Fan Motor Power: 120-volt, 60-Hz ac, thermostatically controlled. Air Filters: Washable aluminum, Hoffman Series A-FLT.

D. General Construction:

1. Panels:

a. Seams shall be continuously welded and ground smooth, no holes or knockouts.
b. Rolled flange around three sides of door and along top of enclosure opening.

c. Freestanding Modular Console Panel: 12 gauge steel construction. Internal frames, Removable center door post. Provide accessories

1) Frames are a single-roll-formed, robotically welded design made of 12 gauge steel with solid steel fully welded corners.
2) Seamless foam-in-place gasket on external accessories.
3) Integral frame channels.
4) Frames accommodate the 25-mm DIN standard and include rectangular holes for clip nuts and thru holes for use with thread forming screws.

d. Freestanding Panels: 12 gauge steel construction, Rigging lifting rings. Body stiffeners for added strength, Removable center post.
e. Floor Mount Panels: 12 gauge steel construction, 12-inch floor stands shall be welded to enclosure. Rigging lifting rings. Body stiffeners for added strength, Removable center post.
f. Wall Mount Panels: 14 gauge steel construction.
g. ANSI 61 gray polyester powder paint inside and out over phosphatized surfaces.

2. Doors:

a. Full height, fully gasketed overlapping doors.
b. Latches: Three-point, Southco Type 44. Provide latch rods with rollers.
c. Handles: “D” ring, foldable type.
d. Hinges: Full length, heavy gauge, continuous, piano type, steel hinges with stainless steel pins.
e. Stainless steel door clamps on three sides of each door and hasp and staple for padlocking (Type 4 Panels for outdoor use only),
f. High impact thermoplastic data pocket, provided on inside of doors.
g. Bonding provision Oil-resistant door gasket attached with oil resistant adhesive on door.

3. Swing-Out-Panel Kits: For use on outdoor panels.

a. Panels: 12 gauge steel construction; Brackets: Heavy-gauge brackets, hinges and stainless steel screws.
b. Designed to support a maximum load of 100 pounds.
c. The full panel assembly will meet original NEMA standards after the installation of swing-out-panel.

4. Miscellaneous Components: Provide internal and external panel accessories and components as specified and as required to provide panels to meet the intended use of the panel.

a. Provide panel light with hand switch.

2.3 HAZARDOUS PANEL ENCLOSURE FABRICATION

A. General:

1. Available Manufacturers: Cooper Industries Co.

2. Panels with external dimensions and instruments arrangement to provide for neat and orderly installation of conductors, materials and equipment. Adjust actual panel sizes to accommodate internal and external components.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
4. Fabricate panels; install instruments, wire, and plumb at the factory.
5. All panels shall bear UL label stating "LISTED ENCLOSED INDUSTRIAL CONTROL PANELS."
6. Instrumentation and Controls and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

B. Panel Construction Ratings:

1. NEMA/EEMAC Type 7: Designed Intended for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the National Electrical Code.

C. General Construction:

1. Panels:

a. Body and cover - Copper free aluminum
b. Gasket - Neoprene
c. Cover bolts - Steel
d. Hinges - Aluminum

e. Seams shall be continuously welded and ground smooth, no holes or knockouts.
f. Rolled flange around three sides of door and along top of enclosure opening.
g. Wall Mount Panels: Copper free aluminum construction.

2. Covers:

a. Full height, fully gasketed bolted covers.
b. Stainless cover bolts and hinges.
c. Bonding provision Oil-resistant door gasket attached with oil resistant adhesive on door.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. NEMA AB 1, with interrupting capacity to meet available fault currents.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

C. Standard frame sizes, trip ratings, and number of poles.

D. Lugs: Mechanical style

2.5 CONTROL TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.6 RELAYS

A. General:

1. Relay Mounting: Plug-in type socket with DIN rail mounting base.
2. Relay Enclosure: Furnish dust cover.
3. Socket Type: Screw terminal interface with wiring.
4. Socket Mounting: Rail.
5. Provide hold down clips.

B. Control Circuit Switching Relay, Nonlatching:

1. Basis of Design Manufacturer and Product: Potter and Brumfield; Series KUP.
2. Type: Compact general purpose plug-in with DIN rail mounting base.
3. Contact Arrangement: 3 Form C contacts.
4. Contact Rating: 10A at 28V dc or 240V ac.
5. Contact Material: Silver cadmium oxide alloy.
6. Coil Voltage: As required.
7. Coil Power: 1.8 watts (dc), 2.7VA (ac).
8. Expected Mechanical Life: 10,000,000 operations.
9. Expected Electrical Life at Rated Load: 100,000 operations.
10. Indication Type: Neon or LED indicator lamp.
11. Push-to-test button.

C. Control Circuit Switching Relay, Latching:

1. Basis of Design Manufacturer and Product: Potter and Brumfield; Series KUL.
2. Type: Dual coil mechanical latching relay with DIN rail mounting base.
3. Contact Arrangement: 2 Form C contacts.
4. Contact Rating: 10A at 28V dc or 120V ac.
5. Contact Material: Silver cadmium oxide alloy.
6. Coil Voltage: As required.
7. Coil Power: 2.7 watts (dc), 5.3VA (ac).
8. Expected Mechanical Life: 500,000 operations.
9. Expected Electrical Life at Rated Load: 50,000 operations.

D. Control Circuit Switching Relay, Time Delay:

1. Basis of Design Manufacturer and Products: Potter and Brumfield; Series CB for 0.1 second to 100-minute delay time ranges, Series CK for 0.1 to 120-second delay time ranges.
2. Type: Adjustable time delay relay.
3. Contact Arrangement: 2 Form C contacts.
4. Contact Rating: 10A at 240V ac.

5. Contact Material: Silver cadmium oxide alloy.
6. Coil Voltage: As required.
7. Operating Temperature: Minus 10 to 55 degrees C.
8. Repeatability: Plus or minus 2 percent.
9. Delay Time Range: Select range such that time delay setpoint falls between 20 and 80 percent of range.
10. Time Delay Setpoint: As noted or shown.
11. Mode of Operation: As noted or shown.
12. Adjustment Type: Integral potentiometer with knob external to dust cover.
13. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1 second to 100-minute delay time ranges, Series CK for 0.1 to 120-second delay time ranges.

2.7 POWER SUPPLIES

A. Provide as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.

B. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

C. Provide output over voltage and over current protective devices to protect instruments from damage due to power supply failure and protect power supply from damage due to external failure.

D. Enclosures: NEMA 1.

E. Mount such that dissipated heat does not adversely affect other components.

F. Fuses: For each dc supply line to each individual two-wire transmitter, provide indicating type fuses and mount so fuses can be easily seen and replaced.

2.8 OPERATORS, LIGHTS, PUSHBUTTONS

A. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

B. Installed devices shall have same NEMA construction rating as panel.

2.9 ALARM ANNUNCIATOR

A. Basis of Design Manufacturer and Products: OMNI8P 8 point Alarm Annunciator Model C1427/8/9 8 Point Annunciator with built in Operator Controls.

1. 24Vdc Powered (48Vdc or 85-264Vac/dc option), Panel mounted.
2. 8 Potential Free Contact Inputs.
3. Normally Open/Closed Selectable via DIP switch.
4. Integral pushbuttons and Audible Warning
5. Optional internal repeat relay outputs
6. Fully “DIP” Switch Configurable

7. Optional Serial Port - Modbus/PLC compatible

2.10 TERMINAL BLOCKS

A. General:

1. Connection Type: Screw compression clamp.
2. Compression Clamp: DIN-VDE 0611 hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
3. Screws: Hardened steel, captive and self-locking.
4. Current Bar: Copper or treated brass.
5. Insulation: Thermoplastic rated for minus 55 to plus 110 degrees C. Two funneled shaped inputs to facilitate wire entry.
6. Mounting: Standard DIN rail. Terminal block can be extracted from an assembly without displacing adjacent blocks. End Stops: Minimum of one at each end of rail.
7. Wire Preparation: Stripping only permitted.
8. Jumpers: Allow jumper installation without loss of space on terminal or rail.
9. Marking System:

    a. Terminal number shown on both sides of terminal block.
    b. Allow use of preprinted and field marked tags.
    c. Terminal strip numbers shown on end stops.
    d. Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
    e. Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

B. Terminal Block, General Purpose:

1. Basis of Design Manufacturer and Product: Entrelec; Type M4/6.D2.
2. Rated Voltage: 600V ac.
3. Rated Current: 30 amp.
4. Wire Size: 22 to 10 AWG.
5. Rated Wire Size: 10 AWG.
6. Color: Gray body.
7. Spacing: 0.25 inch, maximum.

C. Terminal Block, Ground:

1. Basis of Design Manufacturer and Product: Entrelec; Type M4/6.P.
2. Wire Size: 22 to 12 AWG.
3. Rated Wire Size: 12 AWG.
4. Color: Green and yellow body.
5. Spacing: 0.25 inch, maximum.
6. Grounding: Ground terminal blocks electrically grounded to the mounting rail.

D. Terminal Block, Fused, 24V dc:

1. Basis of Design Manufacturer and Product: Entrelec; Type M10/13T.SFL.
2. Rated Voltage: 600V dc.

3. Rated Current: 16 amp.
4. Wire Size: 22 to 10 AWG.
5. Rated Wire Size: 10 AWG.
6. Color: Gray body.
7. Fuse: 0.25 inch by 1.25 inch.
8. Indication: LED diode 24V dc.
9. Spacing: 0.5 12 inch, maximum.

E. Terminal Block, Fused, 120V ac:

1. Basis of Design Manufacturer and Product: Entrelec; Type M10/13T.SFL.
2. Rated Voltage: 600V ac.
3. Rated Current: 16 amp.
4. Wire Size: 22 to 10 AWG.
5. Rated Wire Size: 10 AWG.
6. Color: Gray body.
7. Fuse: 0.25 inch by 1.25 inch.
8. Indication: Neon lamp 1 1OV ac.
9. Leakage Current: 1.8 mA, maximum.
10. Spacing: 0.512 inch, maximum.

2.11 SURGE PROTECTION

A. Panel Surge Protection Device

1. Basis of Design Manufacturer and Product: Lightning Protection Corporation; Model LPC AC Power Surge Arrestor.
2. Description: Sine-wave-tracking type, panel-mounted design, UL 1449.
3. LED indicator lights for power and protection status.
4. One set of dry contacts rated at 5 A and 250 VAC.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. Peak Single-Impulse Surge Current Rating: 20 kA.

B. Signal Circuit Protection:

1. Transient protection shall be integrally provided with all equipment to protect all instrumentation and telemetry devices either receiving or sending signals. The transient protector shall be a three-stage surge suppression device, which shall effectively arrest most transients encountered in an instrumentation environment. Transient protectors utilizing single or dual stage suppression devices shall not be acceptable.

2.12 ALARM INDICATING STROBE LIGHT

A. General:

1. Function: Visual indication for annunciation of alarms.
2. Basis of Design Manufacturer and Model: Federal Signal Corp.; Model FB2PST

B. Performance:

1. Operating Temperature: -31°F to 150°F.
2. Lamp Life: 10,000 Hours.
3. Lamp Style: Strobe.
4. Flash Rate: 80 /Minute.
5. Candlepower Peak: 1,000,000.

C. Enclosure:

1. Dome Color: Red
2. Type: Type 4X, IP66 enclosure.
3. Mounting: Surface mount.
4. Power: 120V ac, 50/60-Hz.
5. UL and cUL Listed, CSA Certified for indoor/outdoor use.

2.13 ALARM INDICATING HORN

A. General:

1. Function: Audible indication for annunciation of alarms.
2. Basis of Design Manufacturer and Model: Federal Signal Corp.; Model 350WB

B. Performance:

1. Temperature, Operating: Minus 65 to 150 degrees F.
2. Sound Output Level: 100 dB nominal at 10 feet.

C. Features:

1. Dimensions: 4-3/8 inches in height and width, and 2.5 inches in depth, for horn and enclosure.
2. Diaphragm: Stainless steel.
3. Projector: None, unless otherwise noted.
4. Listings: UL listed, FM, CSA approved.

D. Enclosure:

1. Type: Cast aluminum neoprene-gasketed weatherproof housing.
2. Mounting: Surface mount.
3. Power: 120V ac, 50/60-Hz.

2.14 UNINTERRUPTIBLE POWER SUPPLIES

A. Each control panel shall include a true on-line type uninterruptible power supply. Each uninterruptible power supply shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and equipment for 30-minute duration.

2.15 MEDIUM SIZE PROGRAMMABLE LOGIC CONTROLLER SYSTEMS

A. General: Provide all necessary I/O modules, power supplies, chassis, communications modules, miscellaneous hardware, and interconnecting cables within control panels.

1. The Basis of Design shall be Allen-Bradley CompactLogix 5370 L2 System

B. Controller: Allen-Bradley model 1769-L24 Controller.

1. Memory Size: 0.75MB.
2. On-Board Communications: Ethernet and RS-232.
3. The CPU shall have built-in realtime clock/calendar and battery backed RAM.
~~7.~~4. Built-in, 24VDC power supply sufficient to provide adequate power to the CPU and all I/O modules.
5. Memory Card: 1784-SD2, 2 GB card.
6. Provide all required discrete input, discrete output, analog input, analog output modules as required to meet all requirements of the control system.
7. Provide a minimum of 10% spare (I/O) of all types.

C. AC Input Modules: Allen-Bradley model 1769-IA4, 8, 16

1. Number of Intputs: 4, 8, 16, provide as required
2. Voltage Category 100/120V
3. Operating Voltage Range 85 - 132V ac @ 47 - 63 Hz
4. Backplane Current (mA) at 5V: 85 mA max.
5. Voltage, Off-State Input, Max. 30V ac
6. Nominal Input Current 12 mA @ 120V ac
7. Current, Off-State Input, Max. 2 mA
8. Inrush Current, Max. 0.8 A
9. Inrush Current Time Duration (max.) 0.5 ms
10. Signal On Delay, Max 35 ms
11. Signal Off Delay, Max 45 ms

A. AC Output Modules: Allen-Bradley model 1769-OA4, 8, 16

1. Number of Outputs: 4, 8, 16, provide as required
2. Voltage Category 100/120V
3. Operating Voltage Range 85 - 132V ac @ 47 - 63 Hz
4. Backplane Current (mA) at 5V: 85 mA max.
5. Voltage, Off-State Input, Max. 30V ac
6. Nominal Input Current 12 mA @ 120V ac
7. Current, Off-State Input, Max. 2 mA
8. Inrush Current, Max. 0.8 A
9. Inrush Current Time Duration (max.) 0.5 ms
10. Signal On Delay, Max 35 ms
11. Signal Off Delay, Max 45 ms

B. Relay Output Modules: Allen-Bradley model 1769-OW4, 8, 16.

1. Number of Outputs: 4, 8, 16
2. Points Per Common: 4, 8
3. Voltage Category ac/dc Relay
4. Operating Voltage Range 5 - 125V dc, 5 - 265V ac

5. Load Current, Min. 10 mA @ 5V dc
6. Signal On Delay, Max (resistive load):10 ms
7. Signal Off Delay, Max (resistive load):10 ms
8. Single Relay Make Rating: 1800 VA
9. Single Relay Break Rating: 180 VA
10. Single Relay Continuous Rating: 2.5 Amps @ 120 VAC
11. Continuous Module Rating: 1440 VA max.

C. Analog Input Modules: Allen-Bradley model 1769-IF8.

1. Backplane Current: 200 mA @ 5V
2. Backplane Current: 100 mA @24 V
3. Backplane Power Consumption: 3.4 W maximum (1.0 W at 5V dc, 2.4 W at 24V dc)
4. Number of Inputs: 8
5. Converter Resolution: 16-bit
6. Type of Input (Selectable): ±10V dc, 0 - 5V dc, 0 - 20 mA, ±20 mA, 1 - 5V dc, 0 - 10V dc, 4 - 20 mA, 0 - 1 mA
7. Type of Data (Selectable): Engineering Units, Scaled for PID, Proportional Counts (-32,768 - +32,767 range), Proportional Counts (User-Defined Range, Class 3 only)
8. 1746-NI4 Data Format
9. A/D Conversion Method: Successive approximation, switched capacitor
10. Input Filter Frequencies: 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz, 50 Hz, 75 Hz
11. Time to Detect Open Circuit: 1 module scan
12. Common-Mode Voltage Range: ±10.5V (15V maximum between any two input signal terminals when connected in a single-ended configuration)
13. Isolation Voltage: 500V ac and 710V dc withstand for 1 minute
14. Module Update Time: 0.75 ms per enabled channel
15. Channel Turn-On Time: 101 - 107 ms maximum
16. Channel Turn-Off Time: 1 - 7 ms maximum
17. Channel Reconsideration Time: 101 - 107 ms maximum
18. Calibration module performs continuous autocalibration

D. Analog Thermocouple/Millivolt Input Modules: Allen-Bradley model 1769-IT6.

1. Backplane Current: 120 mA @ 5V
2. Backplane Current: 70 mA @24 V
3. Number of Inputs: 6
4. Input Type: Thermocouple Types J, K, T, E, R, S, B, N; Millivolt Input Ranges ±50 mV and ±100 mV.
5. Filter Frequency: 10 Hz, 50 Hz, 60 Hz, 250 Hz.
6. Input Step Response, 95% of final value: 80 ms at 60 Hz.
7. Temperature Units: °C or °F.
8. Data Formats: Raw/Proportional, Engineering Units, Engineering Units x 10, Scaled-for-PID.
9. Calibration: Autocalibration at power-up and approximately every 2 minutes afterward.
10. Isolation: 500V dc transient between inputs and chassis ground, and between inputs and backplane. 12.5V dc continuous between channels.

E. Analog Output Modules: Allen-Bradley model 1769-OF8.

1. Backplane Current: 120 mA @ 5 V

2. Backplane Current : 250 mA @ 24 V
3. Backplane Power Consumption: 5.6 W
4. Thermal Dissipation: Max. 6.6 W
5. Isolation Voltage: 500V dc
6. Number of Outputs: 8
7. Output Type: Current
8. Output Range: 0 - 21.5 mA
9. Output Coding: (proportional scaling) 0 - 32,767
10. Resolution: 16-bit, 366 nA/count
11. Non-Linearity: 0.06% of full scale
12. DAC Conversion Method: R-2R Ladder Network
13. Output Step Response: 1 ms (0…95% of full scale)
14. Channel Update Time (typical): Class 1: 5 ms to update all 8 channels, Class 3: 10 ms to update all 8 channels
15. Load Range: 0 - 500 Ω
16. Overall Accuracy: 0.1% of full scale at 77 °F
17. Calibration Factory calibrated

F. Software:

1. Allen-Bradley; Rockwell Studio 5000, latest version.

2.16 SMALL PROGRAMMABLE LOGIC CONTROLLER SYSTEMS

A. General: Provide all necessary I/O modules, power supplies, chassis, communications modules, miscellaneous hardware, and interconnecting cables within control panels.

1. The Basis of Design shall be Allen-Bradley MicroLogix 1500 System.

B. Processor: Allen-Bradley model 1764-LRP Processor with 1764-24-AWA Base Unit.

1. Memory Size: 14K user memory.
2. On-Board Communications: (1) 8-pin mini DIN and (1) isolated 9-pin D-shell, configurable.
3. Power supply sufficiently sized to provide adequate power to the CPU, base unit and all I/O modules.
4. Optional Memory Module: MicroLogix 1500 16K Memory Module with Real-Time Clock, 1764-MM2RTC.
5. Provide all required discrete input, discrete output, analog input, analog output modules as required to meet all requirements of the control system.
6. Provide a minimum of 10% spare (I/O) of all types.

C. Compact Analog Input/Output Modules: Allen-Bradley model 1769-IF4XOF2.

1. Backplane Current: 120 mA @ 5V
2. Backplane Current: 160 mA @24 V
3. Number of Inputs: 4
4. Number of Outputs: 2 individually isolated.
5. Resolution: 8-bits plus sign individually isolated
6. Type of Input/Output (Selectable): ±10V dc, 0 - 10V dc, 1 - 5V dc, 0 - 5V dc.

D. Network Interface Devices

1. Allen-Bradley model 1761-NET-AIC, AIC+ Advanced Interface Converter:

a. Provide Network Interface Devices as required to provide isolated, RS-232 to RS-485 electrical signal converter for supporting DH-485 and DF1 Half-Duplex Master/Slave serial, half-duplex, multi-drop protocols.

2. Allen-Bradley model 1761-NET-ENI Ethernet Interface (ENI):

a. Provide Network Interface Devices as required to provide isolated, RS-232 to an RJ45, 10/100-Base-T Ethernet connector.

E. Software:

1. Allen-Bradley; Rockwell RSLogix 5000 version 5.0 or later, if available.

2.17 ETHERNET SWITCH

A. Ethernet Switch: The Basis of Design shall be Moxa EDS-208 Etherdevice Switch.

1. 10/100 BaseT(X) RJ45.
2. Broadcast Storm Protection.
3. Support IEEE 802.3/802.3u/802.3x.
4. Store and Forward switching process type, 1024 address entries.
5. 10/100M, Full/Half Duplex, MDI/MDI-X autosensing.
6. Din rail mounting.

2.18 HUMAN MACHINE INTERFACE (HMI)

A. Panel Mounted HMI where required shall be provided as outlined in panel schedule and Section 13 “Operator Interface”.

2.19 HUMAN MACHINE INTERFACE (HMI)

A. Available Manufacturers and Product: Allen Bradley PanelView Plus Standard Color, Touchscreen. Include any necessary programs by Allen Bradley for software to meet specified system requirements.

B. HMI shall be Color Active Matrix Thin Film Transistor (TFT) type, Backlight Field replaceable, Real-time Clock Battery-backed clock timestamps critical data.

C. 15 inch diagonal Touchscreen: Display Area shall be 12 in x 9 in. Resolution 1024 x 768 dpi, 18-bit Color Graphics.

1. Application Memory: 310 K Application Runtime; 1008 K Flash, ATA Memory Card Supported
2. Touch Screen: 384 Touch Cells, min.
3. Communication Port: EtherNet/IP.

4. RS-232 Printer Port: 1200, 2400, 9600, 19 200 K.

D. 10 inch diagonal Touchscreen: Display Area shall be 8.3 in x 6.2 in. Resolution 640 x 480 dpi.

1. Application Memory: 310 K Application Runtime; 1008 K Flash, ATA Memory Card Supported
2. Touch Screen: 384 Touch Cells.
3. Communication Port: EtherNet/IP.
4. RS-232 Printer Port: 1200, 2400, 9600, 19 200 K.

E. 6 inch diagonal Touchscreen: Display Area shall be 4.54 in x 3.4 in. Resolution: 320 x 234 dpi.

1. Application Memory: 190 K Application Runtime; 240 K Flash, ATA Memory Card Supported
2. Touch Screen: 128 Touch Cells.
3. Communication Port: DH-485 or as required.
4. RS-232 Printer Port: 1200, 2400, 9600, 19 200 K.

F. Input Voltage: AC 85 - 264V ac, 47 - 63 Hz, Power Consumption: AC 55V A maximum, Input Voltage: DC 18 - 32V dc, Power Consumption: DC 24 W max.

G. Operating Temperature: 32 - 131 °F, Relative Humidity: 5 - 95% without condensation @ 32 - 131 °F.

H. Ratings: NEMA Type 12, 13, 4X (indoor only), IP54, IP65.

I. Certifications: UL; C-UL; Class 1 Div 2 Groups A,B,C,D; CE marked; Class II Div 2; Class III Div 1; C-Tick

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings for Process Monitoring and Control Systems are diagrammatic and not intended to specifically define element locations or wire and conduit run lengths. Base materials and installations on field measurements.

3.2 CONTROL PANELS

A. Power Distribution within Panels:

1. Feeder Circuits: Provide feeder circuits as required. Make provisions for feeder circuit conduit entry. Furnish terminal board for termination of wires.
2. Circuit Wiring: Control Diagrams on Drawings show function only. Use following rules for actual Circuit wiring:

a. Each circuit shall be identified with a unique number to facilitate troubleshooting.

b. Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
c. Branch Circuit Loading: 12 amperes continuous, maximum.
d. Panel Lighting and Service Outlets: Provide for each panel; Feed from separate 15-amp 120V ac branch circuit.
e. Provide 120V ac plug mold for panel components with line cords.

3. Power Distribution Directory: Each breaker or fuse shall be identified with a unique number. Provide typed directory identifying each breaker or fuse and a description of circuit being fed. Directory shall be inserted into a clear plastic pocket attached to the interior of panel.

4. Pump station control panels shall provide 120 VAC power to pump station flow meters.

B. Wires within Enclosures:

1. AC Circuits: 600-volt, Type THHN stranded copper. Sized for current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits: 300-volt stranded copper, twisted shielded pairs. Sized at No. 18 AWG, minimum.
3. Other dc Circuits: 300-volt, Type MFW stranded copper. Sized at No. 18 AWG, minimum.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire to terminal strips. Wire nuts or similar devices are not permitted.
6. Wire Identification: Numbered and tagged at each termination. Taped-on or slip-on wire markers with legible machine printed markings and numbers.
7. Provide 20% spare electrical terminals and 20% spare usable space.

C. Wires entering or leaving enclosures, terminate and identify as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals, terminated using manufacturer's standard connectors.
3. Terminate field wiring associated with the control circuit at the panel terminal block for ease of troubleshooting. No daisy chains of power wiring or neutrals

D. Identify wiring in accordance with requirements in Section 16 "Conductors and Cables".

E. Exposed Electrical Terminations: Control devices with exposed electrical terminals are not permitted.

F. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point within the panel enclosure in accordance with National Electrical Code requirements. This allows for verification that all shields are grounded at one point only.
3. Single Point Ground for Each Analog Loop:

a. Locate at dc power supply for loop.
b. Use to ground wire shields for loop.

c. Group and connect shields in field panels.
d. Provide one shield terminal for each shield wire to be terminated.

4. Ground terminal block rails to ground bus.
5. Connect the isolated ground bus, the electrical safety ground, and the surge suppressor grounds together at a single ground bus to create a single point grounding within the panel enclosures.

G. Ground panel devices in accordance with the manufacturer's recommendations.

H. Panel Raceways: Route control panel wiring within plastic ducts having slotted sides and snap-on plastic covers. Provide separate plastic ducts for incoming field wires and incoming tubing.

I. Wire Tagging System: Provide sequential numbering system at terminations. All wiring labeling standards must be adhered to. See Appendix at the end of this section for the wiring labeling standard.

J. Wiring Methods for Single Conductors:

1. Install no more than 2 wires under a single screw or pressure terminal.
2. Identify same physical conductor with the same tag throughout the circuit.
3. Tag panel terminal strip with the same number as the attached wire.
4. Shop drawings shall utilize the method and numbering system described.
5. Provide 5% spare wires in all raceways but not less than 1 spare wire.
6. Coordinate colors and identification for intrinsically-safe systems in accordance with NFPA 70, Article 504-80.

K. Provide surge protection devices for control panel and auxiliary panels with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide circuit breaker as a dedicated disconnect for suppressors, unless otherwise indicated

L. Instrument Signal Cables: Provide 18-gauge, 600 Volt insulation twisted and shielded pair in accordance with manufacturer's recommendation. For longer runs 16-gauge wire may be required.

M. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.

N. Terminal Blocks for Enclosures:

1. Accommodate present and spare indicated needs.
2. One wire per terminal.
3. Wire spare and unused panel mounted elements to their panels’ terminal blocks.
4. Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.

O. Internal Panel Lights for Freestanding Panels:

1. Type: Switched 100-watt incandescent back-of-panel lights.
2. Quantity: One light for every 4 feet of panel width.
3. Mounting: Inside and in the top of back-of-panel area.
4. Protective metal shield for lights.

P. Service Outlets: Provide one three-wire, 120-volt, 15-ampere, duplex receptacle, with NEMA 4 box and cover. Provide one, adjacent to each control panel. Receptacle shall be protected by dedicated fuse.

3.3 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

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

3.4 INSTALLATION

A. See Division 16 Section "Basic Electrical Materials and Methods" for general installation requirements.

B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 16 Section "Basic Electrical Materials and Methods."

C. Install freestanding and floor mount panels on concrete bases.

3.5 CONTROL PANEL SCHEDULE

A. Provide Control Panels as outlined in the Control Panel Schedule:

CONTROL PANEL SCHEDULE							
				Alarm Indication			
Control Panel	Service	Enclosure Type	PLC	Strobe	Horn	HMI	Source
RP-1-1	PT-1-1 Control Panel	FS; Type 12	Medium	Yes	Yes	15-inch	Packaged with preliminary treatment system
RP-1-2	BS-1-1	WM; Type 4/7/9					Packaged with preliminary treatment system
RP-1-3	VG-1-1	WM; Type 4/7/9					Packaged with preliminary treatment system
RP-1-4	GW-1-3	WM; Type 4/7/9					Packaged with preliminary treatment system
RP-1-5	P-1-1	WM; Type 12	Small			6-inch	Packaged with booster pump system
RP-2-1	PC-2-1	WM; Type 12	Small				Packaged with primary collection system
RP-2-2	PC-2-2	WM; Type 12	Small				Packaged with primary collection system
RP-2-3	PC-2-3, -4	WM; Type 12	Small				Packaged with primary collection system
RP-3-1	Aeration Master Control Panel	WM; Type 12	Medium			10-inch	Packaged with aeration system
B-3-1	Blower B-3-1	WM; Type 12	Small			6-inch	Packaged with aeration system
B-3-2	Blower B-3-2	WM; Type 12	Small			6-inch	Packaged with aeration system
B-3-3	Blower B-3-3	WM; Type 12	Small			6-inch	Packaged with aeration system
B-3-4	Blower B-3-4	WM; Type 12	Small			6-inch	Packaged with aeration system
RP-6-1A,1B	CF-6-1	(2)FS; Type 12	Medium			15-inch	Packaged with sludge dewatering system
RP-6-2	PLY-6-1	WM; Type 12	Small			6-inch	Packaged with polymer blend/feed system
RP-6-3	PS-6-1	WM; Type 12		Yes	Yes		Packaged with centrate pump station
RP-6-4	CVY-6-1	WM; Type 12	Small				Packaged with screw conveyor system
RP-6-5	CVY-6-2	WM; Type 12	Small				Packaged with screw conveyor system
RP-10-1	Air Monitoring Alarm Annunciation	WM; Type 12		Yes	Yes		Fabricated by G.C.

(1) – Selector switch/pushbutton stations shall be explosion proof enclosures.
(2) - Provide two separate freestanding panels; panel RP-6-1B is for controls and RP-6-1A is for motor power and control.

FS - Freestanding Panel
FM - Floor Mount Panel
WM - Wall Mount Panel

END OF SECTION 13520

SECTION 13570 – INSTRUMENTATION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes:
   1. Level Float Switches.
   2. Ultrasonic Level/Flow Transducers.
   3. PH Transmitter.

B. Related Sections include the following:

   1. Other Division 13 Specification Sections.
   2. Division 15 Specification Sections.
   3. Division 16 Specification Sections including containing instrument wiring, conductors and conduit.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   2. Details of control panel faces, including controls, instruments, and labeling.
   3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   4. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

1.4 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

   1. Warranty Period: One year from date of Completion.

PART 2 - PRODUCTS

1.

2.2 LEVEL FLOAT SWITCHES

A. General:

1. Parts: Float switch, interconnecting cable, and intrinsic safety barrier.
2. Basis of Design Manufacturer and Model: US Filter (Consolidated Electric); Model 9G-EF Direct Acting Float Switch and Model IS6 Intrinsic Safety Barrier.

B. Performance:

1. Operating Temperature: 32°F to 130°F.
2. Contacts: SPST magnetic reed switch, mercury switches are not acceptable.
3. Contact Ratings: 100 VA @250 volts ac.
4. Cable: 60-feet; AWG 16/2 CPE jacketed cable.
5. Body: Teflon Coated Type 316 Stainless Steel.

C. Intrinsic Safety Barrier.

1. Operation Principle: Shunt diode barrier ON/OFF switch interface.
2. Listings: UL recognized, Class I, Division 1, Group D Barrier.
3. Provide Intrinsic Safety Barrier for float switches. Barrier to be located in the pump station control panel

2.3 ULTRASONIC LEVEL/FLOW TRANSMITTER

A. General: The contractor shall furnish and install an open channel ultrasonic flow transmitter /transducer suitable for fixed-site monitoring to be utilized in conjunction with the effluent level control weir.

B. Basis of design equipment: ABB, Inc. Model C160, Inform IT, Wall/Pipe Mounted Universal Process Transmitter and Model XRS-5, Field IT, Ultrasonic Flow Measurement Echomax Transducer.

C. Ultrasonic Transducer

1. The sensor shall consist of a single ultrasonic transducer housed in a rugged, watertight, dust-tight, submersible, corrosion resistant (self-certified NEMA 4X, 6 and IP67) Kynar plastic or approved equal.

2. The sensor shall include a temperature probe to automatically compensate for air temperature changes. The sensor shall automatically adjust its gain in response to echo strength to maximize performance in the presence of steam, foam, and turbulence. A setup feature shall aid in aligning the sensor by allowing the user to maximize the return echo. The sensor shall include variable blanking distance to ignore echoes from within a programmable distance from the sensor.

3. The level measurement span shall be from 0 to 10 feet. The level shall be measured with a maximum error of +/- 0.02 feet over a head change of 1 foot or less, and +/- 0.03 feet over a head change of 1 to 10 feet. The temperature coefficient shall be +/- 0.000047 per degree F times the distance from the transducer to the liquid surface over the compensated temperature range of -22 to 140 degrees F.

4. The sensor cable shall be 50 feet long. A stainless steel mounting bracket shall be supplied for mounting the sensor. It shall be possible to suspend the sensor using only the cable.

D. Flow Transmitter

1. The transmitter shall have the ability to convert measured liquid level readings into corresponding flow rate readings using internal conversion algorithms. The flow transmitter shall contain internal conversion algorithms for weirs and Parshall flumes. The flow meter shall accept a two-term, level-flow rate polynomial equation. The flow transmitter shall also be capable of operating in a level-only mode.

2. The flow transmitter shall contain a high-intensity 7-segment, 1x6 digit LED display.

3. The flow transmitter shall contain a tactile keypad and a 7 digit backlit liquid crystal display (LCD). Characters on the LCD shall be 0.5 inch high and 0.26 inch wide. The LCD shall visually prompt the user through the programming sequence by displaying the program step number and the entered value. Programming instructions, including the program steps and the available selections, shall be on the front panel label. The flow transmitter shall also display level and/or flow rate.

4. The flow transmitter shall include a 6 digit, flow totalizer.

5. The flow transmitter shall include an isolated 4 to 20 mA DC output for retransmitting level or flow rate data.

6. The flow transmitter shall have Modbus serial communications output for transmitting level, flow rate, total flow.

7. The flow transmitter shall operate on 120 VAC, 60 Hz line power.

8. The flow transmitter shall be housed in a rugged, watertight, dust-tight, corrosion resistant (NEMA 4X and IP66) enclosure suitable for conduit connections. The enclosure shall include a wall mounting bracket and a clear polycarbonate window for viewing the LCD and totalizer without opening the enclosure.

2.4 PH TRANSMITTERS

A. Available Manufacturers:

1. Hach model pHD-SC Digital Differential pH Sensor, Model DPD1P1.
2. Or Approved Equal.

B. The Hach pHD-SC pH Sensor consists of:

1. Encapsulated sensor with digital signal processor, pre-amplifier, reference electrode, measuring electrode, ground electrode, and replaceable salt bridge.
2. Integral 10-meter cable
3. Wetted material construction: PEEK.

C. Dual Channel Controller:

1. Each pH Sensor shall be furnished with a dual channel controller, Hach Model SC200 or approved equal. Controller shall be furnished with a data logger capability with RS-232 to record 6 months of data, two (2) 4-20mA analog outputs, and an SD card reader for data download.

D. Mounting styles:

1. 1-inch NPT threads on both ends to mount into a standard 1-inch pipe tee.

E. Performance Requirements:

1. Measurement range: 0 to 14 pH
2. Sensitivity: 0.01 pH
3. Stability: 0.03 pH per 24 hours, non-cumulative

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for, installation tolerances and other conditions affecting performance of work.

B. Verify that conditioned power supply is available to devices.

3.2 INSTALLATION

A. Install equipment level and plumb; coordinate installation with other equipment and material in the area.

B. Verify location of devices with plans before installation.

C. Install labels and nameplates to identify control components according to Division 15 Section "Mechanical Identification."

D. Installation and mounting hardware:

1. Mount instrumentation devices in accordance with manufacturers written installation instructions.
2. Mount devices on manufacturer supplied mounting straps.
3. Provide manufacturer provided standard or optional mounting equipment for device mounting.
4. Provide required strut support systems and anchors for mounting of devices off floors and walls.

E. Sensor Tubing: Pressure transducer sensor tubing shall be ¼” stainless steel tubing.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 16 Sections.

B. Install building wire and cable according to Division 16 Sections.

C. Install signal and communication cable according to Division 16 Sections.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Refer to Section 13500, “Process Monitoring And Control System”, for field quality control procedures:

3.5 SYSTEM REQUIREMENTS

A. Components: Provide materials, coordination, and fieldwork to connect and interface components supplied by others as a part of a complete systems integration package.

B. Protection: Deliver material and equipment to site in manufacturer's original, unopened, and labeled containers. Provide protective measures to allow on-site storage exposed to the weather, without damage to the equipment.

3.6 COORDINATION

A. Provide coordination to assure that the control system, as installed, is totally compatible with devices provided by others. Provide additional devices where required to assure complete compatibility at no additional cost to the Owner.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Program unit for applicable use.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain ultrasonic flow meters. Refer to Division 1 Section "Closeout Procedures" and" Demonstration and Training."

END OF SECTION 13570

SECTION 13801
ELECTRIC CONTROLS AND RELAYS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pushbutton and selector switches.

B. Control stations and panels.

C. Relays .

D. Control power transformers.

1.02 REFERENCE STANDARDS

A. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2008).

B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for each component showing electrical characteristics and connection requirements.

1.04 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Control Switches and Stations:
   1. Contacts: NEMA ICS 2, Form A, B, or Z.
   2. Contact Ratings: NEMA ICS 2, B300.
   3. Selector Switch Operators: Rotary type.
   4. Pushbutton Operator: Shrouded type.
   5. Control Stations: Heavy duty oiltight type pushbutton station.

B. Magnetic Control Relays: NEMA ICS 2, Class A300.
   1. Contacts: NEMA ICS 2, Form A, B, or Z.
   2. Contact Ratings: NEMA ICS 2, Class A300.

C. Solid-State Relays: NEMA ICS 2.
   1. Contacts: NEMA ICS 2, Form A, B, or Z.
   2. Contact Ratings: NEMA ICS 2, Class A600.

D. Time-Delay Relays: NEMA ICS 2, Class A600, solid-state time-delay relay.

E. Interval Timing Relays: NEMA ICS 2, Class B300, repeat cycle timer.

F. Control Power Transformers: Machine tool transformer with isolated secondary winding.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install individual relays and time-delay relays in enclosures.

C. Make electrical wiring interconnections as indicated.

END OF SECTION 13801

SECTION 13852 - AIR MONITORING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes equipment and components, including control components for air monitoring.

B. Related Sections include the following:

1. Division 13 Specification Sections.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and method of field assembly, components, and location and size of each field connection.

1. Schematic diagrams showing devices.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
3. Written description of sequence of operation.
4. Listing of connected data points, including connected control unit and input device.

C. Product List: For air monitoring equipment.

1. Including additional material and equipment for installation and calibration of the detectors including two (2) infrared controllers and calibration kits for each type of sensor.

D. Maintenance Data: For air monitoring equipment to include in Installation and Operation and Maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of air monitoring equipment manufacturer for installation and maintenance of units required for this Project.

B. Manufacturer Qualifications:

1. The manufacturer must be capable of supplying all equipment used to check or calibrate the sensor/transmitter units.
2. The manufacturer must be capable of providing on site service with factory-trained personnel.
3. The manufacturer must be capable of providing on site training for owner/operator.

C. Regulatory Requirements:

1. Comply with provisions of the following Requirements: CE, UL Class I, Division 1, Groups A, B, C, and D.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 COORDINATION

A. Coordinate the installation of the air monitoring equipment with the plant process controls contractor.

1. Plant process controls panel shall provide power for units.
2. Coordinate alarm input wiring from air monitoring equipment to plant process controls panel

1.6 WARRANTY

A. Warranty: Manufacturer warrants that this product will be free from mechanical defect or faulty workmanship for a period of eighteen (18) months from date of shipment or one (1) year from Installation, whichever occurs first, provided it is maintained and used in accordance with Seller's instructions and/or recommendations. This warranty does not apply to expendable or consumable parts whose normal life expectancy is less than one (1) year such as, but not limited to, non-rechargeable batteries, sensor elements, filter, lamps, fuses etc.

B. Sensing Element Warranty: All sensing elements (sensors) will have a minimum useful life of one year. The supplier will provide replacement sensors at no charge for any sensor that does not meet the minimum requirement.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide additional zero and span calibration gases, hoses and required material for one year’s amount of calibration of each sensor, based on calibration time intervals directed by the manufacturer.

PART 2 - PRODUCTS

2.1 AIR MONITORING SENSOR/TRANSMITTER

1. Available Manufacturer:

   a. The sensor/transmitter shall be a MSA Ultima X3 Series Gas Monitor Sensor/Transmitter.

2.2 SCHEDULE

1. QET-10-1-1 Transmitter with three gas sensors and alarms.

   a. Combustible Gas Detectors: 0-100% LEL, Alarm set at 10% LEL. Petroleum Vapors and Methane.
   b. Hydrogen Sulfide Detectors: 0-100 ppm, Alarm set at 15 ppm.
   c. Oxygen Detector: 0-25%, Alarm set at 19%.
   d. Basis of design make and model: MSA Model E1M30000311117111411.

2.3 SENSOR/TRANSMITTER

A. The Ultima X3 Series Sensors/Transmitters shall be contained in a 316 stainless steel explosion-proof enclosure.

B. Sensor/Transmitter Requirements:

1. Catalytic Bead Type Combustible Sensor/Transmitter:

   a. The catalytic bead type combustible sensor must have a demonstrated resistance to degradation of silicones and reduced sulfur gases.
   b. The catalytic combustible sensor/transmitter shall detect for an above 100% LEL condition (over-range). This condition must be indicated on the front panel LCD.
   c. The interconnect wiring from the combustible transmitter to the sensor shall be a 5-wire cable.

2. Electrochemical Hydrogen Sulfide and Oxygen Sensors/Transmitters:

   a. The electrochemical sensor/transmitters shall not require the periodic addition of reagents.
   b. The interconnect wiring from the electrochemical transmitter to the sensor shall be a 5-wire cable.

3. Sensor/Transmitter Operating Requirements:

   a. Operating Voltage - The sensor/transmitter shall require 120 VAC.
   b. Sensor/transmitter electronics shall consist of one PCB. This PCB shall provide LED’s and relays.
   c. The single PCB shall not require tools for installation or removal.
   d. The single PCB must be self-aligning in the enclosure.

e. Sensor/transmitter shall require the following wiring configurations:

1) 3-wire cable for electrochemical hydrogen Sulfide and oxygen units configured units configured with LED and/or relay options.
2) 3-wire cable for all combustible units (configured with or without LED or relay options).

f. Sensor/transmitter shall allow for optional reset connector for resetting latched alarms.
g. Set-up and start-up of the sensor/transmitter(s) will be so that the enclosure need not be opened during this process.
h. Sensor/transmitter(s) shall be factory calibrated, ready for use out of the box. A gas check is all that is required to ensure proper operation.
i. Sensor/transmitter shall contain no pots, jumpers or switches.

4. Sensor/Transmitter Display:

a. There will be a local display indicating the gas type being monitored and the concentration of gas present. The display will alternate between the gas type (1 second) and gas concentration (5 seconds). The display will be an integral part of the sensor/transmitter enclosure. The display will be visible from a minimum of 5 feet and will be present always, and will not require being turned on or off. This readout will be three, one half-inch (3 1/2") digit Liquid Crystal Displays (LCD).
b. Sensor/transmitter display shall indicate all diagnostic check/fault conditions with a scrolling message detailing the condition. Error codes shall not be used.
c. Sensor/transmitter will provide for three alarm relay contacts. Alarm levels will be adjustable by means of a hand held infrared controller.

5. Smart Sensor Technology:

a. Sensors shall be contained in sensor modules mounted external to the main enclosure. All sensor modules shall have the capability of replacement while the unit is under power (hazardous areas) without the need for tools.
b. Sensor modules shall contain all relevant sensor information within the module. This information shall include sensor manufacturer date, gas type, gas range, calibration data, and default relay parameters.
c. Sensor module shall store all calibration data so that the module may be calibrated off site and installed in the field without the necessity of re-calibration. The sensor module shall not require a battery or power source to store this data.

6. LED / Relay Options:

a. Sensor/transmitter shall have optional LED’s, viewable from 50 feet, minimum. The LED’s shall operate as follows:

1) Solid green LED – normal operation (measure mode)
2) Solid red LED – fault condition
3) Blinking red LED – alarm condition

b. Sensor/transmitter shall have optional relays. Relays shall be rated at 5 amps @ 30VDC, 5 amps @ 220VAC, single-pole, double-throw and consist of three for

alarm levels and one for fault. All relay contact activation will be monitored. If the relay cannot activate for any reason, the trouble relay will change state. All relays shall be field selectable through a non-intrusive hand-held wireless remote control unit (Controller). Selectable features include:

1) Alarm level
2) Latching / Non-latching
3) Upscale / Downscale
4) Normally-opened / Normally-closed
5) Energized / De-energized

7. Multi-Sensing Capabilities:

   a. The transmitter shall operate up-to three sensors at one time.
   b. Combinations of electrochemical, catalytic and infrared sensing technologies shall be available.

8. Power Supply Requirements:

   a. External Power Supply: Sensor/transmitter, 120 VAC.

9. Other Features:

   a. Sensor/transmitter will be capable of storing and displaying average, minimum and maximum gas concentrations over selected periods of time.
   b. The sensor/transmitter will give an indication of when sensor is nearing the end of its useful life by means of the front panel LCD. This indication that the sensor is nearing its useful life will be based on the sensor output. It shall not be based on the time the sensor was in service.

10. Sensor Enclosure Parameters:

    a. Ultima XE Sensor/Transmitter: The sensor/transmitter will be in a 316 stainless steel enclosure suitable for location in Class I, Division 1, Groups B, C & D classified areas.
    b. The enclosure shall have a minimum of four entries, allowing for flexible mounting options for sensor, power, signal, and optional relay wiring.
    c. The enclosure shall offer a means to mount without using an entryway.

11. Installation and mounting hardware:

    a. Provide manufacturer supplied mounting strap:
       1) Mounting strap shall be used which mounts the sensor/transmitter to a wall or similar structure.
       2) The mounting strap shall attach to the sensor/transmitter via two tapped and threaded holes on the rear of the sensor/transmitter. There shall be no brackets or clamps to secure this strap to the sensor/transmitter.

12. Non-intrusive Calibration Capability:

    a. All sensor/transmitters can be calibrated without opening any enclosures.

b. By means of a non-intrusive hand held wireless remote control unit, the sensor/transmitter will enter the calibration mode. The display of the sensor/transmitter will instruct the user on when to apply zero and span gas. The sensor/transmitter will automatically adjust its internal settings to the proper calibration values without further intervention by the user. Upon completion of a successful calibration, the sensor transmitter will exit the calibration mode. Date stamp of last successful calibration will be retained in the sensor/transmitter internal memory, with capability to be displayed on LCD. If calibration is unsuccessful for any reason, the display must show an unsuccessful calibration attempt and revert to its previous calibration settings. Use of flashlight type devices, magnets or clamp-on devices to achieve calibration is not acceptable. The acceptable method uses a transmitter, which employs a digitally encoded infrared light beam.

c. Provide a two (2) non-intrusive hand held wireless remote control units:

1) The control units shall allow the user to perform sensor zeroing, calibration and setting the multiplex address and activate all functions and features of the sensor/transmitter.

2) The sensor/transmitter and controller will not be affected by low-level ambient light either natural or man-made.

2.4 PROCESS 10, AIR MONITORING

A. Monitoring: The headworks air monitoring system consists of the air monitoring sensors/transmitters and alarm annunciator panel, RP-10-1, located as shown on the drawings.

1. Headworks Area:

a. One transmitter, QET-10-1, with three gas elements will continuously monitor the Headworks Area for Combustible Gas, Hydrogen Sulfide and Oxygen contents.

1) A HIGH COMBUSTIBLE GAS DETECTION alarm shall be generated if the transmitter detects a LEL reading higher than 10%.

2) A HIGH HYDROGEN SULFIDE GAS DETECTION alarm shall be generated if the transmitter detects a reading higher than 15-ppm.

3) A LOW OXYGEN DETECTION alarm shall be generated if the transmitter detects a LEL reading lower than 19%.

b. Alarm activation shall energize the audible alarm, energize the indicating light and close a dry contact for remote monitoring.

c. An “Alarm Silence/Reset” button shall silence and reset alarm upon activation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for, installation tolerances, , and other conditions affecting performance of work.

B. Verify that conditioned power supply is available to control units.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Verify location of sensors with plans and room details before installation.

C. Install labels and nameplates to identify control components according to Division 15 Section "Mechanical Identification."

D. Installation and mounting hardware:

1. Mount devices on manufacturer supplied mounting straps.
2. Provide required strut support systems and anchors for mounting of devices off floors and walls.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install signal and communication cable according to Division 16 Sections.

B. Provide conduit, wiring and boxes to field connect sensors to transmitters.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.

B. Engage a factory-authorized service representative to perform startup service.

C. Replace damaged or malfunctioning controls and equipment.

1. Start, test, and adjust control systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 8 hours' dedicated instructor time on-site.
3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
4. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

3.6 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions

END OF SECTION 13852

SECTION 14600

HOISTS AND SELF-SUPPORTING OVERHEAD BRIDGE CRANE SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

B. ANSI MH 27.1, Specifications for Underhung Cranes and Monorail Systems.

C. ANSI B30.16 Safety Standard for Overhead Hoists (Underhung).

D. ANSI B30.11 Safety Standards for Monorails and Underhung Cranes.

E. ASME HST-4M, Performance Standard for Overhead Electric Wire Rope Hoists.

F. ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes.

G. AWS D1.1, Code for Welding in Building Construction.

H. Hoist Manufacturer's Institute Standard Specification for Electric Wire Rope Hoists.

I. ANSI/NFPA 70 National Electric Code, Article 610, Cranes and Hoists.

J. OSHA 29 CFR 1910.179, Overhead and Gantry Cranes.

1.02 SYSTEMS DESCRIPTION

A. Headworks Hoist and Crane Systems, CH-1-1: Self-Supporting Overhead Bridge Crane System: The system specified consists of an overhead crane, with trolley mounted wire rope hoist, supported by a runway framework and columns, and meeting the requirements of the referenced specifications, standards, rules and codes. The system must be self-supporting. No attachment to the building, other than the columns to the building floor, is allowed. The system, while stationary or in use, must not cause damage to the 6" thick reinforced concrete slab to which it will be attached. The system must be explosion proof and spark resistant.

B. Sludge Dewatering Hoist, CH-6-1 and CH-6-2: Provide two trolley mounted low headroom hoists for the sludge dewatering equipment where shown. The runway beams and rail for this hoist are part of the building steel and are not included in this section.

1.03 DESIGN REQUIREMENTS

A. System Capacity: Will lift and move 2.5 tons of equipment, containers, materials, etc. The 2.5 ton weight is the actual maximum weight of the largest piece of equipment to be lifted, use appropriate safety factors in determining the safe operating load.

B. Crane, carrier, and hoist equipment shall be designed for Class A service.

C. Crane shall be motor propelled, single or double girder with a minimum span of 20 feet. The bridge crane shall be of non-sparking design suitable for Class I, Division I locations and shall be low headroom construction.

D. Bridge travel shall be single speed.

E. Hoist shall be suspended from a motor driven trolley.

F. Hoist, trolley, and crane shall be controlled by a pushbutton control pendant suspended 4’-0” above floor.

G. Runway track shall be supported by and bolted directly to supplied steel columns erected from the concrete slab.

H. Distance between runway supports shall be 30’-0”.

I. Overall length of runway shall be 30’-0”.

J. Distance from floor to top of runway shall not exceed 20’-6”.

K. It is imperative that coordination with the design drawings be performed. The crane system shall not interfere with equipment or other items in the building. It is the responsibility of the crane system manufacturer to ensure proper placement and non-interference with equipment, installations and operations.

L. The electrical system shall and must be explosion proof.

1.04 SUBMITTALS

A. Submittals Package: Submit the shop drawings, product data, and quality control submittals specified below at the same time as a package.

B. Shop Drawings:
   1. Show the construction details of the hoist and crane system and the crane support structure.
   2. Show the electric wiring and control system.
   3. Show installation details.

C. Product Data:
   1. Catalog sheets, specifications, and installation instructions.
   2. Bill of materials.

3. Name, address, and telephone number of nearest fully equipped service organization.

D. Quality Control Submittals:
1. Design data, including safety factor of materials.
2. Test report of hoist and crane system.
3. Certificate required under Quality Assurance.

E. Contract Closeout Submittals:
1. Operation and maintenance data.
2. Warranty.
3. Test reports of the completed hoist and crane system.

1.05 QUALITY ASSURANCE

A. Company Field Advisor: Secure the services of a Company Field Advisor for a minimum of 8 hours for the following:
1. Render advice regarding installation of the hoist and crane system.
2. Witness final system test and then certify with an affidavit that the hoist and crane system is installed in accordance with the contract requirements and is operating properly.

B. All equipment and materials shall be new material.

C. Hoisting equipment shall be the products of manufacturers regularly engaged in the production of such equipment.

D. All hoists shall be factory tested per applicable ANSI requirements.

PART 2 PRODUCTS

2.01 HEADWORKS HOIST AND CRANE SYSTEMS, CH-1-1

A. Hoist: Electric wire rope hoist with all parts and accessories necessary to install on bridge crane and meeting the following requirements:
1. Maximum lifting capacity to be determined by manufacturer based upon the safe operating load for lifting 2.5 tons.
2. Minimum lifting speed 5 feet per minute.
3. Trolleys: Trolley assemblies shall be articulating type. Attach load bars to yokes in such manner as to assume that all wheels are in contact with the operating flange at all times.
   a. Yokes shall be ductile castings and fixture machined.
4. Motor driven trolley with travel speed of 10 feet per minute.
5. Festoon system for control cable.
6. Friction clutch assembly on hoist to prevent overloading.
7. Dual braking system.
8. Upper and lower limit switches.
9. Hook with safety latch. Hook shall be mounted to swivel on thrust bearing.

B. Crane: Motor driven, single girder crane with track, suspension system and all parts necessary to meet the following requirements:

1. Rating of Service “Class A” as specified in ANSI MH 27.1.
2. Vertical impact load shall be 1/2 percent of the rated load for each fpm hoisting speed of the carrier.
3. Track and Fittings:
   a. Track size based on the load positioned on the track system to produce the most severe conditions of stress and deflection.
   b. The total track deflection shall not exceed 1/450 of the span or 1-1/4 inch, whichever is the least.
   c. Track sections shall be installed with bolted type splice plates to provide flush and level connections at the operating tread of the track. The maximum gap between the adjacent ends of the load carrying flange not to exceed 1/16 inch.
   d. Rigid track support shall be accomplished by bolting the runway track to the supporting structure.
4. Electrification:
   a. All electrical enclosures and motors shall be rated for Class I, Division I locations
   b. Conductors shall be complete with mounting clips, end caps, splices with covers, and power feeds.
   c. Current collectors shall be non sparking.
   d. Separate conductors shall be provided for each phase. More than one conductor in a single enclosure will not be permitted.
   e. All controls shall be housed in a single NEMA 12 panel.
   f. A fused, manual disconnect switch with a lockable handle mounted through the panel door shall be provided and wired into the incoming power circuit.
   g. All motors equipped with magnetic contactors operated with ON-OFF push button station pendant suspended 4’-0” above the floor, from the hoist trolley unit.
   h. Unless otherwise noted, all electrical equipment shall meet NEMA 7 requirements.
   i. Crane operation: 480 volt, 3 phase, 60 hertz.
   j. Control circuits: Maximum 120 volts.
5. Interlocks (if applicable):
   a. The interlock mechanism shall be manually operated, cross-connected, double locking pin type so designed that they will not operate until the crane is in proper alignment with the connecting crossover or spur rail.
   b. Equip crane with a crane travel lockout limit switch to prevent bridge travel motion while in the latched position with the crossover or spur rail.
6. Single Girder Cranes: Single girder motor driven cranes with single spans of 40 feet or more, must have rigid outrigger beam mounted parallel to the crane girder running the entire span of the crane.
7. End Trucks: End trucks consisting of structural steel weldments bolted directly to the crane bridge member forming a rigid and square connection.

a. Safety lugs shall limit drop of end truck to not more than one inch in event of wheel yoke, axle or load bar failures. Place safety lugs on both sides of the rail so that if failure occurs the rail is centrally loaded about the vertical axis.

8. Brakes:
   a. Hoisting Brakes: In accordance with Hoist Manufacturers Institute specifications and ANSI B30.16 Safety Standards for Overhead Hoists (Underhung).
   b. Brakes supplied for carrier and crane travel shall conform with ANSI B30.11 Safety Standards.
9. Miscellaneous:
   a. Paint: Crane manufacturer's standard paint system. Color shall be selected by the Owner from the manufacturer's standard color selection.
   b. Letter the crane rated capacity on the bridge rail and on the control box.
   c. Electrical Equipment: Comply with the provisions of ANSI/NFPA 70 National Electrical Code, Article 610, for wiring and equipment. Must be explosion proof.

C. Manufacturers
   a. Acco Lifting Solutions by MHT, Inc., North Syracuse, NY
   b. Nomad Freestanding Crane System by EMH, Valley City, OH
   c. Freestanding Tarca Systems by Gorbel. Fishers, NY
   d. Or approved equal

2.02 SLUDGE DEWATERING HOIST, CH-6-1 and CH-6-2

A. Hoist: Basis of design equipment is R&M Loadmate LM20 Hoist with a Low Headroom Push Trolley.

1. System shall utilize the LoadMate electric chain hoist as manufactured by R&M Materials Handling Inc., Springfield, OH. Maximum lifting capacity to be determined by manufacturer based upon the safe operating load for lifting 4 tons
2. The hoists shall be designed for indoor use and limited outdoor use where the ambient temperature is between 14°F [-10°C] and 104°F [40°C], elevation is less than 3280 ft [1000 m] and the relative humidity is less than 90%.
3. The hoist shall have a durable polymer control enclosure with IP55 / Nema 3R type protection rating.
4. The hoist nameplate shall carry an enclosure protection rating of NEMA 3R type [IP55] and have a CSA c/us rating.
5. The sound intensity level of the hoist in the assumed operating location shall not exceed 75 dB.
6. The hoist body is to be constructed of durable pressure-cast aluminum for light weight and easy handling.
7. Hoist gearing shall be a minimum AGMA quality class 10. Gearing shall be lubricated with semi-fluid grease or oil and shall be sealed.

8. The type of paint for the hoist shall be a non-reflecting matte black, powdered epoxy where the paint thickness is 70 to 100 microns. Before the paint is applied, the surface must be degreased.
9. The hoist shall be equipped with electro-zinc plated load chain specially designed for chain hoist use. The weld on the chain shall face towards the load sprocket of the hoist.
10. The hoist shall be equipped with a load sprocket (or load wheel) with a minimum of five precision-machined chain pockets providing exceptionally smooth lifting and reduced chain wear.
11. The hoist shall be equipped with a chain container resistant to oil and dirt and that completely encloses the chain exit area of the hoist.
12. The hoist shall be equipped with upper / lower limit switches for over-travel protection. The limit switches are to be load block or chain-stop activated when the hook reaches the top or bottom limit of travel. A slip clutch that also serves as a safety device for over-travel protection if the limit fails due to phase reversal shall be included.
13. The hoist shall be equipped with a chain stop assembly attached to the load chain to reduce the possibility of the dead end of the load chain from running out of the hoist.
14. The standard load hook shall be forged alloy steel (34CrMo4 or StE355). The hook is to be equipped with a spring-loaded safety latch and supported on a thrust bearing to allow the hook to rotate 360° easily even under load.
15. Capacity plates shall be affixed to each side of the block and to the hoist body clearly identifying the rated capacity of the hoist.
16. The hoist shall be equipped with a combined torque-limiting device and motor brake. Both must be easily adjustable without opening the hoist gearcase.
17. A lower chain guide and one-piece internal chain guide are to be provided to help guide and hold the load chain in the pockets of the load wheel for safe operation and to prevent jamming. Both should be easily removable for inspection.
18. The hoist shall have a round cable gland for power connection and shall accept a cable diameter from 5/16” to 5/8” [8 to 15 mm].
19. Hoisting motor shall be totally enclosed with IP55 protection, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 25% ED rating.
20. Hoisting motor shall be single speed squirrel cage type.
19. Hoisting motor shall be totally enclosed with IP55 protection, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 50% ED rating.
20. Hoisting motor shall be single speed squirrel cage type.
19. Hoisting motor shall be totally enclosed with IP55 protection, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 50% ED rating.
20. Hoisting motor shall be two-speed/two winding squirrel cage type with a speed ratio of 4:1.
21. The hoist shall be equipped with a push type trolley attached to the hoist body with a coupling or lug connection. The push trolley shall be equipped with crown tread wheels for use on standard I-beams and wide

flange W-beams. Safety drop lugs and rubber bumpers shall be included.

22. The hoist shall be equipped with a plug-in pendant with appropriate drop for lift of hoist. Pendant station enclosure shall have a rating of NEMA 4, 4X, 5 or IP65. P/B station to include emergency red mushroom stop button - push to maintain, turn to release, and two buttons for hoist motion – one for each direction of travel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the Work in this Section in accordance with the manufacturer's printed instructions, shop drawings, and directions of the Company Field Advisor.

END OF SECTION

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Expansion Joints.
5. Mechanical sleeve seals.
6. Sleeves.
7. Escutcheons.
8. Grout.
9. Mechanical demolition.
10. Equipment installation requirements common to equipment sections.
11. Painting and finishing.
12. Concrete bases.
13. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Available Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Eslon Thermoplastics.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:

a. Thompson Plastics, Inc.
b. Insert manufacturer's name.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Available Manufacturers:

a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Available Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Available Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.

2.6 EXPANSION JOINTS

A. Rubber Packless Expansion Joints:

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

a. Amber/Booth Company, Inc.; a div. of Vibration Isolation Products of Texas, Inc.
b. Flex-Hose Co., Inc.
c. Flexicraft Industries.
d. Flex-Weld, Inc.
e. Garlock Sealing Technologies.
f. General Rubber Corporation.

g. Mason Industries, Inc.; Mercer Rubber Co.
h. Metraflex, Inc.
i. Proco Products, Inc.
j. Red Valve Company, Inc.
k. Tozen Corporation.
l. Unaflex.
m. Unisource Manufacturing, Inc.

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
4. Arch Type: multiple arches with external control rods.
5. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F .
6. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F .
7. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F .
8. Material for Water or Wastewater: EPDM.
9. End Connections: Full-faced, integral steel flanges with steel retaining rings.

B. Alignment Guides:

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

a. Adsco Manufacturing LLC.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.
d. Flexicraft Industries.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.
h. Senior Flexonics Pathway.
i. Unisource Manufacturing, Inc.
j. U.S. Bellows, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

C. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.

2.7 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Available Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.9 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, ongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
   g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
   i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-NMEJ-702.

3.6 ALIGNMENT-GUIDE INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two guide(s) on each side of pipe expansion fittings and loops.

3.7 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. Install Expansion Joints at all piping connections to equipment.

3.8 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 9 Section "Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.9 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 5000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Concrete."

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.12 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 15050

SECTION 15052 – PROCESS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow (non-pressure) and force main (pressure) sanitary sewerage piping and wastewater process piping located inside buildings and tunnels, and up to 5 feet outside the buildings and tunnels.

B. Related Sections include the following:

1. Division 15 Section “Basic Mechanical Materials and Methods”.
2. Division 15 Section “Meters and Gages” for thermometers, pressure gages, and fittings.
3. Division 15 Section “Plumbing Specialties” for strainers and other specialties.
4. Division 2 Section “Earthwork”

1.3 DEFINITIONS

A. NPS: Nominal pipe size.

B. PE: Polyethylene plastic.

C. PP: Polypropylene plastic.

D. PVC: Polyvinyl chloride plastic

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Welding Certificates: Copies of certificates for welding procedures and personnel.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

B. Notify Owner no fewer than seven days in advance of proposed interruption of service.

1.7 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

C. Fusion Welding: Polyethylene piping systems, ASTM 2657

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.8 COORDINATION

A. Coordinate layout and installation of piping and suspension system components with other construction.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

C. Coordinate installation of pipe sleeves for penetrations through walls and floor assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 PIPING MATERIALS

A. Refer to Part 3 “Piping Applications” Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Linings and coatings, pipe and fittings:

1. Lining: AWWA C104 cement mortar lining.
2. Buried Piping, Exterior Coating: AWWA C151/C110 asphaltic coating

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, thickness class 53, with mechanical-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2. Pipe-Mechanical Joint Materials: Suitable for chemical and thermal conditions of piping system contents.

a. Gaskets: AWWA C111, SBR rubber, gasket size as indicted.
b. Mechanical Joint Bolts and Nuts: AWWA C111, tee head.
c. Glands: Mechanical Joint Retaining Gland

1) The joint restraint shall be incorporated in the restraining mechanism gland.
2) Glands shall be manufactured of ductile iron conforming to ASTM A536, Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN.
3) Dimensions of the glands shall be such that it can be used with the standardized mechanical joint bell and Type 304 stainless steel, tee-head bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153/A21.53.
4) Torque limiting twist off nuts shall be of the same material and sizes as the tee-head bolts to ensure proper actuating of restraining devices.
5) Available Manufacturer/Product: Ebaa Iron, Megalug.

C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, thickness class 53, with push-on-joint, bell- and plain-spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Gaskets: AWWA C111, Restraint type SBR rubber.

b. Available Manufacturer: US Pipe, Field Lok.

D. Flanged Joint, Ductile-Iron Pipe: AWWA C151, thickness class 53, with ANSI B16.1 Class 125 Flanged joint.

1. Flanged Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern. ANSI B16.1 Class 125 Flange.
2. Flange Fillers: ANSI B16.1 Class 125 pattern, AWWA C210 interior coating.
3. Pipe-Flange Materials: Suitable for chemical and thermal conditions of piping system contents.

a. Gaskets: AWWA C111, SBR rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
b. Flange Bolts and Nuts: AWWA C115, ASME B18.2.1, carbon steel, unless otherwise indicated.

E. Grooved Connection, Ductile-Iron Pipe: AWWA C151, thickness class 53, 250 psi minimum working pressure, grooved end.

1. Grooved Joint, Ductile-Iron Fittings: AWWA C110, ductile-iron standard pattern or AWWA C153 ductile iron compact pattern with AWWA C606 grooved connections.

a. Joints: Grooved with couplings.
b. Couplings and Gaskets: ASTM A47/A47M Galvanized Malleable iron casting or ASTM A536 Ductile iron casting grooved coupling with ASTM A183 Grade 2 Zinc Plated Carbon Steel Bolts and ASTM A563 Zinc Plated Nuts and EPDM Gsskets.

2.4 STAINLESS-STEEL PIPE AND FITTINGS

A. Stainless-Steel Pipe and Fittings: Schedule as indicated, ASTM A 312/A 312M, Grade TP304L or TP316L, welded seam, and grooved joint fittings unless otherwise indicated.

1. Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron casting; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

a. Grooved-End-Pipe Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule as indicated, black steel, ends matching joining method.

1. Fittings:

a. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.

b. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
c. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
d. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
e. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
f. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
g. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.6 GALVANIZED STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, Grade A, Schedule as indicated, galvanized. Include ends matching joining method.

1. Fittings:

a. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, welded steel pipe, threaded and coupled.
b. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
c. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
d. Malleable Iron, Threaded Fittings: ASME B16.3, Class 150, galvanized, standard pattern.
e. Joints: Threaded, ASME B1.20.1

2. Grooved-Joint Systems

a. Steel-Piping: ASTM A53, Grade A, grooved ends.
b. Grooved-Joint Fittings: ASTM A536, Grade 65-45-12 Ductile iron; ASTM A47, Grade 32510 Malleable iron; ASA B36.10 Carbon steel. All to be galvanized. Elbows to be long radius type.
c. Grooved-End-Pipe Joints: ASTM A47/A47M Galvanized malleable iron casting or ASTM A536 Ductile iron casting grooved coupling with ASTM A183 Grade 2 Zinc plated carbon steel bolts and ASTM A563 zinc plated nuts and EPDM gaskets.

2.7 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Joining Materials:

    a. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
    b. Mueller, or approved equal compression fittings.

B. Hard Copper Tube: ASTM B 88, Types L tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Joining Materials:

    a. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
    b. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.8 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings, Elliptical: ASTM C 507, with bell-and-spigot ends for gasketed joints with ASTM C 443, rubber gaskets.

2.9 POLYETHYLENE PIPE AND FITTINGS

A. Polyethylene (PE) pipe, (SDR-PR), HDPE (High Density Polyethylene), EMHW (Extra High Molecular Weight) 3408, ASTM F714, ASTM D3035, ASTM D3350, iron pipe size, DR 17, 100 PSI rating

1. Fittings: Polyethylene butt fusion type, ASTM F1055, to match pipe dimensions and pressure classifications. Provide adapters as necessary for connection to dissimilar pipe and valves.

2. Joints: Heat fusion as per ASTM 2657.

2.10 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. PVC Schedule 80 Pipe: ASTM D 1785.

1. PVC Schedule 80 Fittings: ASTM D 2467, socket type.

E. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.11 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40.

B. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Division 2 Section “Earthwork.”

3.2 PIPING APPLICATIONS

A. Buried Gravity-Flow, Nonpressure Sewer Piping: Includes headworks building influent and effluent sewer piping:
1. NPS 8 and larger: Ductile-iron, mechanical-joint pipe and fittings.
2. Elliptical: Reinforced-Concrete sewer pipe and fittings, elliptical, bell and spigot.

B. Buried Force-Main, Pressure Piping: Includes existing building sewer force main extension, existing D.C. garbage facility force main extension, existing plant effluent line extension
1. NPS 3 and larger: Ductile-iron, push-on-joint pipe; and ductile-iron, mechanical-joint fittings. Use mechanical joint retainer gland with all mechanical joints.

C. Wastewater Piping: Includes process waste stream piping, plant effluent (non-potable) piping and sewage piping, grit pump discharge piping, grit washer blowdown piping, grit washer discharge piping, 10 psi operating pressure; 25 psi test pressure:

1. NPS ½ - 2 ½:

   a. Aboveground/Indoor: PVC Schedule 80 pipe, with PVC Schedule 80 Fittings, glued socket joints.
   b. Aboveground/Outdoor: Schedule 40 galvanized steel pipe and galvanized cast iron or malleable iron fittings, threaded joints.
   c. Belowground or within slabs: Polyethylene HDPE pipe.

2. NPS 3 and Larger:

   a. Aboveground: Flanged-joint ductile iron pipe with flanged joint fittings or Grooved-joint ductile iron pipe with grooved joint fittings.
   b. Belowground or within slabs: Push-on-joint or mechanical joint ductile iron pipe and mechanical joint fittings. Use the fewest possible joints belowground and within floor slabs.

D. Sludge Piping: Includes supernatant piping, secondary sludge (WAS/RAS) piping, primary sludge piping and thickened sludge piping. 100 psi operating pressure; 150 psi test pressure:

1. NPS 2 ½ and Smaller:

   a. Aboveground/Indoor: PVC Schedule 80 pipe, with PVC Schedule 80 Fittings, glued socket joints.
   b. Aboveground/Outdoor: Schedule 40 galvanized steel pipe and galvanized cast iron or malleable iron fittings, threaded joints.
   c. Belowground or within slabs: Polyethylene HDPE pipe.

2. NPS 3 and Larger:

   a. Aboveground: Flanged-joint ductile iron pipe with flanged joint fittings or Grooved-joint ductile iron pipe with grooved joint fittings.
   b. Belowground or within slabs: Push-on-joint or mechanical joint ductile iron pipe and mechanical joint fittings. Use the fewest possible joints belowground and within floor slabs.

E. Dewatered Sludge Piping: Includes dewatered sludge piping connected to the discharge fitting of the Sludge Cake Feed Pump. 250 psi operating pressure.

1. NPS 2 and Smaller:

   a. Aboveground: Schedule 40 galvanized steel, pressure fittings, threaded joints.

2 NPS 2-1/2 and Larger:

   a. Aboveground: Schedule 10 Stainless-Steel Pipe, grooved joint, grooved joint fittings.

F. Process Air Piping: Includes low-pressure air piping for aeration tanks and grit chamber air piping. 10 psi operating pressure; 25 psi test pressure:

1. NPS 2 and Smaller:

a. Aboveground: Schedule 40 galvanized steel, pressure fittings, threaded joints.

3 NPS 2-1/2 through 4:

a. Schedule 10 Stainless-Steel Pipe, grooved joint, grooved joint fittings.

4 NPS 5 and Larger:

a. Schedule 10 Stainless-Steel Pipe, grooved joint, grooved joint fittings.

G. Pump Seal Water Piping: Includes seal water supply piping for secondary sludge pumps and make-up water pump. 100 psi operating pressure; 150 psi test pressure:

1. NPS 2 and Smaller:

a. Aboveground: Hard Copper Tube, Copper Pressure Fittings.

H. Plant effluent (Non-potable) process water Piping: Includes all non-potable water or effluent water for process water in the plant. 100 psi operating pressure; 150 psi test pressure:

1. NPS ½ - 2 ½:

a. Aboveground: Hard Copper Tube, Copper Pressure Fittings.
b. Belowground or within slabs: Polyethylene HDPE pipe or Soft Copper Tube, Brazed Copper Pressure Fittings or compression fittings.

2. NPS 3 and NPS 4:

a. Aboveground: Hard Copper Tube, Copper Pressure Fittings.
b. Belowground or within slabs: Push-on-joint or mechanical joint ductile iron pipe and mechanical joint fittings. Use the fewest possible joints belowground and within floor slabs.

3. NPS 6 and Larger:

a. Aboveground: Flanged-joint ductile iron pipe with flanged joint fittings or Grooved-joint ductile iron pipe with grooved joint fittings.
b. Belowground or within slabs: Push-on-joint or mechanical joint ductile iron pipe and mechanical joint fittings. Use the fewest possible joints belowground and within floor slabs.

I. Pumped filtrate drain and polymer piping: 100 psi operating pressure; 150 psi test pressure:

1. NPS ½ - 4:

a. Aboveground: CPVC pipe and pressure fittings.

J. Filtrate drain piping, gravity flow: 0 psi operating pressure; 5 psi test pressure:

1. NPS ½ - 4:

a. Aboveground: CPVC pipe and pressure fittings.

3.3 GENERAL PIPING INSTALLATION

A. Refer to Division 15 Section “Basic Mechanical Materials and Methods” for basic piping installation.

B. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of process piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer’s written instructions.

C. Install buried gravity-flow, nonpressure, piping according to the following:

1. Install piping pitched down in direction of flow, at slope indicated.
2. Install piping with 48-inch minimum cover.
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install RCP sewer pipe according to ASTM C 1479.

D. Install buried force-main, pressure piping according to the following:

1. Install piping with restrained joints at fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 48-inch minimum cover.
3. Install ductile-iron pressure piping according to AWWA C600.

E. Clear interior of buried piping of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

F. Install air and drain piping with 1 percent slope downward in direction of airflow.

G. Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

H. Install flexible pipe connectors at equipment connections.

I. Install thermometer and pressure gage on process air discharge piping from each air blower; install according to Division 15 Section “Meters and Gages.”

3.4 JOINT CONSTRUCTION

A. Flanged Joints: ASME B16.1, Class 125.

B. Mechanical Joints: AWWA C111, with restraining gland.

C. Push-On Joints: AWWA C111, restraining type gaskets.

D. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer’s written instructions.

E. Pipe Threads: ASME B1.20.1 for threaded pipe and pipe fittings.

F. Fusion Weld Joints: As per pipe manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect process piping to equipment. Use transition fitting to join dissimilar piping materials.

3.6 PIPING HANGERS AND SUPPORTS

A. Refer to Division 15 Section "Hangers and Supports for Piping and Equipment" for piping support inside buildings, tunnels and vaults.

3.7 PAINTING

A. Pant in accordance with Division 9 Section "Painting"

3.8 FIELD QUALITY CONTROL

A. Pressure test process piping as follows:
   1. Fill piping with working fluid. Check components to determine that they are not air bound and that piping is full of water. Provide taps, temporary valves and caps as required for testing.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water and/or air pressure indicated, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for two hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of piping systems. Remove dirt and debris as work progresses.

END OF SECTION 15140

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fiberglass strut systems.
5. Thermal-hanger shield inserts.
6. Fastener systems.
7. Pipe stands.
8. Pipe positioning systems.
9. Equipment supports.

B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Fiberglass strut systems. Include Product Data for components.
4. Pipe stands. Include Product Data for components.
5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Available Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.

4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Champion Fiberglass, Inc.
3. Cope, T. J., Inc.; Tyco International Ltd.
4. Seasafe, Inc.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Available Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Available Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

2.8 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

1. Provide welded plate to obtain required anchor strength; Basis of design Anvil, concrete clevis plate.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

1. Maximum Support Spacing and Minimum Rod Size:

a. Ductile Iron Pipe

Pipe Size	Max. Support/Hanger Spacing	Min. Rod Size for Single Rod Hangers
3-inch	12-feet	1/2-inch
4-inch	12-feet	5/8-inch
5-inch	12-feet	5/8-inch
6-inch	12-feet	3/4-inch
8-inch	12-feet	7/8-inch
10-inch	12-feet	7/8-inch
12-inch	12-feet	7/8-inch
14-inch	12-feet	1-inch
16-inch	12-feet	1-inch
18-inch	12-feet	1-inch
20-inch	12-feet	1 1/4-inch
24-inch	12-feet	1 1/4-inch

b. Copper Piping:

Pipe Size	Max. Support/Hanger Spacing	Min. Rod Size for Single Rod Hangers
3/4 -inch and smaller	5-feet	3/8-inch
1-inch	6-feet	3/8-inch
1-1/4 -inch	7-feet	3/8-inch
1-1/2 -inch	8-feet	3/8-inch
2-inch	8-feet	3/8-inch
2-1/2 -inch	9-feet	1/2-inch
3-inch	10-feet	1/2-inch
4-inch	12-feet	1/2-inch

c. Steel/Stainless Steel Piping:

Pipe Size	Max. Support/Hanger Spacing	Min. Rod Size for Single Rod Hangers
1-1/4 –inch and smaller	7-feet	3/8-inch
1-1/2 -inch	9-feet	3/8-inch
2-inch	10-feet	3/8-inch
2-1/2 -inch	11-feet	1/2-inch
3-inch	12-feet	1/2-inch
4-inch	14-feet	5/8-inch
6-inch	16-feet	3/4-inch
8-inch	16-feet	7/8-inch
10-inch	16-feet	7/8-inch
12-inch	16-feet	7/8-inch
14-inch	16-feet	1-inch
16-inch	16-feet	1-inch

d. Plastic Piping:

Pipe Size	Max. Support/Hanger Spacing	Min. Rod Size for Single Rod Hangers
1-1/4 –inch and smaller	4-feet	3/8-inch
1-1/2 -inch	5-feet	3/8-inch
2-inch	6-feet	3/8-inch
2-1/2 -inch	6-feet	1/2-inch
3-inch	6-feet	1/2-inch
4-inch	6-feet	5/8-inch
6-inch	7-feet	3/4-inch
8-inch	8-feet	7/8-inch
10-inch	8-feet	7/8-inch
12-inch	9-feet	7/8-inch
14-inch	10-feet	1-inch
16-inch	10-feet	1-inch

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation, where shown on drawings.

I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

P. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Equipment signs.
4. Access panel and door markers.
5. Pipe markers.
6. Duct markers.
7. Stencils.
8. Valve tags.
9. Valve schedules.
10. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data:

a. Name and plan number.
b. Equipment service.
c. Design capacity.
d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.
2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
3. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.

4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.

1. Stencil Material: Aluminum.
2. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Engineer. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Pumps, compressors, chillers, condensers, and similar motor-driven units.
2. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
3. Fans, blowers, primary balancing dampers, and mixing boxes.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Fire department hose valves and hose stations.
    c. Meters, gages, thermometers, and similar units.
    d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
    e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    g. Fans, blowers, primary balancing dampers, and mixing boxes.
    h. Tanks and pressure vessels.
    i. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Include signs for the following general categories of equipment:

    a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
    b. Pumps, compressors, chillers, condensers, and similar motor-driven units.
    c. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
    d. Fans, blowers, primary balancing dampers, and mixing boxes.
    e. Tanks and pressure vessels.
    f. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

D. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided on Aeration Piping instead of manufactured pipe markers. Install stenciled pipe markers complying with ASME A13.1 on piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 15075

SECTION 15110 – PROCESS VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Ferrous-alloy butterfly valves.
3. Bronze check valves.
4. Gray-iron swing check valves.
5. Cast-iron gate valves.
6. Knife gate valves.
7. Pinch Valves.
8. Eccentric Plug Valves.
9. Surge Relief Valves.
10. Solenoid valves.
11. Automatic Actuators.
12. Valve Stem Guides.

B. Related Sections include the following:

1. Division 15 Section "Mechanical Identification" for valve tags and charts.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include

rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot- and cold-water, sanitary waste, and storm drainage piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive: For quarter-turn valves NPS 8 and larger, with handwheel for aboveground applications; AWWA C504 with operating nut for buried applications.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.
6. Automatic Actuators: As indicated and specified.

G. Provide with valve box.

H. Extended Valve Stems: On insulated valves and where shown.

I. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

J. Valve Grooved Ends: AWWA C606.

K. Threaded: With threads according to ASME B1.20.1.

L. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

A. Available Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. DynaQuip Controls.
f. Flow-Tek, Inc.
g. Grinnell Corporation.

h. Hammond Valve.
i. Honeywell Braukmann.
j. Jamesbury, Inc.
k. Jomar International, LTD.
l. Kitz Corporation of America.
m. Legend Valve & Fitting, Inc.
n. Milwaukee Valve Company.
o. Nexus Valve Specialties.
p. NIBCO INC.
q. R & M Energy Systems (Borger, TX).
r. Red-White Valve Corp.
s. Richards Industries; Marwin Ball Valves.
t. Watts Industries, Inc.; Water Products Div.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.4 FERROUS-ALLOY BUTTERFLY VALVES

A. Available Manufacturers:

1. Ferrous-Alloy Butterfly Valves:

a. American Valve, Inc.
b. Bray International, Inc.
c. Cooper Cameron Corp.; Cooper Cameron Valves Div.
d. Crane Co.; Crane Valve Group; Center Line.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Div.
g. Dover Corp.; Dover Resources Company; Norriseal Div.
h. General Signal; DeZurik Unit.
i. Grinnell Corporation.
j. Hammond Valve.
k. Kitz Corporation of America.
l. Legend Valve & Fitting, Inc.
m. Metraflex Co.
n. Milwaukee Valve Company.
o. Mueller Steam Specialty.
p. NIBCO INC.
q. Process Development & Control.
r. Red-White Valve Corp.
s. Techno Corp.
t. Tyco International, Ltd.; Tyco Valves & Controls, Keystone.
u. Watts Industries, Inc.; Water Products Div.

B. Type 1: 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Basis of Design: Tyco, Keystone Figure 602 butterfly valve.
2. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: NBR.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Nickel-plated ductile iron.

C. Type 2: 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Basis of Design: Tyco, Keystone K-Lok Figure 312 high performance butterfly valve.
2. Description:

    a. Standard: MSS SP-68, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 351-CF8M, stainless steel.
    e. Seat: EPDM.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Stainless steel.

D. Type 3: Flanged, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Flanged-end type with one- or two-piece stem.

1. Basis of Design: Pratt, Model 2FII Flanged Butterfly Valve.
2. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 150 psig.
    c. Body Design: Flanged; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: NBR.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Ductile-iron.

E. Type 4: Mechanical Joint Butterfly Valves: AWWA C504, Class 150B, short body, gray- or ductile-iron body; with bronze or gray- or ductile-iron disc, rubber seats, 304 stainless steel shaft.

1. Basis of Design: Pratt, MODEL 2MII Mechanical Joint End Butterfly Valve.
2. Description:

    a. Minimum Working Pressure: 150 psig.
    b. End Connections: AWWA C111 Mechanical joint.

c. Interior Coating: Complying with AWWA C550.
d. Provide buried service operator

2.5 BRONZE CHECK VALVES

A. Available Manufacturers:

1. Bronze, Swing Check Valves with Metal Disc:

a. American Valve, Inc.
b. Cincinnati Valve Co.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Div.
f. Grinnell Corporation.
g. Hammond Valve.
h. Kitz Corporation of America.
i. Legend Valve & Fitting, Inc.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Powell, Wm. Co.
m. Red-White Valve Corp.
n. Walworth Co.
o. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

C. Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

2.6 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

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

a. NIBCO INC.
b. GA Industries.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

h. Closure Control: Factory-installed, exterior lever and adjustable spring.
i. Closure Position Switch: Factory or field installed closure position indicating switch, rated for 10-amps/120-volts.

2.7 CAST-IRON GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. Available Manufacturers:

a. American AVK Co.; Valves & Fittings Div.
b. American Cast Iron Pipe Co.; American Flow Control Div.
c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. East Jordan Iron Works, Inc.
f. Grinnell Corporation; Mueller Co.; Water Products Div.
g. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
h. McWane, Inc.; Kennedy Valve Div.
i. McWane, Inc.; Tyler Pipe; Utilities Div.
j. United States Pipe and Foundry Company.

2. Type 1, Mechanical Joint, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, nonrising-stem, resilient seats, bronze stem, and stem nut.

a. Minimum Working Pressure: 200 psig.
b. End Connections: AWWA C111 Mechanical joint.
c. Interior Coating: Complying with AWWA C550.

3. Type 2, Flanged Joint, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, nonrising-stem, resilient seats, bronze stem, and stem nut.

a. Minimum Working Pressure: 200 psig.
b. End Connections: ANSI B16.1 Class 125 Flanged joint.
c. Interior Coating: Complying with AWWA C550.

2.8 KNIFE GATE VALVES

A. Available Manufacturers:

a. Red Valve Company, Inc.
b. Hilton Valve, Incorporated
c. Fabri-Valve, ITT Industries.

B. Bronze, Rising-Stem, Solid-Wedge Gate Valves:

1. Basis of Design: Basis of Design: ITT Industries, Fabri-Valve, Figure CF 134 Knife Gate Valves.
2. Description:

    a. Knife Gate Valves, General: MSS SP-81, with ferrous-alloy hand wheel.
    b. Class 150, Knife Gate Valves: The knife gate valve shall be bonneted, wafer type made with a cast iron or stainless steel body. Cast iron body valves shall have a fabricated stainless steel liner.
    c. Standard flange holes shall be drilled and tapped. Flange dimensions shall meet MSS SP-81 and ANSI B16.5 Class 125/150 requirements.
    d. The valve has a raised face flanges and meets MSS SP-81 face-to-face dimensions. Valve shall have all wetted parts made of 304 or 316 stainless steel. Stainless steel liner shall extend through the valve chest to the top of the packing gland. Both sides of the gate shall be finish ground. The stem shall be stainless steel and have double lead threads. The yoke nut shall be acid-resistant bronze. The valve shall have a raised seat with a relieved area around the seat to prevent jamming.
    e. The valve gate shall be suitable for 150-psi pressure differential. The packing gland shall have three (3) layers of fiber packing with a 4th elastomer seal. The valve shall be metal seated with a round port.

2.9 PINCH VALVES

A. Available Manufacturers:

    a. Red Valve Company, Inc.

B. Iron Body, Non-Metalic Sleeve Flanged Pinch Valves:

1. Basis of Design: Basis of Design: Red Valve, Series 5200E Pinch Valves.
2. Description:

    a. CWP Rating: 150 psig.
    b. Body Design: Flanged ASTM Class 150 type.
    c. Body Material: Ductile-Iron.
    d. Sleeve: EPDM, Cone Sleeve.
    e. Stem: One- or two-piece stainless steel.

2.10 ECCENTRIC PLUG VALVES

A. Available Manufacturers:

1. General Signal; DeZurik Unit.
2. Milliken Valve Company.
3. Olson Technologies; Homestead Div.
4. Pratt, Henry Company.
5. Val-Matic Valve & Mfg. Corp.

B. Resilient-Seated, Eccentric Plug Valves, NPS 3 and Larger: ASTM A126 Class B cast iron body, MSS SP-108, and rated for 175-psig minimum CWP, ANSI B16.1 Class 125 Flanged joint.
   1. Resilient Seating Material: Suitable for wastewater service, unless otherwise indicated.
   2. Interior coating according to AWWA C550.

2.11 SURGE RELIEF VALVE

A. Basis-of-Design Product: Subject to compliance with requirements, provide Singer model 106-RPS-L&H Surge Anticipating Relief Valve.

   1. Body: ASTM A 536 - 65/45/12 Ductile Iron
   2. Disc: B16 Brass / B62 Bronze / A48 or A536 Ductile Iron.
   3. Seat Ring: AISI 316 Stainless Steel.
   4. Diaphragm: EPDM.
   5. Wetted, Internal Work Parts: Brass and rubber.
   6. Valve Seat and Stem: Noncorrosive.
   7. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.12 SOLENOID VALVES

A. Solenoid Valves, NPS 2” and smaller:

   1. Available Manufacturers and Products:

      a. Asco, Series 8210

   2. Two way internal pilot operated diaphragm type, brass body, 250 psi CWP, resilient seat suitable for air or water. Molded epoxy solenoid coil, NEMA insulation Class F, 120 VAC, 60 Hz. NEMA Type 4 solenoid enclosure. Normal position and size as indicated on the drawings.

2.13 VALVE STEM GUIDES

A. Stem Guides shall be constructed of cast stainless steel, type 316. Stem guides fabricated by welding stainless steel shall not be permitted. Stem guides shall include a bronze bushing with an inside diameter 1/16” larger than the outside diameter of the extension stem and shall be retained with two stainless steel screws.

B. The stem guide shall be of the adjustable design for plumb alignment. The adjusting bolt and washer shall be type 316 stainless. Stem guides shall be spaced so that the unsupported length between extension stem guides shall not exceed 7 feet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

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

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

B. Wastewater Piping: Includes process waste stream piping, plant effluent piping, tank drain piping and sewage piping:

1. Use the following for buried valves underground:

a. NPS 3 through NPS 10: Type 1, AWWA, Cast Iron Gate Valve, Nonrising-Stem, Resilient-Seated Gate Valves, mechanical joint and valve box.
b. NPS 12 and larger: Type 3, AWWA, Cast-Iron Butterfly Valves, mechanical joint with buried manual operator and valve box.

2. Use the following for valves in vaults, tunnels and aboveground:

a. NPS 2 and Smaller: Ball Valves, Two-Piece, Copper-Alloy Ball Valves.
b. NPS 2-1/2 through NPS 8: Type 2, AWWA, Nonrising-Stem, Resilient-Seated Gate Valves, flange joint.
c. NPS 10 and Larger: Type 1, Ferrous Alloy Butterfly Valves, flange joint with manual gear drive exposed actuator.

C. Wastewater Piping: Includes Headworks influent piping and Headworks grit pump discharge piping:

1. Use the following for valves in vaults, tunnels and aboveground:
   a. NPS 3 and Larger: Resilient-Seated Eccentric Plug Valves, flange joint.

   b. NPS 2-1/2 through NPS 8:
      1) Iron Swing Check Valves, Class 125, gray iron, without position switch.

D. Sludge Piping: Includes supernatant piping, return activated sludge piping, waste sludge piping and thickened sludge piping. 100 psi operating pressure; 150 psi test pressure:

1. Use the following for buried valves underground:

   a. NPS 3 through NPS 10: Type 1, AWWA, Cast Iron Gate Valve, Nonrising-Stem, Resilient-Seated Gate Valves, mechanical joint and valve box.
   b. NPS 12 and larger: Type 3, AWWA, Cast-Iron Butterfly Valves, mechanical joint with buried manual operator and valve box.

2. Use the following for valves in vaults, tunnels and aboveground:

   a. NPS 2 and Smaller: Ball Valves, Two-Piece, Copper-Alloy Ball Valves.
   b. NPS 2-1/2 and Larger:

      1) Knife Gate Valves, flange joint.
      2) Iron Swing Check Valves, Type 1, Class 125, cast iron with position switch.

E. Low-Pressure, Process Air Aeration Piping: Use the following types of valves:

1. Use the following for valves in vaults, tunnels and aboveground:

   a. NPS 2 and Smaller: Ball Valves, Two-Piece, Copper-Alloy Ball Valves.
   b. NPS 2-1/2 through NPS 6, Manual Operation: Type 1, Ferrous Alloy Butterfly Valves, flange joint with lever handle actuator.
   c. NPS 8 and Larger, Manual Operation: Type 1, Ferrous Alloy Single Flange Butterfly Valves, flange joint with manual gear drive exposed actuator.
   d. Automatic Operation (CV-3-1, CV-3-2, CV-3-3, CV-3-4, CV-3-5, CV-3-6, CV-3-7): Type 2, Ferrous Alloy Flanged Butterfly Valves, flange joint with electric automatic actuator.

F. Non-potable Process Water and Seal Water Piping: Includes all non-potable water or effluent water for process water in the plant. 100 psi operating pressure; 150 psi test pressure:

1. Use the following for buried valves underground:

   a. NPS 3 through NPS 10: Type 1, AWWA, Cast Iron Gate Valve, Nonrising-Stem, Resilient-Seated Gate Valves, mechanical joint and valve box.
   b. NPS 12 and larger: Type 3, AWWA, Cast-Iron Butterfly Valves, mechanical joint with buried manual operator and valve box.

2. Use the following for valves in vaults, tunnels, tanks and aboveground:

a. NPS 2 and Smaller:

1) Ball Valves, Two-Piece, Copper-Alloy Ball Valves.
2) Swing Check Valves, Class 150, bronze.

b. NPS 2-1/2 through NPS 8:

1) Gate Valves, Type 2, AWWA, Nonrising-Stem, Resilient-Seated Gate Valves, flange joint.
2) Swing Check Valves, Class 125, gray iron.

c. NPS 10 and Larger:

1) Butterfly Valves, Type 1, Ferrous Alloy Butterfly Valves, flange joint with manual gear drive exposed actuator.
2) Swing Check Valves, Class 125, gray iron.

3. Use the following for centrifuge and conveyor flush water control valves, CV-6-1,2,3,4:

a. NPS 2 and Smaller:

1) Solenoid Valves.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

G. Install valve stem guides where indicated and such that the unsupported length between extension stem guides shall not exceed 7 feet.

3.4 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15110

SECTION 15122 - METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following meters and gages for mechanical systems:

1. Thermometers.
2. Pressure Gages.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Available Manufacturers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum or brass, 9 inches long.

C. Tube: Red or blue reading, mercury or organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Plastic.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 THERMOWELLS

A. Available Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Miljoco Corp.
6. NANMAC Corporation.
7. Noshok, Inc.
8. Palmer - Wahl Instruments Inc.
9. REO TEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

A. Available Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade B, plus or minus 2 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball valve or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each aeration blower.

B. Provide the following temperature ranges for thermometers:

1. Aeration Process Air: 30 to 240 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each aeration blower.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

D. Install remote-mounting pressure gages on panel.

3.4 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.5 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 15122

SECTION 15140 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes domestic water piping inside the building.

B. Water meters will be furnished and installed by utility company as required.

C. Related Sections include the following:

1. Division 2 Section "Project Water Mains" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Water Samples: Specified in Part 3 "Cleaning" Article.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

    a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

2.4 STAINLESS-STEEL PIPE AND FITTINGS

A. Stainless-Steel Pipe and Fittings: Schedule 10, ASTM A 312/A 312M, Grade TP304L or TP316L, welded seam, and grooved joint fittings unless otherwise indicated.

1. Steel-Piping, Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron casting; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

b. Grooved-End-Pipe Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 COPPER-ALLOY BALL VALVES

A. Available Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:

a. Conbraco Industries, Inc.; Apollo Div.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. DynaQuip Controls.
f. Flow-Tek, Inc.
g. Grinnell Corporation.
h. Hammond Valve.
i. Honeywell Braukmann.
j. Jamesbury, Inc.
k. Jomar International, LTD.
l. Kitz Corporation of America.
m. Legend Valve & Fitting, Inc.
n. Milwaukee Valve Company.
o. Nexus Valve Specialties.
p. NIBCO INC.
q. R & M Energy Systems (Borger, TX).
r. Red-White Valve Corp.
s. Richards Industries; Marwin Ball Valves.
t. Watts Industries, Inc.; Water Products Div.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

2.6 FERROUS-ALLOY BUTTERFLY VALVES

A. Available Manufacturers:

1. Ferrous-Alloy Butterfly Valves:

a. American Valve, Inc.
b. Bray International, Inc.
c. Cooper Cameron Corp.; Cooper Cameron Valves Div.
d. Crane Co.; Crane Valve Group; Center Line.
e. Crane Co.; Crane Valve Group; Jenkins Valves.

f. Crane Co.; Crane Valve Group; Stockham Div.
g. Dover Corp.; Dover Resources Company; Norriseal Div.
h. General Signal; DeZurik Unit.
i. Grinnell Corporation.
j. Hammond Valve.
k. Kitz Corporation of America.
l. Legend Valve & Fitting, Inc.
m. Metraflex Co.
n. Milwaukee Valve Company.
o. Mueller Steam Specialty.
p. NIBCO INC.
q. Process Development & Control.
r. Red-White Valve Corp.
s. Techno Corp.
t. Tyco International, Ltd.; Tyco Valves & Controls.
u. Watts Industries, Inc.; Water Products Div.

B. Ferrous-Alloy Butterfly Valves, General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated.

C. Single-Flange, 200-psig CWP Rating, Ferrous-Alloy Butterfly Valves: Wafer-lug type with one- or two-piece stem.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPE AND FITTING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Grooved joints may be used on aboveground grooved-end piping.

D. Under-Building-Slab, Water-Service Piping on Service Side of Water Meter: Refer to Division 2 Section "Project Water Mains."

E. Domestic Water Piping on Service Side of Water Meter inside the Building and Tunnels: Use the following piping materials for each size range:

1. NPS 1/2 to NPS 4: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2 NPS 6 and Larger: Schedule 10 Stainless-Steel Pipe, grooved joint, grooved joint fittings.

3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly for piping NPS 2-1/2 and larger.

B. Cast-iron, grooved-end valves may be used with grooved-end piping.

C. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

D. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

3.4 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 15 Section "Meters and Gages," and drain valves and strainers are specified in Division 15 Section "Plumbing Specialties."

D. Install domestic water piping level and plumb.

3.5 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

C. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 15 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 15 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:

1. Booster Pumps: Cold-water suction and discharge piping.

2. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Fixtures."
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 15140

SECTION 15160 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.

1.3 DEFINITIONS

A. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground storm drainage piping shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.2 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 2 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 15 Section "Plumbing Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."

F. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

G. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

I. Install PVC storm drainage piping according to ASTM D 2665.

J. Install underground PVC storm drainage piping according to ASTM D 2321.

K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 15 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

F. Install supports for vertical PVC piping every 48 inches.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15160

SECTION 15430 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following plumbing specialties:

1. Backflow preventers.
2. Strainers.
3. Key-Operation Hydrants
4. Nondraining nonfreeze post hydrants.
5. Miscellaneous piping specialties.
6. Flashing materials.
7. Floor drains.
8. Roof drains.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. PE: Polyethylene plastic.
3. PUR: Polyurethane plastic.
4. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water and Process Piping: 125 psig.
2. Sanitary Waste and Vent Piping: 10-foot head of water.
3. Storm Drainage Piping: 10-foot head of water.

1.5 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components.

B. Field test reports.

C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1. Backflow preventers and water regulators.
2. Hose stations and hydrants.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

D. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.
2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 BACKFLOW PREVENTERS

A. Available Manufacturers:

B. Manufacturers:

1. Ames Co., Inc.
2. B & K Industries, Inc.
3. Cla-Val Co.
4. CMB Industries, Inc.; Febco Backflow Preventers.
5. Conbraco Industries, Inc.
6. FLOMATIC Corp.
7. IMI Cash Valve.
8. Mueller Co.; Hersey Meters Div.
9. Sparco, Inc.
10. Watts Industries, Inc.; Water Products Div.
11. Zurn Industries, Inc.; Wilkins Div.

C. General: ASSE standard, backflow preventers.

1. NPS 2 and Smaller: Bronze body with threaded ends.
2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.

   a. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.

3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
5. Strainer: On inlet, if indicated.

D. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves.

1. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

E. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

2.3 STRAINERS

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
2. NPS 2 and Smaller: Bronze body, with female threaded ends.
3. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.

a. Drain: Factory- or field-installed, drain ball-valve.

2.4 KEY-OPERATION HYDRANTS

A. Available Manufacturers:

1. Josam Co.
2. Murdock, Inc.
3. Simmons Manufacturing Co.
4. Smith, Jay R. Mfg. Co.
5. Tyler Pipe; Wade Div.
6. Watts Industries, Inc.; Drainage Products Div.
7. Woodford Manufacturing Co.
8. Zurn Industries, Inc.; Jonespec Div.
9. Zurn Industries, Inc.; Specification Drainage Operation.

B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.

1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
2. Outlet: ASME B1.20.7, garden-hose threads.
3. Operating Keys: Two with each key-operation hydrant.

C. Nonfreeze Exposed-Outlet Wall Hydrants: ASSE 1019, self-drainable with integral nonremovable hose-connection backflow preventer, casing and operating rod to match wall thickness, projecting outlet, and wall clamp.

1. Classification: Type A, for automatic draining with hose removed orType B, for automatic draining with hose removed or with hose attached and nozzle closed.
2. Nozzle and Wall Plate Finish: Stainless steel.
3. Box and Cover Finish: Stainless steel.

2.5 NONDRAINING NONFREEZE POST HYDRANTS

A. General: All-metal lever operation with nondraining water-storage reservoir, designed without drain and to be freezeproof with components of at least length required for burial of valve and water storage reservoir below frost line.

B. Vented-Reservoir, Nondraining, Nonfreeze Post Hydrants: With reservoir venturi and vent devices; NPS 3/4 minimum threaded inlet; nonremovable, drainable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose threads complying with ASME B1.20.7 on outlet.

1. Available Manufacturers:

a. Hoeptner Products.
b. Simmons Manufacturing Co.
c. Woodford Manufacturing Co.

2.6 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

B. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with NPS 1/8 side drain outlet and cap.

2.7 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F.

1. Available Manufacturers:

a. Josam Co.
b. Smith, Jay R. Mfg. Co.
c. Tyler Pipe; Wade Div.
d. Zurn Industries, Inc.; Specification Drainage Operation.

B. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 1/2 or NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral or field-installed, nonremovable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.

1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
2. Finish for Service Areas: Rough bronze.
3. Finish for Finished Rooms: Chrome or nickel plated.
4. Operation for Equipment Rooms: Wheel handle or operating key.
5. Operation for Service Areas: Wheel handle.
6. Operation for Finished Rooms: Wheel handle.
7. Include operating key with each operating-key hose bibb.
8. Include integral wall flange with each chrome- or nickel-plated hose bibb.

C. Roof Flashing Assemblies: Manufactured assembly made of 6-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting.

1. Available Manufacturers:

a. Acorn Engineering Company; Elmdor/Stoneman Div.

2. Open-Top Vent Cap: Without cap.

3. Low-Silhouette Vent Cap: With vandal-proof vent cap.
4. Extended Vent Cap: With field-installed, vandal-proof vent cap.

D. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

E. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.

F. Vent Terminals: Commercially manufactured, shop- or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

G. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.

H. Downspout Boots: ASTM A 48, gray-iron casting, with NPS 4 outlet; shop-applied bituminous coating; and inlet size to match downspout.

I. Downspout Boots: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.

2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 FLOOR DRAINS

A. Materials:

1. Body Material: Cast iron.
2. Dimensions of Body: 15” diameter.
3. Outlet: Bottom.
4. Grate Material: Cast iron.

B. Roof Drains: Comply with ASME A112.21.2M.

1. Available Products: Zurn Industries, Inc., Specification Drainage Operation; Z503.

2.10 ROOF DRAINS

A. Materials:

1. Body Material: Cast iron.
2. Dimensions of Body: 15” diameter.
3. Combination Flashing Ring and Gravel Stop: Required.
4. Outlet: Bottom.
5. Dome Material: Cast iron.
6. Extension Collars: Required.
7. Underdeck Clamp: Required.
8. Sump Receiver: Required.

B. Roof Drains: Comply with ASME A112.21.2M.

1. Available Products: Zurn Industries, Inc., Specification Drainage Operation; Z100.

C. Overflow Drains: Comply with ASME A112.21.2M.

1. Available Products:

a. Zurn Industries, Inc., Specification Drainage Operation; Z108.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.

D. Install draining-type ground and ground post hydrants with 1 cu. yd. of crushed gravel around drain hole.

1. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.
2. Provide Warning Tags indicating “Non-Potable Water” at post hydrants.

E. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

F. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install roof-drain flashing collar or flange so no leakage occurs between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

H. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

I. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 15 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.

J. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect plumbing specialties to piping specified in other Division 15 Sections.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer.

1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
2. Refer to Division 15 Section " Mechanical Identification" for nameplates and signs.

3.5 FIELD QUALITY CONTROL

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15430

SECTION 15542 – ELECTRIC RADIANT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electric, infrared radiant heaters.

1.3 SUBMITTALS

A. Product Data: For each type of radiant heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For radiant heaters to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of radiant heater that fails in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 ELECTRIC INFRARED HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings.

B. Emitter: Ceramic surface.

C. Reflector: Polished aluminum.

D. Accessories:

1. Parabolic reflector.
2. Wire grid for increased efficiency.
3. Protective screen.
4. Heat-deflector shield.
5. Stainless-steel flexible connector with manual valve.
6. Hanger chain with "S" hooks.
7. Preassembled chain suspension kit.

2.2 CONTROLS

A. Thermostat: Single-stage, wall-mounting type with 50 to 90 deg F operating range and fan on switch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Suspended Units: Suspend from substrate using chain hanger kits and building attachments.

B. Maintain manufacturers' recommended clearances to combustibles.

3.2 CONNECTIONS

A. Electrical Connections: Comply with applicable requirements in Division 16 Sections.

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

END OF SECTION 15542

SECTION 15767 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes propeller unit heaters.

1.3 SUBMITTALS

A. Product Data: Include specialties and accessories for each unit type and configuration.

B. Shop Drawings: Submit the following for each unit type and configuration:

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
4. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section.

D. Maintenance Data: For propeller unit heaters to include in maintenance manuals specified in Division 1. Include the following:

1. Maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate layout and installation of propeller unit heaters and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with horizontal, adjustable louvers in blow-through configuration.

B. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings.

C. Description: An assembly including casing, coil, fan, and motor in vertical discharge configuration with adjustable discharge louvers.

D. Comply with UL 2021.

E. Comply with UL 823.

F. Cabinet: Removable panels for maintenance access to controls.

G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

I. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

   1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
   2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

K. Control Devices:

   1. Wall-mounting thermostat.

2.2 MATERIALS

A. Casing: Galvanized steel, with removable panels.

B. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer and manufacturer's standard paint applied to factory-assembled and -tested propeller unit heater before shipping.

2.3 ELECTRIC-RESISTANCE HEATING ELEMENTS

A. Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium-oxide insulating refractory and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for overtemperature protection of heaters.
2. Wiring Terminations: Match conductor materials and sizes indicated.

2.4 FAN

A. Propeller with aluminum blades directly connected to motor.

2.5 FAN MOTORS

A. Multispeed motor with integral thermal-overload protection.

2.6 ACCESSORIES

A. Horizontal Configuration: Louver fin diffuser.

B. Wall or ceiling mounting brackets.

2.7 CONTROLS

A. Control Devices: Unit-mounted fan-speed switch and thermostat.

2.8 SOURCE QUALITY CONTROL

A. Test propeller unit heater coils according to ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with rubber-in-shear vibration isolators (rubber hangers). Vibration isolators are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

3.3 CONNECTIONS

A. Ground equipment.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safeties.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. After installing units, clean propeller unit heaters internally according to manufacturer's written instructions.

C. Install new filters in each propeller unit heater within two weeks after Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

END OF SECTION 15767

SECTION 15838 - POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Wall Mounted Propeller Fan
2. Centrifugal roof/wall exhaust fan.
3. Centrifugal roof supply fan.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on sea-level conditions.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Show roof penetration requirements and reflected ceiling plans drawn to scale and coordinating roof penetrations and units mounted above ceiling.

D. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
9. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**insert value**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

E. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.

2.2 CENTRIFUGAL ROOF EXHAUST FANS

A. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

   a. Configuration: Built-in raised cant and mounting flange.
   b. Overall Height: 8 inches.
   c. Metal Liner: Galvanized steel.

2.3 CENTRIFUGAL ROOF SUPPLY FANS

A. Description: Belt-driven or centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

C. Housing: Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

D. Filters: 1” thick removable filters.

E. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

F. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

G. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

a. Configuration: Built-in raised cant and mounting flange.
b. Overall Height: 8 inches.
c. Metal Liner: Galvanized steel.

2.4 MOTORS

A. Enclosure Type: Guarded dripproof.

2.5 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power fans level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Install ducts adjacent to power ventilators to allow service and maintenance.

B. Ground equipment.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Verify lubrication for bearings and other moving parts.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
7. Disable automatic temperature-control operators.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Shut unit down and reconnect automatic temperature-control operators.

F. Replace fan and motor pulleys as required to achieve design airflow.

G. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

END OF SECTION 15838

SECTION 16051

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance requirements for overcurrent protective devices.

B. Short circuit study.

C. Coordination study and analysis.

1.02 RELATED REQUIREMENTS

A. Section 16411 - Enclosed Circuit Breakers.

B. Section 16442 - Switchboards: Overcurrent protective devices in switchboards.

C. Section 16443 - Panelboards: Overcurrent protective devices in panelboards.

D. Section 16491 - Fuses.

1.03 REFERENCE STANDARDS

A. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001.

B. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Study Preparer's Qualifications.

C. Study Report: Submit protective device studies as specified, prior to submission of product data submittals or ordering or fabrication of protective devices.
   1. Evaluation of product data submittals by Engineer will not commence until acceptable studies have been submitted.

D. Product Data: In addition to submittals specified elsewhere, submit manufacturer's time-current curves for all protective devices.

E. Field Engineer Qualifications.

F. Field Inspection Report: Show final adjusted settings of protective devices.

G. Certificates: Prior to final inspection, certify that field adjustable protective devices have been set in accordance with requirements of protective device analysis.

H. Project Record Documents: Revise protective device study as required to show as-built conditions.
   1. Submit not less than 60 days prior to final inspection of electrical system.
   2. Include hard copies in operation and maintenance data submittals.
   3. Include all files prepared using software packages, on CD-ROM, with file name cross-references to specific pieces of equipment and systems.

1.05 PROTECTIVE DEVICE STUDY

A. Analyze the specific electrical and utilization equipment (according to NEC definition), the actual protective devices to be used, and the actual feeder lengths to be installed.
   1. Scope of Studies: All new and existing distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
   2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
   3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.

4. Report: State the methodology and rationale employed in making each type of calculation; identify computer software package(s) used.

B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with all electrical equipment and wiring to be protected by the protective devices; identify nodes on the diagrams for reference on report that includes:
   1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the main switchboard bus and all downstream devices containing protective devices.
   2. Breaker and fuse ratings.
   3. Generator kW and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   4. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   5. Identification of each bus, with voltage.
   6. Conduit materials, feeder sizes, actual lengths, and X/R ratios.

C. Short Circuit Study: Calculate the fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
   1. Show fault currents available at key points in the system down to a fault current of 7,000 A at 480 V and 208 V.
   2. Include motor contributions in determining the momentary and interrupting ratings of the protective devices.
   3. Primary Fault Level Assumptions: Obtain data from utility company.
   4. Report: Include all pertinent data used in calculations and for each device include:
      a. Device identification.
      b. Protective device.
      c. Device rating.
      d. Calculated short circuit current, asymmetrical and symmetrical, and ground fault current.

D. Coordination Study: Perform an organized time-current analysis of each protective device in series from the individual device back to the primary source, under normal conditions, alternate operations, and emergency power conditions.
   1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
   2. Plot the specific time-current characteristics of each protective device on log-log paper.
   3. Organize plots so that all upstream devices are clearly depicted on one sheet.
   4. Also show the following on curve plot sheets:
      a. Device identification.
      b. Voltage and current transformer ratios for curves.
      c. 3-phase and 1-phase ANSI damage curves for each transformer.
      d. No-damage, melting, and clearing curves for fuses.
      e. Cable damage curves.
      f. Transformer inrush points.
      g. Maximum short circuit cutoff point.
      h. Simple one-line diagram for the portion of the system that each curve plot illustrates.
      i. Software report for each curve plot, labeled for identification.

E. Analysis: Determine ratings and settings of protective devices to minimize damage caused by a fault and so that the protective device closest to the fault will open first.
   1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
   2. Identify any equipment that is underrated as specified.
   3. Identify existing protective devices that will not achieve required coordination and cannot be field adjusted to do so.

4. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve a change to the contract sum.
5. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.

F. Protective Device Rating and Setting Chart: Summarize in tabular format the required characteristics for each protective device based on the analysis; include:
1. Device identification.
2. Relay CT ratios, tap, time dial, and instantaneous pickup.
3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4. Fuse rating and type.
5. Ground fault pickup and time delay.
6. Input level and expected response time at two test points that are compatible with commonly available test equipment and the ratings of the protective device.
7. Highlight all devices that as furnished by Contractor will not achieve required protection.

1.06 QUALITY ASSURANCE

A. Study Preparer Qualifications: Qualified engineer of switchgear manufacturer or approved professional engineer.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

C. Contractor Responsibility: Provide all project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, and actual circuit lengths.

PART 2 PRODUCTS

2.01 PROTECTIVE DEVICES

A. Provide protective devices of ratings and settings as required so that the protective device closest to the fault will open first.

B. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of this analysis.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the installed protective devices to conform to requirements determined by the coordination analysis.

B. Adjust installed protective devices having adjustable settings to conform to requirements determined by the coordination analysis.

C. Submit report showing final adjusted settings of all protective devices.

END OF SECTION 16051

SECTION 16060
GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D. Ground bars.

E. Ground rod electrodes.

1.02 RELATED REQUIREMENTS

A. Section 16123 - Building Wire and Cable: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 16075 - Electrical Identification: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; National Electrical Manufacturers Association; 2007.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

E. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
   2. Metal Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet (3.0 m) at an accessible location not more than 5 feet (1.5 m) from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal Building or Structure Frame:
      a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
   4. Ground Rod Electrode(s):
      a. Provide two electrodes unless otherwise indicated or required.
      b. Space electrodes not less than 10 feet (3.0 m) from each other and any other ground electrode.
      c. Where location is not indicated, locate electrode(s) at least 5 feet (1.5 m) outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
   5. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

F. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.

6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 16123:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Manufacturers - Exothermic Welded Connections:
      a. Burndy: www.burndy.com.
      b. Cadweld, a brand of Erico International Corporation: www.erico.com.
      c. ThermOweld, a brand of Continental Industries, Inc: www.thermoweld.com.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   2. Material: Copper-bonded (copper-clad) steel.
   3. Size: 3/4 inch (19 mm) diameter by 10 feet (3.0 m) length, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that field measurements are as shown on the drawings.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
   1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches (150 mm) below finished grade.

D. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.

2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.

E. Identify grounding and bonding system components in accordance with Section 16075.

END OF SECTION 16060

SECTION 16070
HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 16131 - Conduit: Additional support and attachment requirements for conduits.

C. Section 16138 - Boxes: Additional support and attachment requirements for boxes.

D. Section 16510 - Interior Luminaires: Additional support and attachment requirements for interior luminaires.

E. Section 16520 - Exterior Luminaires: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.

D. MFMA-4 - Metal Framing Standards Publication; Metal Framing Manufacturers Association; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03300.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems and post-installed concrete and masonry anchors.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   5. Do not use wood for permanent supports unless specifically indicated or permitted.
   6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel unless otherwise indicated.
      c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
   2. Channel Material:
      a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use Stainless Steel.
   3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch (2.66 mm).
   4. Minimum Channel Dimensions: 1-5/8 inch (41 mm) width by 13/16 inch (21 mm) height.
   5. Manufacturers:
      a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com.
      b. Thomas & Betts Corporation: www.tnb.com.
      c. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
      d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch (13 mm) diameter.
      b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch (6 mm) diameter.

c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch (10 mm) diameter.
d. Trapeze Support for Multiple Conduits: 3/8 inch (10 mm) diameter.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Hammer-driven anchors and fasteners are not permitted.
12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
a. Comply with MFMA-4.
b. Channel Material: Use galvanized steel.
c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive support and attachment components.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 16070

SECTION 16075
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

E. Underground warning tape.

F. Floor marking tape.

1.02 RELATED REQUIREMENTS

A. Section 09900 - Paints and Coatings.

B. Section 16123 - Building Wire and Cable: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

C. Section 16140 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Switchboards:
         1) Identify voltage and phase.
         2) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
      b. Motor Control Centers:
         1) Identify voltage and phase.
         2) Identify power source and circuit number.

3) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

c. Panelboards:
1) Identify voltage and phase.
2) Use identification nameplate to identify power source and circuit number.
3) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
4) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

d. Transformers:
1) Identify power source and circuit number. Include location.
2) Identify load(s) served. Include location.

e. Enclosed switches, circuit breakers, and motor controllers:
1) Identify power source and circuit number.
2) Identify load(s) served.

f. Enclosed Contactors:
1) Identify load(s) and associated circuits controlled.

g. Transfer Switches:
1) Identify voltage and phase.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.

3. Use voltage marker to identify highest voltage present for each piece of electrical equipment in the preceding section

4. Use identification label or identification nameplate on inside of door at each fused switch to identify required NEMA fuse class and size.

5. Use identification label or identification nameplate on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.

6. Use field-painted floor markings or floor marking tape to identify required equipment working clearances for all equipment in Part A above.
a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches (76 mm) wide, painted in accordance with Section 09900.

7. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
a. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements".

C. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 16123.
2. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
a. At each source and load connection.
b. Within boxes.
c. Within equipment enclosures when conductors and cables enter or leave the enclosure.

D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.

E. Identification for Devices:
1. Wiring Device and Wallplate Finishes: Comply with Section 16140.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
   2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/8 inch (3 mm); engraved text.
   3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
   4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
   5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
      a. Use only for indoor locations.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
   2. Legend:
      a. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. Equipment Designation: 1/2 inch (13 mm).
      b. Other Information: 1/4 inch (6 mm).
   5. Color: White text on a black background.

D. Format for Receptacle Identification:
   1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
   2. Legend: Power source and circuit number or other designation indicated.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 3/16 inch (5 mm).
   5. Color: Black text on white background.

E. Format for Control Device Identification:
   1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
   2. Legend: Load controlled or other designation indicated.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 3/16 inch (5 mm).
   5. Color: Black text on white background.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, or plastic sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch (3 mm).

F. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

B. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   3. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).

C. Legend:
   1. Markers for Voltage Identification: Highest voltage present.

D. Color: Black text on orange background unless otherwise indicated.

2.05 UNDERGROUND WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:
   1. Tape for Buried Power Lines: Black text on yellow background.
   2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.06 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches (76 mm) wide, with alternating black and white stripes.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Enclosure front.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Boxes: Outside face of cover.
   8. Conductors and Cables: Legible from the point of access.
   9. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches (75 mm) below finished grade.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 16075

SECTION 16095
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

PART 3 EXECUTION

2.01 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

B. Demolition drawings are based on casual field observation .

C. Report discrepancies to Owner before disturbing existing installation.

D. Beginning of demolition means installer accepts existing conditions.

2.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.
2. Make temporary connections to maintain service in areas adjacent to work area.

2.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:

1. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

2.04 CLEANING AND REPAIR

A. See Section 01732 - Waste Management for additional requirements.

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

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

D. Luminaires: Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps and broken electrical parts.

END OF SECTION 16095

SECTION 16123
BUILDING WIRE AND CABLE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Wiring connectors.

C. Electrical tape.

D. Heat shrink tubing.

E. Wire pulling lubricant.

1.02 RELATED REQUIREMENTS

A. Section 07840 - Firestopping.

B. Section 16095 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.

C. Section 16121 - Medium-Voltage Cable: Cables and terminations for systems 601 V through 35,000 V.

D. Section 16060 - Grounding and Bonding: Additional requirements for grounding conductors and grounding connectors.

E. Section 16075 - Electrical Identification: Identification products and requirements.

F. Section 16210 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conductors.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010.

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2009).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

H. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; National Electrical Manufacturers Association; 2009 (ANSI/NEMA WC 70/ICEA S-95-658).

I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

K. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

L. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

M. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

N. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

O. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.07 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (-10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

E. Service entrance cable is not permitted.

F. Armored cable is not permitted.

G. Metal-clad cable is not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

H. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.

I. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

J. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.
      a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
   3. Color Code:
      a. 480Y/277 V, 3 Phase, 4 Wire System:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral/Grounded: Gray.
      b. 208Y/120 V, 3 Phase, 4 Wire System:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral/Grounded: White.
      c. Equipment Ground, All Systems: Green.
      d. Travelers for 3-Way and 4-Way Switching: Pink.
      e. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
   1. Feeders and Branch Circuits:
      a. Size 10 AWG and Smaller: Solid.
      b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
   1. Copper Building Wire: Type THHN/THWN, except as indicated below.
      a. Installed Underground: Type XHHW-2.

2.04 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
   2. Copper Conductors Size 6 AWG and Larger: Use compression connectors.

C. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.

5. Conductors for Control Circuits: Use crimped terminals for all connections.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

F. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
   1. Manufacturers:
      a. 3M: www.3m.com.
      b. Ideal Industries, Inc: www.idealindustries.com.
      c. NSI Industries LLC: www.nsiindustries.com.

G. Compression Connectors: Provide circumferential type crimp configuration.
   1. Manufacturers:
      a. Burndy: www.burndy.com.
      b. Ilsco: www.ilsco.com.
      c. Thomas & Betts Corporation: www.tnb.com.

H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
   1. Manufacturers:
      a. Burndy: www.burndy.com.
      b. Ilsco: www.ilsco.com.
      c. Thomas & Betts Corporation: www.tnb.com.

2.05 WIRING ACCESSORIES

A. Electrical Tape:
   1. Manufacturers:
      a. 3M: www.3m.com.
      b. Plymouth Rubber Europa: www.plymouthrubber.com.
   2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 8.5 mil (0.21 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
   1. Manufacturers:
      a. 3M: www.3m.com.
      b. Burndy: www.burndy.com.
      c. Thomas & Betts Corporation: www.tnb.com.

C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M: www.3m.com.
      b. American Polywater Corporation: www.polywater.com.
      c. Ideal Industries, Inc: www.idealindustries.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as shown on the drawings.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated and routing is not shown, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
      a. Provide no more than four current-carrying conductors in a single raceway. Neutral conductors are considered current-carrying conductors.

B. Install products in accordance with manufacturer's instructions.

C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.

D. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

G. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.

H. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.

I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

K. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use heat shrink tubing.
   2. Damp Locations: Use heat shrink tubing.
   3. Wet Locations: Use heat shrink tubing.

M. Insulate ends of spare conductors using heat shink tubing.

N. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

O. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07840.

P. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION 16123

SECTION 16131
CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Flexible metal conduit (FMC).

C. Liquidtight flexible metal conduit (LFMC).

D. Electrical metallic tubing (EMT).

E. Rigid polyvinyl chloride (PVC) conduit.

F. Conduit fittings.

G. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07840 - Firestopping.

B. Section 16060 - Grounding and Bonding.
   1. Includes additional requirements for fittings for grounding and bonding.

C. Section 16070 - Hangers and Supports.

D. Section 16075 - Electrical Identification: Identification products and requirements.

E. Section 16210 - Low-Voltage Electrical Service Entrance: Additional requirements for electrical service conduits.

F. Section 16710 - Structured Telecommunications Cabling and Enclosures: Additional requirements for communications systems conduits.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.

B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); National Electrical Contractors Association; 2006.

E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); National Electrical Contractors Association; 2003.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

G. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; National Electrical Manufacturers Association; 2013.

H. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association; 2013.

I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

K. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

L. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

N. UL 651 - Schedule 40 and 80 Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

O. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
   4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use rigid PVC conduit.
   2. Exterior, Direct-Buried: Use rigid PVC conduit.
   3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
   4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground or concrete, and ensure entire radius of rigid metal conduit is burried.
   5. Where rigid polyvinyl (PVC) conduit larger than 1 1/2 inch (41 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:
   1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): Use rigid PVC conduit.
   2. Within Slab Above Ground: Not permitted.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit or electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit.
   1. except within dedicated electrical and communication rooms: Use electrical metallic tubing (EMT)

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.

K. Exposed, Exterior: Use galvanized steel rigid metal conduit.

L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

M. Hazardous (Classified) Locations: Use galvanized steel rigid metal conduit.

N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet (1.8 m).

O. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Hazardous (Classified) Locations, as Follows:
      a. Class I, Division 1: Use listed flexible explosionproof couplings.
      b. Class I, Division 2: Use listed flexible explosionproof couplings or liquidtight flexible metal conduit with listed fittings.
      c. Class II, Division 1: Use listed flexible explosionproof couplings.
      d. Class II, Division 2: Use listed flexible explosionproof couplings or liquidtight flexible metal conduit with listed fittings.
      e. Class III: Use listed flexible explosionproof couplings or liquidtight flexible metal conduit with listed fittings.
   4. Maximum Length: 3 feet (0.9 m) unless otherwise indicated.
   5. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.

B. Electrical Service Conduits: Also comply with Section 16210.

C. Communications Systems Conduits: Also comply with Section 16710.

D. Fittings for Grounding and Bonding: Also comply with Section 16060.

E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

F. Provide products listed, classified, and labeled as suitable for the purpose intended.

G. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.
   2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
   3. Control Circuits: 3/4 inch inch (21 mm) trade size.
   4. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
   5. Underground, Interior: 3/4 inch (21 mm) trade size.
   6. Underground, Exterior: 1 inch (27 mm) trade size.
   7. Exposed, Interior or Exterior: 3/4" (21 mm) trade size.

H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Hazardous (Classified) Locations: Use fittings listed and labeled as complying with UL 1203 for the classification of the installed location.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
   4. Conduit Bodies: Use galvanized, malleable iron type with threaded hubs and tapered threads.
   5. Conduit Body Covers: Use galvanized, malleable iron type with neoprene gaskets.

2.04 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel.
      a. Do not use die cast zinc fittings.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel.
      a. Do not use die cast zinc fittings.

2.06 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel.
      a. Do not use die cast zinc fittings.
   3. Connectors and Couplings: Use compression (gland) type.
      a. Do not use indenter type connectors and couplings.

2.07 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage, or where otherwise required; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.08 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

B. Solvent Cement for PVC Conduit and Fittings: Low VOC, and as recommended by manufacturer of conduit and fittings to be installed.

C. Primer for PVC Conduit and Fittings: Low VOC, and as recommended by manufacturer of conduit and fittings to be installed.

D. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force (890 N).

E. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that mounting surfaces are ready to receive conduits.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

E. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 and Section 16070 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Use conduit strap to support single surface-mounted conduit.
      a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
   4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
   5. Use conduit clamp to support single conduit from beam clamp or threaded rod.
   6. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
   7. Use of wire for support of conduits is not permitted.

F. Connections and Terminations:
   1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
   2. Clean all ends of rigid polyvinyl chloride (PVC) conduit and insides of fittings to be terminated with PVC primer prior to applying appilying PVC solvent cement.
   3. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings. Do not use running threads.
   4. Use suitable adapters where required to transition from one type of conduit to another.
   5. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
   6. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

7. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
8. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
9. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

G. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Provide suitable modular seal where conduits penetrate exterior wall below grade.
7. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
8. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
9. Provide metal escutcheon plates for conduit penetrations exposed to public view.
10. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07840.

H. Underground Installation:
1. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches (610 mm).
2. Provide underground warning tape in accordance with Section 16075 along entire conduit length.

I. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.

J. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

K. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.

L. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 36 inches (900 mm) at each end.

M. Provide grounding and bonding in accordance with Section 16060.

N. Identify conduits in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 16131

SECTION 16138
BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

C. Boxes for hazardous (classified) locations.

D. Underground boxes/enclosures.

1.02 RELATED REQUIREMENTS

A. Section 07840 - Firestopping.

B. Section 08310 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

C. Section 16060 - Grounding and Bonding.

D. Section 16070 - Hangers and Supports.

E. Section 16075 - Electrical Identification: Identification products and requirements.

F. Section 16140 - Wiring Devices:
   1. Wall plates.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association; 2010.

C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).

D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; National Electrical Manufacturers Association; 2008 (Revised 2010) (ANSI/NEMA OS 1).

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. SCTE 77 - Specification for Underground Enclosure Integrity; Society of Cable Telecommunications Engineers; 2013 (ANSI/SCTE 77).

H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

J. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

L. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for outlet and device boxes, junction and pull boxes, cabinets and enclosures, and boxes for hazardous (classified) locations.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use malleable cast iron boxes with malleable cast iron covers where exposed galvanized steel rigid metal conduit is used.
4. Use suitable concrete type boxes where flush-mounted in concrete.
5. Use suitable masonry type boxes where flush-mounted in masonry walls.
6. Use raised covers suitable for the type of wall construction and device configuration where required.
7. Use shallow boxes where required by the type of wall construction.
8. Do not use "through-wall" boxes designed for access from both sides of wall.

9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
13. Wall Plates: Comply with Section 16140.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   a. Indoor Clean, Dry Locations: Type 1, painted steel.
   b. Outdoor Locations: Type 4X, stainless steel.
3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

D. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.

E. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Provide logo on cover to indicate type of service.
3. Applications:
   a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
   b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 22 load rating.
   c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
4. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide separate boxes for emergency power and normal power systems.

E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

F. Box Locations:
   1. Locate boxes to be accessible. Provide access panels in accordance with Section 08310 as required.
   2. Locate boxes so that wall plates do not cross masonry joints.
   3. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.

G. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 16070 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

H. Install boxes plumb and level.

I. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.

J. Install boxes as required to preserve insulation integrity.

K. Underground Boxes/Enclosures:
   1. Install enclosure on gravel base, minimum 6 inches (150 mm) deep.
   2. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

L. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07840.

N. Close unused box openings.

O. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

P. Provide grounding and bonding in accordance with Section 16060.

Q. Identify boxes in accordance with Section 16075.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 16138

SECTION 16140
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Wall plates.

1.02 RELATED REQUIREMENTS

A. Section 16138 - Boxes.

B. Section 16075 - Electrical Identification: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification; Revision G, 2001.

B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2010).

E. NEMA WD 6 - Wiring Device -- Dimensional Specifications; National Electrical Manufacturers Association; 2002 (R2008).

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.

H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
   3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
   4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   5. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hubbell Incorporated: www.hubbell-wiring.com.

B. Leviton Manufacturing Company, Inc: www.leviton.com.

C. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

D. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer.

2.02 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.

C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.

D. Provide GFI protection for all receptacles installed within 6 feet (1.8 m) of sinks.

E. Unless noted otherwise, do not use combination switch/receptacle devices.

2.03 WALL SWITCHES

A. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring with separate ground terminal screw.

B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

C. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.04 RECEPTACLES

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com.
   2. Leviton Manufacturing Company, Inc: www.leviton.com.
   3. Pass & Seymour, a brand of Legrand North America, Inc: www.legrand.us

B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:
   1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.

D. GFI Receptacles:
   1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
   2. Standard GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

2.05 WALL PLATES

A. All Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard; _____.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

C. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

D. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

E. Surface mounted device boxes connected to exposed galvanized steel rigid metal conduit (RMC) systems: Use malleable cast iron device covers in lieu of wall plates.

F. Surface mounted device boxes connected to exposed electrical metallic tubing (EMT) systems: Use exposed work (industrial) device covers in lieu of wall plates.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 16138 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches (1.2 m) above finished floor.
      b. Receptacles: 18 inches (450 mm) above finished floor or 6 inches (150 mm) above counter.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Locate wall switches on strike side of door with edge of wall plate 3 inches (80 mm) from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Install wiring devices plumb and level with mounting yoke held rigidly in place.

I. Install wall switches with OFF position down.

J. Install vertically mounted receptacles with grounding pole on bottom and horizontally mounted receptacles with grounding pole on left.

K. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

L. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

M. Identify wiring devices in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.04 ADJUSTING

A. Adjust devices and wall plates to be flush, plumb and level to the eye.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 16140

SECTION 16210

LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical service requirements.

1.02 RELATED REQUIREMENTS

A. Section 16060 - Grounding and Bonding.

B. Section 16070 - Hangers and Supports.

C. Section 16131 - Conduit.

D. Section 16075 - Electrical Identification: Identification products and requirements.

E. Section 16412 - Enclosed Switches: Service entrance equipment.

F. Section 16231 - Packaged Engine Generators: Emergency/standby power systems for interconnection with normal utility electrical supply.

1.03 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.04 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; Institute of Electrical and Electronic Engineers; 2012.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date established in Notice to Proceed, notify Utility Company of anticipated date of service.

B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
      e. Available fault current at the Servie Point.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with other installers to provide communication lines required for Utility Company meters.
   5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.

D. Utility Company charges associated with providing permanent service to be paid by Contractor..

E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.

F. Scheduling:

1. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner.
2. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.06 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Project Record Documents: Record actual locations of equipment and installed service routing.

1.07 QUALITY ASSURANCE

A. Comply with the following:
1. IEEE C2 (National Electrical Safety Code).
2. NFPA 70 (National Electrical Code).
3. The requirements of the Utility Company.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 ELECTRICAL SERVICE REQUIREMENTS

A. Provide replacement of existing electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Division of Responsibility:
1. Pad-Mounted Utility Transformers:
a. Transformer Vaults: Furnished and installed by Owner.
b. Transformers: Furnished and installed by Utility Company.
c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.
d. Transformer Protective Bollards: Furnished and installed by Contractor per Utility Company requirements.
e. Primary:
1) Trenching and Backfilling: Provided by Owner.
2) Conduits: Furnished and installed by Owner.
3) Conductors: Furnished and installed by Contractor per Utility Company requirements.
f. Secondary:
1) Trenching and Backfilling: Provided by Contractor.
2) Conduits: Furnished and installed by Contractor.
3) Conductors: Furnished and installed by Contractor (Service Point at transformer).

D. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Verify and mark locations of existing underground utilities.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required trenching and backfilling in accordance with Section 02315 - Excavation and Section 02316 - Fill and Backfill.

E. Provide required protective bollards in accordance with Utility Company requirements.

F. Provide required support and attachment components in accordance with Section 16070.

G. Provide grounding and bonding for service entrance equipment in accordance with Section 16060.

H. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 16075.

3.04 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION 16210

SECTION 16231
PACKAGED ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.
   4. Generator set enclosure.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 15191 - Fuel Oil Piping System:
   1. Diesel fuel piping.

C. Section 16060 - Grounding and Bonding.

D. Section 16070 - Hangers and Supports.

E. Section 16075 - Electrical Identification: Identification products and requirements.

F. Section 16413 - Enclosed Transfer Switches.

1.03 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel Oils; 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NECA/EGSA 404 - Standard for Installing Generator Sets; National Electrical Contractors Association; 2007.

D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2011.

E. NFPA 30 - Flammable and Combustible Liquids Code; National Fire Protection Association; 2012.

F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2010.

G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. NFPA 99 - Health Care Facilities Code; National Fire Protection Association; 2012.

I. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2013.

J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.

K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.

L. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
      a. Transfer Switches: See Section 16413.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.

3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
   1. Include generator set sound level test data.
   2. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.
   3. Include characteristic trip curves for overcurrent protective devices.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.

E. Specimen Warranty: Submit sample of manufacturer's warranty.

F. Manufacturer's factory emissions certification.

G. Source quality control test reports.

H. Manufacturer’s detailed field testing procedures.

I. Field quality control test reports.

J. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

K. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

L. Maintenance contracts.

M. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
   1. Document and record the tightened torque of each mechanical connection made in the field.

N. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01600 - Product Requirements, for additional provisions.
   2. Extra Fuses: One of each type and size.
   3. Extra Filter Elements: One of each type, including fuel, oil and air.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems).
   3. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   4. NFPA 30 (Flammable and Combustible Liquids Code).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Packaged Engine Generator Set:
   1. Caterpillar Inc: www.cat.com/power-generation.
   2. Cummins Power Generation Inc: www.cumminspower.com.
   3. Generac Power Systems: www.generac.com/industrial.
   4. Kohler Co: www.kohlerpower.com.

B. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
   1. Application: Emergency/standby.
   2. Configuration: Single packaged engine generator set operated independently (not in parallel).
   3. Where design is based on single generator set, use of multiple, smaller unit(s) operated in parallel to obtain equivalent total system power rating is not permitted.

D. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Power Rating: As indicated on drawings, standby.
   3. Voltage: As indicated on drawings.
   4. Main Line Circuit Breaker:
      a. Type: Thermal magnetic.
      b. Rating: 100 percent rated.
      c. Trip Rating: As indicated on drawings.

E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
   4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
   5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
   6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.

G. Starting and Load Acceptance Requirements:
   1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
   2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
   3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
   4. Maximum Load Step: Supports 100 percent of rated load in one step.

H. Exhaust Emissions Requirements:
   1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
   2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
   1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
   2. Fuel Storage: Sub-base fuel tank.
   3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
   4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
   5. Sub-Base Fuel Tank:
      a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
      b. Tank Capacity: Size for minimum of 48 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
      c. Features:
         1) Direct reading fuel level gauge.
         2) Normal atmospheric vent.
         3) Emergency pressure relief vent.
         4) Fuel fill opening with lockable cap.
         5) Dedicated electrical conduit stub-up area.
         6) Low fuel level switch.
         7) Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.

C. Engine Starting System:
   1. System Type: Electric, with DC solenoid-activated starting motor(s).
   2. Battery(s):
      a. Battery Type: Lead-acid.
      b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through three complete periods of cranking limiter time-outs without recharging.

c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 12 hours while carrying normal loads.
   c. Recognized as complying with UL 1236.
   d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
   f. Provide alarm output contacts as necessary for alarm indications.

D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide industrial grade or better exhaust silencer; select according to manufacturer's recommendations to meet sound performance requirements, where specified.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:

1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:
   a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
   b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
   c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
   d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
   e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
   f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
   g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Indications:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (W/kW).
   e. Reactive power (VAR/kVAR).
   f. Apparent power (VA/kVA).
   g. Power factor.
   h. Duty Level: Actual load as percentage of rated power.
   i. Engine speed (RPM).
   j. Battery voltage (Volts DC).
   k. Engine oil pressure.
   l. Engine coolant temperature.
   m. Engine run time.
   n. Generator powering load (position signal from transfer switch).
4. Generator Set Protection and Warning/Shutdown Indications:
   a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (shutdown).
      6) Overspeed (shutdown).
      7) Low fuel level (warning).
      8) Low coolant level (warning/shutdown).
      9) Generator control not in automatic mode (warning).
      10) High battery voltage (warning).
      11) Low cranking voltage (warning).
      12) Low battery voltage (warning).
      13) Battery charger failure (warning).
   b. In addition to NFPA 110 requirements, provide the following protections/indications:

1) High AC voltage (shutdown).
2) Low AC voltage (shutdown).
3) High frequency (shutdown).
4) Low frequency (shutdown).
5) Overcurrent (shutdown).
6) Fuel tank leak (warning), where applicable.

c. Provide contacts for local and remote common alarm.
d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
   a. Event log.
   b. Remote monitoring capability via PC.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
   a. Generator powering load (via position signal from transfer switch).
   b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
   a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
      1) Overcrank (shutdown).
      2) Low coolant temperature (warning).
      3) High coolant temperature (warning).
      4) High coolant temperature (shutdown).
      5) Low oil pressure (shutdown).
      6) Overspeed (shutdown).
      7) Low fuel level (warning).
      8) Low coolant level (warning/shutdown).
      9) Generator control not in automatic mode (warning).
      10) High battery voltage (warning).
      11) Low cranking voltage (warning).
      12) Low battery voltage (warning).
      13) Battery charger failure (warning).
   b. Provide audible alarm with silence function.
   c. Provide lamp test function that illuminates all indicator lamps.

2.06 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.

F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.

I. Exhaust Silencers: Where exhaust silencers are mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.

2.07 SOURCE QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

C. Generator Set production testing to include, at a minimum:
   1. Operation at rated load and rated power factor.
   2. Single step load pick-up.
   3. Transient and steady state voltage and frequency performance.
   4. Operation of safety shutdowns.

D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive equipment.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized 6 inch (150 mm) high concrete pad constructed in accordance with Section 03300. Provide suitable vibration isolators, where not factory installed.

F. Provide required support and attachment in accordance with Section 16070.

G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

H. Provide diesel fuel piping and venting in accordance with Section 15191, where not factory installed.

I. Provide engine exhaust piping in accordance with Section 15550, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer's maximum back pressure requirements.

J. Install exhaust silencer in accordance with Section 15550, where not factory installed.

K. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

L. Provide grounding and bonding in accordance with Section 16060.

M. Identify system wiring and components in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

C. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.

D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

F. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.

G. Prepare and start system in accordance with manufacturer's instructions.

H. Perform acceptance test in accordance with NFPA 110.

I. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
   3. Verify phase sequence.
   4. Verify control system operation, including safety shutdowns.
   5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
   6. Perform load tests using load bank at 100% percent full load for minimum of 4 hours.

J. Provide field emissions testing where necessary for certification.

K. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

L. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01780 - Closeout Submittals, for closeout submittals.

B. See Section 01820 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of four hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

3.07 MAINTENANCE

A. See Section 01700 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion;

Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 16231

SECTION 16272
DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

B. Buck-boost transformers.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 16060 - Grounding and Bonding.

C. Section 16075 - Electrical Identification: Identification products and requirements.

D. Section 16131 - Conduit: Flexible conduit connections.

1.03 REFERENCE STANDARDS

A. IEEE C57.94 - Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).

B. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 1999 (R2004).

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

D. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2009.

E. NEMA ST 20 - Dry-Type Transformers for General Applications; National Electrical Manufacturers Association; 1992 (R1997).

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008

G. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; 2002.

H. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; 2005.

I. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency; 2000.

J. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

L. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Maintenance Data: Include recommended maintenance procedures and intervals.

E. Project Record Documents: Record actual locations of transformers.

1. Document and record the tightened torque of each mechanical connection made in the field.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

C. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

1.08 FIELD CONDITIONS

A. Ambient Temperature: Do not exceed 86 degrees F (30 degrees C) average or 104 degrees F (40 degrees C) maximum measured during any 24 hour period during and after installation of transformers.
   1. Provide temporary electric heat within transformer enclosure to prevent condensation buildup on coils prior to energizing transformer.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens Industry, Inc: www.usa.siemens.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project.

2.02 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
   1. Altitude: Less than 3,300 feet (1,000 m).
   2. Ambient Temperature: Not exceeding 86 degrees F (30 degrees C) average or 104 degrees F (40 degrees C) maximum measured during any 24 hour period.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.03 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 15 kVA: Class 185 degrees C insulation system with 115 degrees C average winding temperature rise.
   2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.

D. Winding Taps:
   1. Less than 3 kVA: None.
   2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
   3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
   4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
   1. Test efficiency according to NEMA TP 2.
   2. Label transformer according to NEMA TP 3.

F. Sound Levels: Low sound levels with maximum sound levels as follows:
   1. 0-9 kVA: 40 dB.
   2. 10-50 kVA: 45 dB.
   3. 51-150 kVA: 50 dB.
   4. 151-300 kVA: 55 dB.
   5. 301-500 kVA: 60 dB.
   6. 501-700 kVA: 62 dB.
   7. 701-1000 kVA: 64 dB.

G. Mounting Provisions:
   1. Less than 15 kVA: Suitable for wall mounting.
   2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
   3. Larger than 75 kVA: Suitable for floor mounting.

H. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 1.
      b. Outdoor locations: Type 3R.
   2. Construction: Steel.
      a. Less than 15 kVA: Totally enclosed, non-ventilated.
      b. 15 kVA and Larger: Ventilated.
   3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
   4. Provide lifting eyes or brackets.

I. Accessories:
   1. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.04 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, four winding, buck-boost transformers listed and labeled as complying with UL 506 or UL 1561, and suitable for field connection as an autotransformer; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:
   1. Less than 0.25 kVA: Class 105 degree C insulation system with 55 degrees C rise.
   2. 0.25 kVA and Larger: Class 185 degree C insulation system with 115 degree C rise.

C. Coil Conductors: Continuous windings.

D. Lugs: Suitable for terminating conductors sized for full rated load ampacity of transformer when operating in buck-boost configuration shown.

E. Mounting Provisions: Suitable for wall mounting.

F. Transformer Enclosure: Comply with NEMA ST 20.
   1. Environment Type per NEMA 250: Type 3R.
   2. Construction: Steel, totally enclosed, non-ventilated.
   3. Finish: Manufacturer's standard grey, suitable for outdoor installations.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install transformers in accordance with manufacturer's instructions.

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 16131, 2 feet (600 mm) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Mount floor-mounted transformers on properly sized 3 inch (80 mm) high concrete pad constructed in accordance with Section 03300.

G. Mount floor-mounted transformers using vibration isolators suitable for isolating the transformer noise from the building structure.

H. Provide grounding and bonding in accordance with Section 16060.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.

K. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

L. Where furnished as a separate accessory, install transformer weathershield per manufacturer's instructions.

M. Identify transformers in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

3.04 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from transformer components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 16272

SECTION 16289
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices for service entrance locations.

1.02 RELATED REQUIREMENTS

A. Section 16060 - Grounding and Bonding.

1.03 ABBREVIATIONS AND ACRONYMS

A. SPD: Surge Protective Device.

1.04 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to ordering equipment.

1.06 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.

C. Operation and Maintenance Data: Include information on status indicators and recommended maintenance procedures and intervals.

1.07 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.

C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Factory-installed, Internally Mounted Surge Protective Devices:

1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

C. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   1. Indoor clean, dry locations: Type 1.

D. Equipment Containing Factory-installed, Internally Mounted SPDs: Listed and labeled as a complete assembly including SPD.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Unless otherwise indicated, provide factory-installed, internally mounted SPDs.

B. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

C. Provide SPDs utilizing field-replaceable modular or non-modular protection circuits.

D. Surge Current Rating: Not less than 160 kA per mode/320 kA per phase.

E. UL 1449 Nominal Discharge Current (I-n): 20 kA.

F. UL 1449 Short Circuit Current Rating (SCCR): Not less than the short circuit current rating of the equipment the SPD is connected to, including any series ratings.

G. Diagnostics:
   1. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
   2. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
   3. Surge Counter: Provide surge event counter with manual reset button, surge count retention upon power loss, and six digit LCD display that indicates quantity of surge events.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.

C. Verify system grounding and bonding is in accordance with Section 16060, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

C. Unless indicated otherwise, provide, install, and connect service entrance surge protective device on load side of service disconnect main overcurrent device.

D. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 16060 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

3.03 FIELD QUALITY CONTROL

A. Perform inspection and testing in accordance with Section 01400.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 16289

SECTION 16411
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS

A. Section 16060 - Grounding and Bonding.

B. Section 16070 - Hangers and Supports.

C. Section 16051 - Overcurrent Protective Device Coordination Study.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

H. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.
   2. Include characteristic trip curves for each type and rating of circuit breaker.

C. Project Record Documents: Record actual installed locations of enclosed circuit breakers.
   1. Document and record the tightened torque of each mechanical connection made in the field.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens Industry, Inc: www.usa.siemens.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet (2,000 m).
   2. Ambient Temperature: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 16051.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Provide thermal magnetic circuit breakers unless otherwise indicated.

H. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

I. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

K. Provide externally operable handle with means for locking in the OFF position.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:
   1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating _____
   2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

C. Conductor Terminations:
   1. Provide mechanical lugs unless otherwise indicated.
   2. Lug Material: Copper, suitable for terminating copper conductors only.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

E. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 16070.

E. Install enclosed circuit breakers plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.

G. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

H. Provide grounding and bonding in accordance with Section 16060.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01400.

B. Test GFCI circuit breakers to verify proper operation.

C. Test shunt trips to verify proper operation.

D. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 16411

SECTION 16412
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

1.02 RELATED REQUIREMENTS

A. Section 16060 - Grounding and Bonding.

B. Section 16070 - Hangers and Supports.

C. Section 16075 - Electrical Identification: Identification products and requirements.

D. Section 16051 - Overcurrent Protective Device Coordination Study.

E. Section 16491 - Fuses.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2013.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

G. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

H. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.

C. Project Record Documents: Record actual locations of enclosed switches.
   1. Document and record the tightened torque of each mechanical connection made in the field.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens Industry, Inc: www.usa.siemens.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project.

2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet (2,000 m).
   2. Ambient Temperature: Between -22 degrees F (-30 degrees C) and 104 degrees F (40 degrees C).

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:
   1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 16051.

G. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

H. Provide with switch blade contact position that is visible when the cover is open.

I. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
   1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

J. Conductor Terminations: Suitable for use with the conductors to be installed.

K. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

L. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

M. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 4X, stainless steel.

2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.

N. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

O. Heavy Duty Switches:
   1. Comply with NEMA KS 1.
   2. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Lug Material: Copper, suitable for terminating copper conductors only.
   3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed safety switches.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install enclosed switches in accordance with manufacturer's instructions.

B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 16070.

E. Install enclosed switches plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches (2000 mm) above the floor or working platform.

G. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

H. Provide grounding and bonding in accordance with Section 16060.

I. Provide fuses complying with Section 16491 for fusible switches as indicated or as required by equipment manufacturer's recommendations.

J. Identify enclosed switches in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01400.

B. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 16412

SECTION 16413
ENCLOSED TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Includes service entrance rated transfer switches.
   3. Remote annunciators.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 16060 - Grounding and Bonding.

C. Section 16070 - Hangers and Supports.

D. Section 16075 - Electrical Identification: Identification products and requirements.

E. Section 16051 - Overcurrent Protective Device Coordination Study.

F. Section 16231 - Packaged Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.
   2. Includes related demonstration and training requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; National Electrical Manufacturers Association; 2005.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. NFPA 110 - Standard for Emergency and Standby Power Systems; National Fire Protection Association; 2013.

F. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

G. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
      a. Engine Generators: See Section 16231.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.
   2. Include characteristic trip curves for overcurrent protective devices.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

D. Specimen Warranty: Submit sample of manufacturer's warranty.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

F. Source quality control test reports.

G. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
   1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

H. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

I. Maintenance contracts.

J. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.
   1. Document and record the tightened torque of each mechanical connection made in the field.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 16231.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transfer Switches:
   1. ASCO Power Technologies, a brand of Emerson Network Power: www.emersonnetworkpower.com.
   2. Same as manufacturer of engine generator(s) used for this project.

B. Source Limitations: Furnish transfer switches and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize open transition transfer unless otherwise indicated or required.
   2. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
      a. Unless otherwise indicated or required, provide solid (unswitched) neutral.

D. Automatic Transfer Switch:
   1. Transfer Switch Type: Service entrance rated automatic transfer switch.
   2. Voltage: 480V, 3-phase, 4-wire.
   3. Ampere Rating: 2000A.
   4. Neutral Configuration: Solid neutral (unswitched), except as indicated.

E. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

F. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

G. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

H. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
   2. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

I. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

J. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
   2. Finish: Manufacturer's standard unless otherwise indicated.

K. Short Circuit Current Rating:
   1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 16051.

L. Automatic Transfer Switches:

1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
2. Control Functions:
    a. Automatic mode.
    b. Test Mode: Simulates failure of primary/normal source.
    c. Voltage and Frequency Sensing:
        1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
        2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
        3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
    d. Outputs:
        1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
        2) Auxiliary contacts; two set(s) for each switch position.
    e. Adjustable Time Delays:
        1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
        2) Transfer to alternate/emergency source time delay.
        3) Retransfer to primary/normal source time delay.
        4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
    f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
    g. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
3. Status Indications:
    a. Connected to alternate/emergency source.
    b. Connected to primary/normal source.
    c. Alternate/emergency source available.
    d. Primary/normal source available.
4. Other Features:
    a. Remote monitoring capability via PC.
5. Automatic Sequence of Operations:
    a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
    b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
    c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
    d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

M. Service Entrance Rated Transfer Switches:
1. Furnished with integral disconnecting and overcurrent protective device on the primary/normal source and with ground-fault protection.
2. Electronic Trip Circuit Breaker: Furnish solid state, microprocessor-based, true rms sensing trip units.
    a. Provide the following field-adjustable trip response settings:
        1) Long time pickup, adjustable by setting dial.
        2) Long time delay.

3) Short time pickup and delay.
4) Instantaneous pickup.
5) Ground fault pickup and delay
6) 100 Percent Rated, listed for application.

3. Listed and labeled as suitable for use as service equipment according to UL 869A.

N. Remote Annunciators:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Transfer Switch Status Indications:
a. Connected to alternate/emergency source.
b. Connected to primary/normal source.
c. Alternate/emergency source available.
d. Primary/normal source available.

O. Interface with Other Work:
1. Interface with engine generators as specified in Section 16231.

2.03 SOURCE QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Perform production tests on transfer switches at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

C. Verify that rough-ins for field connections are in the proper locations.

D. Verify that mounting surfaces are ready to receive transfer switches.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install transfer switches in accordance with manufacturer's instructions.

C. Arrange equipment to provide minimum clearances and required maintenance access.

D. Provide required support and attachment in accordance with Section 16070.

E. Install transfer switches plumb and level.

F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03300.

G. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

H. Provide grounding and bonding in accordance with Section 16060.

I. Identify transfer switches and associated system wiring in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Prepare and start system in accordance with manufacturer's instructions.

C. Automatic Transfer Switches:

D. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01780 - Closeout Submittals, for closeout submittals.

B. See Section 01820 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

E. Programming: Program engine exerciser to exercise generator, under load, once a week for a duration as recommended by generator manufacturer. Coordinate exercise time of day and day of week with Owner and Authority Having Jurisdiction. Program engine cool down cycle, not under load, for a duration as recommended by generator manufacturer, immediately after exercise period.

F. Coordinate with related generator demonstration and training as specified in Section 16231.

3.06 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.07 MAINTENANCE

A. See Section 01700 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

C. Conduct site visit at least once every three months to perform inspection, testing, and preventive maintenance. Submit report to Owner indicating maintenance performed along with evaluations and recommendations.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 16413

SECTION 16423
ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manual motor controllers.

B. Magnetic motor controllers.

C. Combination magnetic motor controllers and disconnects.

1.02 RELATED REQUIREMENTS

A. Section 16070 - Hangers and Supports.

B. Section 16075 - Electrical Identification: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2008).

C. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; 2000 (R2010).

D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); National Electrical Manufacturers Association; 2013.

E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Maintenance Data: Replacement parts list for controllers.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation; Cutler-Hammer Product: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 MANUAL CONTROLLERS

A. Manual Motor Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, and toggle operator.

B. Fractional Horsepower Manual Controllers: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.

C. Motor Starting Switches: NEMA ICS 2, AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, with red pilot light and toggle operator.

2.03 AUTOMATIC CONTROLLERS

A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

B. Reversing Controllers: Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.

C. Overload Relays: NEMA ICS 2; melting alloy.

2.04 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2.

B. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type.

C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated B600.

D. Pushbuttons: Shrouded type.

E. Indicating Lights: LED type.

F. Selector Switches: Rotary type.

G. Relays: NEMA ICS 2.

H. Control Power Transformers: 150 VA minimum, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.05 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Nonfusible Switch Assemblies: NEMA KS 1, enclosed knife switch with externally operable handle.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.

B. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

C. Provide supports in accordance with Section 16070.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Identify enclosed controllers in accordance with Section 16075.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

END OF SECTION 16423

SECTION 16424
MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Motor control centers.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Housekeeping pads.

B. Section 16075 - Electrical Identification: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 402 - Recommended Practice for Installing and Maintaining Motor Control Centers; National Electrical Contractors Association; 2007.

B. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2008).

C. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers; National Electrical Manufacturers Association; 1995 (R2008).

D. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; 2000 (R2010).

E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time/current curves of all equipment and components.

D. Project Record Documents: Record actual installed locations of motor control centers.
   1. Document and record the tightened torque of each mechanical connection made in the field.

E. Maintenance Data: Replacement parts list for controllers.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with NEMA ICS 2.3. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Conform to NEMA ICS 2 service conditions during and after installation of motor control centers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc.: www.usa.siemens.com

2.02 DESCRIPTION

A. Configuration: NEMA ICS 2, Class I, Type B motor control center.

B. Feeder Tap Units: Molded case thermal-magnetic circuit breakers.

C. Horizontal Bus: Copper. Include copper ground bus entire length of control center.

D. Vertical Bus: Copper.

E. Configuration: Units front mounting only, accessible from the front only.

F. Finish: Manufacturer's standard gray enamel.

2.03 AUTOMATIC CONTROLLERS

A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

B. Reversing Controllers: Include electrical interlock and integral time delay transition between FORWARD and REVERSE rotation.

C. Overload Relay: NEMA ICS 2; melting alloy.

2.04 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, quantity and type as shown on drawings.

B. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty oiltight type.

C. Pushbuttons: Shrouded type.

D. Indicating Lights: ____, LED type.

E. Selector Switches: Rotary type.

F. Control Power Transformers: Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.05 DISCONNECTS

A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.

B. Thermal Magnetic Circuit Breakers: Integral thermal and instantaneous magnetic trip in each pole; UL listed.

2.06 SOURCE QUALITY CONTROL

A. Shop inspect and perform standard productions tests for each controller.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are suitable for motor control center installation.

3.02 PREPARATION

A. Provide housekeeping pads under the provisions of Section 03300.

3.03 INSTALLATION

A. Install motor control centers in accordance with NECA 402.

B. Tighten accessible bus connections and mechanical fasteners after placing motor control center.

C. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

D. Select and install heater elements in motor starters to match installed motor characteristics.

E. Identify motor control centers in accordance with Section 16075.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

END OF SECTION 16424

SECTION 16425
VARIABLE FREQUENCY CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable frequency controllers.

1.02 RELATED REQUIREMENTS

A. Section 16075 - Electrical Identification: Identification products and requirements.

B. Section 16491 - Fuses.

1.03 REFERENCE STANDARDS

A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association; 2006.

B. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives; National Electrical Manufacturers Association; 2006.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; International Electrical Testing Association; 2013 (ANSI/NETA ATS).

E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

D. Test Reports: Indicate field test and inspection procedures and test results.

E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

G. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Reliance Electric/Rockwell Automation: www.reliance.com.

B. Siemens Energy & Automation: www.sea.siemens.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public.

C. Finish: Manufacturer's standard enamel.

2.03 COMPONENTS

A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.

B. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.

C. Include undervoltage release.

D. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.

E. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.

F. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.

G. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.

H. Wiring Terminations: Match conductor materials and sizes indicated.

2.04 SOURCE QUALITY CONTROL

A. Shop inspect and perform standard productions tests for each controller.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surface is suitable for controller installation.

B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.02 INSTALLATION

A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

B. Tighten accessible connections and mechanical fasteners after placing controller.

C. Provide fuses in fusible switches; refer to Section 16491 for product requirements.

D. Identify variable frequency controllers in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. Provide the service of the manufacturer's field representative to prepare and start controllers.

B. Perform field inspection and testing in accordance with Section 01400.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Perform inspections and tests listed in NETA ATS, Section 7.17.

3.04 ADJUSTING

A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.05 CLOSEOUT ACTIVITIES

A. Demonstrate operation of controllers in automatic and manual modes.

END OF SECTION 16425

SECTION 16426
ENCLOSED CONTACTORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose contactors.

B. Lighting contactors.

1.02 RELATED REQUIREMENTS

A. Section 16070 - Hangers and Supports.

B. Section 16075 - Electrical Identification: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2008).

B. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; 2000 (R2010).

C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide dimensions, size, voltage ratings and current ratings.

C. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Allen-Bradley/Rockwell Automation: www.ab.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

2.02 GENERAL PURPOSE CONTACTORS

A. Description: NEMA ICS 2, AC general purpose magnetic contactor.

B. Poles: As required to match circuit configuration and control function.

C. Accessories:
   1. Indicating Light: RED.
   2. Auxiliary Contacts: One, field convertible.

2.03 LIGHTING CONTACTORS

A. Description: NEMA ICS 2, magnetic lighting contactor.

B. Poles: As required to match circuit configuration and control function.

C. Contact Rating: Match branch circuit overcurrent protection, considering derating for continuous loads.

D. Accessories:
   1. Indicating Light: RED.

2. Auxiliary Contacts: One, field convertible.

2.04 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 1 field convertible contacts in addition to seal-in contact.

B. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.

C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A600.

D. Indicating Lights: ____, LED type.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed contactors where indicated, in accordance with manufacturer's instructions.

B. Install enclosed contactors plumb. Provide supports in accordance with Section 16070.

C. Identify enclosed contactors in accordance with Section 16075.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01400.

END OF SECTION 16426

SECTION 16442
SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 16060 - Grounding and Bonding.

C. Section 16070 - Hangers and Supports.

D. Section 16075 - Electrical Identification: Identification products and requirements.

E. Section 16051 - Overcurrent Protective Device Coordination Study.

F. Section 16289 - Surge Protective Devices.

1.03 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; Institute of Electrical and Electronic Engineers; 2008.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

D. NECA 400 - Standard for Installing and Maintaining Switchboards; National Electrical Contractors Association; 2007.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

F. NEMA PB 2 - Deadfront Distribution Switchboards; National Electrical Manufacturers Association; 2011.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2013 (ANSI/NEMA PB 2.1).

H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

J. UL 891 - Switchboards; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.

5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.
   2. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include wiring diagrams showing all factory and field connections.

D. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.
   1. Document and record the tightened torque of each mechanical connection made in the field.

E. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01600 - Product Requirements, for additional provisions.
   2. Enclosure Keys: Two of each different key.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switchboards:
   1. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.
   2. General Electric Company: www.geindustrial.com.
   3. Schneider Electric; Square D Products: www.schneider-electric.us.
   4. Siemens Industry, Inc: www.usa.siemens.com.

B. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project.

2.02 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Front-Connected Switchboards:
   1. Main Device(s): Individually-mounted.
   2. Feeder Devices: Panel/group-mounted.
   3. Arrangement: Front accessible only (not rear accessible), rear aligned.
   4. Gutter Access: Bolted covers.

E. Service Conditions:
   1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
      a. Altitude: Less than 6,600 feet (2,000 m).
      b. Ambient Temperature:
         1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
   2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

F. Short Circuit Current Rating:
   1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 16051.

G. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

H. Bussing: Sized in accordance with UL 891 temperature rise requirements.
   1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
   2. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   3. Phase and Neutral Bus Material: Aluminum or copper.
   4. Ground Bus Material: Aluminum or copper.

I. Conductor Terminations: Suitable for use with the conductors to be installed.
   1. Line Conductor Terminations:
      a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Main and Neutral Lug Type: Mechanical.
   2. Load Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      b. Lug Type:
         1) Provide mechanical lugs unless otherwise indicated.

J. Enclosures:
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).
   2. Finish: Manufacturer's standard unless otherwise indicated.

K. Future Provisions:

1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.

L. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 16289, list switchboards as a complete assembly including surge protective device.

M. Owner Metering:
1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
2. Measured Parameters:
   a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
   b. Current (Amps): For each phase.
   c. Frequency (Hz).
   d. Real power (kW): For each phase, 3-phase total.
   e. Reactive power (kVAR): For each phase, 3-phase total.
   f. Apparent power (kVA): For each phase, 3-phase total.
   g. Power factor.
3. Meter Accuracy: Plus/minus 0.5 percent.
4. Features:

N. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
1. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
2. Molded Case Circuit Breakers:
   a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
      1) Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 600 amperes.
      2) Provide electronic trip circuit breakers for circuit breaker frame sizes 600 amperes and above.
   b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
      1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
      1) Provide the following field-adjustable trip response settings:
         (a) Long time pickup, adjustable by setting dial.
         (b) Long time delay.
         (c) Short time pickup and delay.
         (d) Instantaneous pickup.

d. Provide the following features and accessories:
   1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Provide required support and attachment components in accordance with Section 16070.

E. Install switchboards plumb and level.

F. Unless otherwise indicated, mount switchboards on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03300.

G. Provide grounding and bonding in accordance with Section 16060.

H. Install all field-installed devices, components, and accessories.

I. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 16051.

L. Provide filler plates to cover unused spaces in switchboards.

M. Identify switchboards in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.05 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

3.06 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION 16442

SECTION 16443
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.

B. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS

A. Section 03300 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 16060 - Grounding and Bonding.

C. Section 16070 - Hangers and Supports.

D. Section 16075 - Electrical Identification: Identification products and requirements.

E. Section 16051 - Overcurrent Protective Device Coordination Study.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

B. NECA 407 - Standard for Installing and Maintaining Panelboards; National Electrical Contractors Association; 2009.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.

D. NEMA PB 1 - Panelboards; National Electrical Manufacturers Association; 2011.

E. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; National Electrical Manufacturers Association; 2013 (ANSI/NEMA PB 1.1).

F. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

I. UL 67 - Panelboards; Current Edition, Including All Revisions.

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include manufacturers recommended tightening torque for all mechanical connections to be made in the field.
   2. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
   1. Document and record the tightened torque of each mechanical connection made in the field.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01600 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Siemens Industry, Inc: www.usa.siemens.com.

B. Eaton Corporation; Cutler-Hammer Products: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project.

2.02 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet (2,000 m).
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 16051.

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
      b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
   3. Fronts:
      a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
      b. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

J. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

K. Load centers are not acceptable.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   1. Phase and Neutral Bus Material: Aluminum or copper.
   2. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers:
   1. Provide bolt-on type.
   2. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 600 amperes.
   3. Provide electronic trip circuit breakers for circuit breaker frame sizes 600 amperes and above.

E. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
   a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating _____
   b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
   a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   a. Provide the following field-adjustable trip response settings:
      1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      2) Long time delay.
      3) Short time pickup and delay.
      4) Instantaneous pickup.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
   b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide the following features and accessories:
    a. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive panelboards.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 16070.

E. Install panelboards plumb.

F. Mount floor-mounted power distribution panelboards on properly sized 4 inch (100 mm) high concrete pad constructed in accordance with Section 03300.

G. Provide grounding and bonding in accordance with Section 16060.

H. Install all field-installed branch devices, components, and accessories.

I. Use a properly calibrated torque wrench for tightening all lugs, terminals, and field conneted mechanical connections.

J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 16051.

K. Provide filler plates to cover unused spaces in panelboards.

L. Identify panelboards in accordance with Section 16075.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01400.

B. Test GFCI circuit breakers to verify proper operation.

C. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 16443

SECTION 16491
FUSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fuses.

1.02 REFERENCE STANDARDS

A. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association; 2002 (R2007).

B. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.

E. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.

F. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
   2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
   3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01600 - Product Requirements, for additional provisions.
   2. Extra Fuses: One set(s) of three for each type and size installed.

1.05 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com.

B. Mersen (formerly Ferraz Shawmut): ferrazshawmut.mersen.com.

C. Littelfuse, Inc: www.littelfuse.com.

2.02 APPLICATIONS

A. Service Entrance:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
   2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay, 5 second (minimum)

B. Feeders:

1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay, 5 second (minimum)

C. General Purpose Branch Circuits: Class RK1, time-delay.

D. Individual Motor Branch Circuits: Class RK1, time-delay.

E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.

F. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Comply with UL 248-1.

E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.

F. Voltage Rating: Suitable for circuit voltage.

G. Class R Fuses: Comply with UL 248-12.

H. Class L Fuses: Comply with UL 248-10.

I. Class CC Fuses: Comply with UL 248-4.

J. Provide the following accessories where indicated or where required to complete installation:
1. Fuseholders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 16491

SECTION 16510
INTERIOR LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.

B. Emergency lighting units.

C. Exit signs.

D. Ballasts and drivers.

E. Lamps.

F. Luminaire accessories.

1.02 RELATED REQUIREMENTS

A. Section 16138 - Boxes.

B. Section 16520 - Exterior Luminaires.

1.03 REFERENCE STANDARDS

A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.

B. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).

C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.

D. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

F. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.

G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

H. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. NFPA 101 - Life Safety Code; National Fire Protection Association; 2012.

J. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

K. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

L. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.

M. UL 1598 - Luminaires; Current Edition, Including All Revisions.

N. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.

2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.

C. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01600 - Product Requirements, for additional provisions.
   2. Extra Lamps: Five percent of total quantity installed for each type, but not less than two of each type. (n/a to LED fixtures)

E. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all linear fluorescent ballasts.

C. Provide five year manufacturer warranty for all LED drivers.

D. Provide five year full warranty for batteries for emergency lighting units.

E. Provide five year full warranty for batteries for self-powered exit signs.

F. Provide five year full warranty for emergency power supply units.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.

H. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

C. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101; provide indicator light(s) to report test and diagnostic status.

G. Accessories:
   1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
   2. Provide compatible accessory wire guards.
   3. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.04 EXIT SIGNS

A. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single or double as indicated or as required for the installed location.
   2. Directional Arrows: As indicated or as required for the installed location.

B. Self-Powered Exit Signs:
   1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
   2. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
   3. Provide low-voltage disconnect to prevent battery damage from deep discharge.

4. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101; provide indicator light(s) to report test and diagnostic status.

C. Accessories:
1. Provide compatible accessory wire guards.

2.05 BALLASTS AND DRIVERS

A. All Ballasts and Drivers:
1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

B. Fluorescent Ballasts:
1. All Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.
a. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.
b. Total Harmonic Distortion: Not greater than 20 percent.
c. Power Factor: Not less than 0.95.
d. Thermal Protection: Listed and labeled as UL Class P, with automatic reset for integral thermal protectors.
e. Sound Rating: Class A, suitable for average ambient noise level of 20 to 24 decibels.
f. Lamp Compatibility: Specifically designed for use with the specified lamp, with no visible flicker.
g. Lamp Operating Frequency: Greater than 20 kHz.
h. Lamp Current Crest Factor: Not greater than 1.7.
i. Provide automatic restart capability to restart replaced lamp(s) without requiring resetting of power.
j. Provide end of lamp life automatic shut down circuitry for T5 and smaller diameter lamp ballasts.
k. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.
l. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 18, for Class A, non-consumer application.
m. Ballast Marking: Include wiring diagrams with lamp connections.

2.06 LAMPS

A. Lamps - General Requirements:
1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

2.07 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, factory finished to match luminaire or field-painted as directed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 16138 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Secure recessed luminaires to building structure.
   3. Secure pendant-mounted luminaires to building structure.
   4. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.

F. Suspended Luminaires:
   1. Provide minimum of two supports for each luminaire, with no more than 4 feet (1.2 m) between supports.
   2. Install canopies tight to mounting surface.

G. Install accessories furnished with each luminaire.

H. Bond products and metal accessories to branch circuit equipment grounding conductor.

I. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

J. Exit Signs:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

K. Install lamps in each luminaire.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs and emergency lighting units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.04 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.05 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Just prior to Substantial Completion, replace all lamps that have failed.

3.07 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 16510

SECTION 16520
EXTERIOR LUMINAIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Ballasts.

C. Lamps.

1.02 RELATED REQUIREMENTS

A. Section 16138 - Boxes.

1.03 REFERENCE STANDARDS

A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.

B. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).

C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.

D. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.

F. NECA/IESNA 501 - Recommended Practice for Installing Exterior Lighting Systems; 2006.

G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 844 - Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

I. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.

J. UL 1598 - Luminaires; Current Edition, Including All Revisions.

K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
   2. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.

C. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01600 - Product Requirements, for additional provisions.
   2. Extra Lamps: Five percent of total quantity installed for each type, but not less than two of each type. (n/a to LED fixtures)

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. Hazardous (Classified) Location Luminaires: Listed and labeled as complying with UL 844 for the classification of the installed location.

I. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 BALLASTS

A. All Ballasts and Drivers:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

B. Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.

1. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.
2. Total Harmonic Distortion: Not greater than 20 percent.
3. Power Factor: Not less than 0.95.
4. Thermal Protection: Listed and labeled as UL Class P, with automatic reset for integral thermal protectors.
5. Sound Rating: Class A, suitable for average ambient noise level of 20 to 24 decibels.
6. Lamp Compatibility: Specifically designed for use with the specified lamp, with no visible flicker.
7. Lamp Operating Frequency: Greater than 20 kHz, except as specified below.
8. Lamp Current Crest Factor: Not greater than 1.7.
9. Lamp Starting Temperature: Capable of starting standard lamp(s) at a minimum of -20 degrees F (-29 degrees C) unless otherwise indicated.
10. Provide automatic restart capability to restart replaced lamp(s) without requiring resetting of power.
11. Provide end of lamp life automatic shut down circuitry for T5 and smaller diameter lamp ballasts.
12. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.
13. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 18, for Class A, non-consumer application.
14. Ballast Marking: Include wiring diagrams with lamp connections.

2.04 LAMPS

A. Lamps - General Requirements:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Engineer to be inconsistent in perceived color temperature.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 16138 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer's instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Luminaires:

1. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet (1.2 m) between supports.
2. Install canopies tight to mounting surface.

F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

G. Install accessories furnished with each luminaire.

H. Bond products and metal accessories to branch circuit equipment grounding conductor.

I. Install lamps in each luminaire.

3.03 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.04 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Engineer.

3.05 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. Just prior to Substantial Completion, replace all lamps that have failed.

3.07 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 16520