SP- 150160a
(New)

SPECIAL PROVISIONS
FOR
STORM WATER PUMP STATION

Black Hawk County
NHSX-063-6(78)--3H-07

Effective Date
December 20, 2016

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

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SECTION 01110
SUMMARY OF WORK

PART 1 DESCRIPTION

1.01 SUMMARY

A. Work on this Contract entails construction of a storm water pump station on the south bank of the Cedar River, west of southbound US 63. This pump station will allow storm runoff in the adjacent storm sewer system to be pumped into the Cedar River when the gravity outlet is closed due to high river levels. Work includes construction of an inlet RCB, outlet RCB with a headwall, an electrical building, a parking area and a driveway to the station from the adjacent parking lot. Project also includes levee excavation, backfill and restoration, and all other related work.

Work involved also includes modification of an existing storm water pump station on the north bank of the Cedar River, west of northbound US 63. Modifications to this pump station include removal of the top slab and interior walls, pumps, outlet piping, electrical equipment and station controls. Once removals are completed, new interior walls, pumps, pump tubes, outlet piping, stop logs, top slab and electrical building will be installed. Levee excavation, backfill and restoration, driveway and parking lot paving, and other related work are also included.

1.05 WORK BY OTHERS

A. Utility Services:

1. Electric Utility will furnish and install electric power services to point of termination and provide meters at locations as shown on plans. Contractor to pay electric utility for all costs associated with providing electric power services.
2. Refer to referenced Specification sections for cost, if any, to be included in Bid.

1.06 MILESTONES (WORK SEQUENCE)

A. Construct Work in stages to provide for public convenience; coordinate construction progress schedule and operations with Engineer.

1.07 CONTRACTOR'S USE OF PREMISES

A. Conduct operations to ensure least inconvenience to general public. Coordinate use of premises with Contracting Authority.

B. Assume full responsibility for protection and safekeeping of products under this Contract.

C. Obtain and pay for use of additional storage or Work areas needed for operations at no additional cost to Contracting Authority.

D. Confine operations to areas within Contract limits indicated. Do not disturb portions of site beyond areas in which Work is indicated.

1.08 EASEMENTS, LICENSES, AND PERMITS

A. Easements, construction licenses, and permits obtained for Work shown on plans.

1. Contracting Authority has copies of documents on file for review.
2. Comply with provisions of easements, licenses, and permits.
3. Obtain additional construction licenses necessary to complete Work.

4. Perform construction within existing rights-of-way.
5. Obtain written authorization from affected property owners or maintaining authorities if construction is outside these areas.
6. Comply with requirements of City and Contracting Authority.
7. Obtain written approval of restoration from construction license grantors shown on plans.

1.09 STAKING

A. All staking will be provided by the Contractor.

B. Temporary Electricity and Lighting. Temporary lighting shall be sufficient to enable Contractor to complete work and enable Engineer to observe work as it is being performed. Illumination shall meet or exceed state code requirements.

1. Provide, maintain and remove temporary electric service facilities.
2. Facilities exposed to weather shall be weatherproof type and electrical equipment enclosure locked to prevent access by unauthorized personnel.
3. Pay for installation of temporary services, including poles, transformer charges and metering.
4. Arrange with local electric utility for temporary electric service subject to their requirements and approval.
5. Register temporary meter in Contractor's name.
6. Provide and maintain lamps, wiring, switches, sockets and similar equipment required for temporary lighting and small power tools.
7. Pay for electrical energy consumed for construction purposes, including operation of ventilating equipment for heating of buildings, and for testing and operating of equipment after permanent wiring has been installed, until final acceptance by Engineer or until occupancy by City.
8. Provide and pay for service to temporary offices.

1.10 OPERATIONS DURING FLOOD CONDITIONS

A. Submit a Flood Contingency Plan at Preconstruction Meeting demonstrating ability and equipment to meet requirements of Attachment A, Flood Contingency Plan, approved by US Army Corps of Engineers. Contractor shall add names, contact numbers, equipment, materials, and planned staging of construction affecting existing flood control system and submit to Engineer for approval. Identify dates Cedar River levee will be degraded and restored and risk factors that would result in opening being in place longer than anticipated.

B. Contractor shall have personnel on-site during flood conditions to coordinate with Engineer and Contracting Authority personnel.

PART 2 MATERIAL

2.01 Materials shall meet the requirements of the project contract documents.

PART 3 CONSTRUCTION

3.01 Construction shall meet the requirements of the project contract documents.

PART 4 METHOD OF MEASUREMENT

4.01 Measurement of the South Pump Station work shall be for one completed pump station as noted in Paragraph 1.01.A. All quantities shown in the plans are for informational and estimating purposes only. No individual items or work elements will be measured for payment. Variations from the quantities as shown in the plans shall not by itself be considered grounds for change

order. Contractor's lump sum bid price shall include all labor, materials, tools and equipment necessary to complete work as described in the plans. All work associated with this new pump station shall be completed and accepted, and the entire pump station shall be in working order prior to being accepted by the Contracting Authority.

4.02 Measurement of the North Pump Station work shall be for one completed modification of the existing pump station as noted in Paragraph 1.01.A. All quantities shown in the plans are for informational and estimating purposes only. No individual items or work elements will be measured for payment. Variations from the quantities as shown in the plans shall not by itself be considered grounds for change order. Contractor's lump sum bid price shall include all labor, materials, tools and equipment necessary to complete work as described in the plans. All work associated with this modification shall be completed and accepted and the entire pump station shall be in working order prior to being accepted by the Contracting Authority.

PART 5 BASIS OF PAYMENT

5.01 Payment for the South Pump Station shall be made on the basis of the percentage complete of the overall pump station construction.

5.02 Payment for the North Pump Station shall be made on the basis of the percentage complete of the overall pump station modification.

* * * END OF SECTION * * *

ATTACHMENT A

FLOOD CONTINGENCY PLAN
U.S. HIGHWAY 63 STORM WATER PUMP STATIONS
CITY OF WATERLOO/IOWA DOT
WATERLOO, IOWA

COMPLETE/IN PROGRESS TO DATE:

a. 100% Engineering and Plan Design

b. Permit Applications – Iowa DNR Flood Plain, USACE Sections 408 and 404

SCHEDULE SUMMARY:

a. Bidding: December 2016

b. Pump Station Construction Duration: December 2016 - December 2017

GENERAL:

The Contractor is responsible for monitoring river stages and forecasts. Contractor contact is to be determined when the contract has been awarded. City contact is Jamie Knutson, Associate City Engineer (319-291-4312). The USACE contact is Kalvin Kalafut (309-210-5383).

Contractor shall update and resubmit this Flood Contingency Plan for approval prior to beginning work on the project. At a minimum, the Contractor shall update this plan with:

a. Contact names and 24 hour phone numbers.

b. Anticipated dates for work items that are covered under this plan.

c. Anticipated construction timelines and durations when any portion of the levee system will be compromised for excavation and construction.

d. Equipment make and model that will be kept on-site for emergency backfill of excavations.

e. Number, size and capacity of temporary pumps that will be provided at each pump station site.

Official river stages and forecasts for the Contractor is the Cedar River gage at Waterloo (National Weather Service number ALOI4). Seven-day forecasts for this gage are available at the website http://water.weather.gov/ahps2/hydrograph.php?wfo=dmx&gage=aloi4 .

NORTH PUMP STATION SITE:

The existing north pump station site is located on the north bank of the Cedar River, between Mullan Avenue (U.S. Highway 63 Southbound) and First Street (U.S. Highway 63 Northbound). The existing station is located within the existing earthen levee protection system and will be modified to increase the pumping capacity. The existing station is currently active and used as the outlet for a 77-acre urbanized drainage area during gate-closed conditions on the Cedar River. The Contractor will be required to remove the existing pumps and reconstruct the interior of the station to house new, larger pumps. In addition, the Contractor will be constructing an electrical and control building on top of the existing levee. During construction, the Contractor shall maintain the closure gate to the Cedar River and provide temporary pumping to meet the existing station capacity of 33 cfs. Pumping shall be available on-site from the time the existing pumps are removed and prior to the new pumps being operational.

The City will notify the Contractor of gate closure, as required according to the established operations manual. At any time, the Contractor shall be able to close the gate within 24 hours of notice. The gates are closed when the water surface elevation at the project site reaches elevation 842.0, or when the Waterloo gage reaches 9.2 feet or elevation or water surface elevation 833.3 at the gage site.

The new electrical building will be constructed on top of the existing levee and will include a frost footing and impact the top of the levee in the existing freeboard area to approximate Elevation 853.0 feet. This elevation is above the FIS 100 year elevation of 852.6 feet at this location. The Contractor shall provide a construction schedule and duration of levee degradation prior to construction. It is estimated that this portion of the project will take 2-4 months to be completed. The Contractor shall complete all portions of the project that require levee degradation as soon as possible to restore the flood protection system to existing conditions. The Contractor is also required to stockpile material on-site to be used in the event of a flood forecast higher than an elevation of 850 feet at the project site, which is roughly 1.3 feet below the existing FIS 50-year level.

In addition to the specific criteria discussed for the north station, the Contractor shall follow the requirements provided at the bottom of this document for work within the levee area.

SOUTH PUMP STATION SITE:

The proposed south pump station is located on the south bank of the Cedar River, upstream of Mullan Avenue (U.S. Highway 63 Southbound). There is no existing pump station at this location. The Contractor will be responsible for construction of a new pump station and gravity outlet at this location. The station will be located within the flood protection system and will require excavation that will reduce the design flood protection elevations during construction.

Prior to construction, the Contractor shall provide shoring/stabilization details for the pump station excavation to stabilize the existing levee and provide flood protection up the 10 year FIS flood elevation of 848.4 feet at the project site. If the Cedar River is forecast to be above this elevation, emergency measures will be taken which include backfilling open trenches and excavations with material stockpiled on-site. The Contractor shall provide a construction schedule and duration of levee degradation prior to construction of this phase of the project. It is estimated that wet well construction will take 4 to 6 months to complete and approximately 4 to 6 weeks for the gravity 4 foot by 6 foot RCB culvert outlet through the existing levee system. The Contractor shall complete all portions of the project that require levee degradation as soon as possible to restore the flood protection system to existing conditions.

During the construction of the outlet culvert, the Contractor shall maintain the 10 year flood protection for the majority of the culvert construction. However, during construction of the culvert portion through the levee the Contractor shall provide protection to approximate elevation 845.0 feet at the project site. The Contractor shall not start construction through the levee if the river is forecast to be above elevation 840 at the project site within the next 7 days.

If the Cedar River is forecast to be above elevation 845 during outlet culvert construction or elevation 842 at the project site (Gage Height of 9.2 feet) during culvert construction through the levee, emergency measures will be taken which include backfilling open trenches and excavations with material stockpiled on-site. The Contractor shall provide a construction schedule and duration of levee degradation prior to construction of this phase of the project.

In addition to the specific criteria discussed for the South Station, the Contractor shall follow the requirements provided at the bottom of this document for work within the levee area.

It is the Contractor's responsibility to monitor river levels during construction and follow the requirements below for work within the levee area.

Contractor Requirements for Excavation in or Within 25 Feet of Earthen Levee

a. Notify U.S. Army Corps of Engineers, Rock Island District, 1 week in advance of any excavation that compromises any portion of the earthen levee. The USACE contact is Kalvin Kalafut (309-210-5383).

b. Excavations that compromise the full height of the earthen levee shall be completed and restored to full height as soon as reasonably possible.

c. The action stage for both stations is Elevation 842.0 feet at the project site or 833.2 feet at the USGS Gage Station which corresponds to a gage height of 9.2 feet. Excavation shall only be completed when the Cedar River gage is below 9.2 feet and is forecasted (according to the National Weather Service site provided on the first page of this plan) to remain below 9.2 feet for the next 7 days.

d. The Contractor shall maintain stockpiles of soil on-site for backfilling open trenches.

e. Maintain presence of equipment on-site for emergency backfilling throughout the duration of open excavation. At any time, the Contractor shall be able to close an open trench within 24 hours of notification from the City of Waterloo or the USACE.

If flooding is forecast on the Cedar River according to the National Weather Service site within the next 7 days, Contractor shall take the following actions within 24 hours:

a. Cease excavation dewatering operations.

b. Backfill open trenches within 25 feet of earthen levee.

c. Make the north gate operational. Prepare to close the gate as directed by City.

d. Ready temporary pumps for the North Station as necessary.

SECTION 01455
TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 PERFORMANCE REQUIREMENTS

A. Employ and pay for services of testing laboratory approved by Contracting Authority to perform specified services and testing as described in Specifications.

1. Employment of laboratory shall, in no way, relieve Contractor's obligations to perform Work of Contract.

B. Related Requirements in Other Parts of contract documents:

1. Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities, Conditions of Contract.

1.02 QUALIFICATION OF LABORATORY

A. Meet basic requirements of ASTM E329.

B. Authorized to operate in state in which Project is located.

C. Testing Equipment:

1. Calibrated at reasonable intervals by devices of accuracy traceable to either:

a. National Bureau of Standards.
b. Accepted values of natural physical constants.

1.03 LABORATORY DUTIES

A. Cooperate with Engineer and Contractor; provide qualified personnel to perform Work after due Notice to Proceed.

B. Perform specified inspections, secure samples, and test materials.

1. Comply with specified standards.
2. Ascertain compliance of materials with contract documents.

C. Promptly notify Engineer and Contractor of observed irregularities or deficiencies of Work, equipment or material.

D. Promptly submit written report of each test and inspection; one copy each to Engineer, Contracting Authority, material supplier, and Contractor, and one copy to record document file. Each report shall include following.

1. Date issued.
2. Project title and number.
3. Testing laboratory name, address, and telephone number.
4. Name and signature of laboratory inspector.
5. Date and time of sampling or inspection.
6. Record of temperature and weather conditions if test performed in field.
7. Date of test.

8. Identification of product and Specification section.
9. Location of sample or test in Project.
10. Type of inspection or test.
11. Results of tests and compliance with contract documents.
12. Interpretation of test results, when requested by Engineer.

E. Perform additional tests as required by Engineer or Contractor.

1.04 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of contract documents.
2. Approve or accept any portion of Work.
3. Perform duties of Contractor.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel and provide access to Work.

B. Provide to laboratory preliminary design mix proposed to be used for concrete and other material mixes which require control by testing laboratory.

C. Furnish copies of product test reports.

D. Furnish incidental labor and facilities.

1. Provide access to Work to be tested.
2. Obtain and handle samples at Project site or at source of product to be tested.
3. Facilitate inspections and tests.
4. Store and cure test samples.

E. Notify laboratory and Engineer sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.

1. When tests or inspections cannot be performed after such notice, reimburse Contracting Authority for laboratory personnel and travel expenses incurred due to Contractor’s negligence.

F. Make arrangements with laboratory and pay for additional samples and tests required for Contractor’s convenience.

G. Employ and pay for services of testing laboratory to perform additional inspections, sampling, and testing required when initial tests indicate Work does not comply with contract documents.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

(Not Used)

* * * END OF SECTION * * *

SECTION 01456
TESTING TANKS AND RESERVOIRS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing wetwells which are to hold storm water.

1.02 SUBMITTALS

A. Test Results:

1. Records on tank testing indicating date of test, amount of leakage, amount of evaporation, amount of precipitation, water temperature, corrective action if any, and retest results.

B. Submit in accordance with Section 1105 of the Standard Specifications**.**

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 GENERAL

A. Supply water for testing.

B. Water from Cedar River may be used.

3.02 PREPARATION

A. Structures shall be subjected to leakage tests after concrete has obtained design strength, and before backfilling or other Work which will cover faces of walls is begun.

B. Tanks laterally restrained or supported by cross-walls, beams or slabs shall not be tested until such restraining or supporting construction is placed and design strength obtained.

C. Perform cleaning in accordance with Section 01740.

D. Initial filling of structure shall not exceed rate of 4 feet per hour.

E. Water shall be kept at test level of structure for at least 3 days prior to actual test. This waiting period will be considered sufficient for absorption of moisture by concrete and temperature stabilization of test water.

F. Each cell of multi-cell tanks shall be considered single tank and tested individually unless otherwise directed by Engineer.

G. Coatings if noted, shall not be applied until after leakage testing is complete.

3.03 TESTING AND TEST MEASUREMENTS

A. Test criteria: ACI 350.1-01 designation HST-050, maximum of 0.05% loss of water volume in 24 hours.

B. Fill structure with water to elevation given in Table 01456.

1. Select four fixed points above water surface, 90 degrees apart to measure change in water level and water temperature during test period.
2. Measure change in water level at 24 hour intervals during test period.
3. Record water temperature at depth of 18 inches below water surface at 24 hour intervals during test period.
4. Test period shall be as given in Table 01456.

C. In open structures, fill 55 gallon container with water and place in tank for evaporation and precipitation measurement. Evaporation shall be measured in well-ventilated covered tanks. Level of water in 55 gallon container shall be measured and recorded for same period as tank.

D. During test period, examine structure daily for damp spots, seepage and leakage.

E. Test measurements shall not be made when weather forecast indicates water surface would be frozen before test is completed or when there would be more than 35°F difference between temperature readings at initial measurement and final measurement of water surface.

F. Test shall be restarted if test measurements become unreliable due to unusual precipitation or other external factors.

G. Structure shall be considered to have failed test if any of following occurs:

1. Loss of water exceeds required criterion.
2. Water is observed flowing or seeping from structure.
3. Moisture can be transferred from exterior surface to dry hand.

H. Drain structure to 2 foot minimum below leaks and damp spots, and repair. Method of repair shall be Contractor's, subject to requirements of these Specifications and review by Engineer. Tanks shall be refilled and retested until they meet required criterion.

I. Repairs and additional tests shall be made by Contractor in acceptable manner at no additional cost to Contracting Authority.

J.

TABLE 01456
LIQUID LEVEL TEST ELEVATION

Structure No. and Name	Liquid Level		
	Tank Designation	Test Elevation	Test Period In Days
South Pump Station	Wetwell	841.50	5

APPENDIX I

EXAMPLE TEST RESULTS

Tank Description =

HWL Elevation in Tank for leakage testing =

Number of days tank stayed filled before first water level reading was taken =

Number of days tested = *5* **days**

				Test Pt #1			**Test Pt #2**			**Test Pt #3**			**Test Pt #4**			Avg loss or gain at all test	**55 Gal**		
				Water			Water			Water			Water				Water		
Day	Date	Tester	Time	Temp	Elev	Loss or gain	Temp	Elev	Loss or gain	Temp	Elev	Loss or gain	Temp	Elev	Loss or gain		Temp	Elev	Loss or gain
0	12/01			75	66.875	*0.00*	75	66.813	*0.00*	75	67.375	*0.00*	75	67.063	*0.00*	*0.00*	76	64.500	*0.00*
1	12/02			78	66.750	*0.13*	78	66.938	*-0.13*	78	67.625	*-0.25*	78	67.313	*-0.25*	*-0.13*	74	64.625	*-0.13*
2	12/03			72	67.063	*-0.31*	72	67.313	*-0.38*	72	67.688	*-0.06*	72	67.563	*-0.25*	*-0.25*	72	64.813	*-0.19*
3	12/04			70	67.438	*-0.38*	70	67.750	*-0.44*	70	67.813	*-0.13*	70	67.750	*-0.19*	*-0.28*	70	65.125	*-0.31*
4	12/05			74	67.750	*-0.31*	74	68.000	*-0.25*	74	68.250	*-0.44*	74	67.938	*-0.19*	*-0.30*	74	65.500	*-0.38*
5	12/06			73	68.063	*-0.31*	73	68.375	*-0.38*	73	68.500	*-0.25*	73	68.188	*-0.25*	*-0.30*	73	65.688	*-0.19*
	Total loss or gain				-1.19	*-1.19*		-1.56	*-1.56*		-1.13	*-1.13*		-1.13	*-1.13*	***-1.25***		-1.19	***-1.19***
															Average daily loss or gain =	***-0.25***			**-0.24**

Weather description when water level readings were taken:

12/01	
12/02	
12/03	
12/04	
12/05	
12/06	

Remarks:

Damp spot : _____

Leakage : _____

Seepage : _____

APPENDIX II

EXAMPLE TABLE

Tank Description =

HWL Elevation in Tank for leakage testing =

Number of days tank stayed filled before first water level reading was taken =

Number of days tested = **days**

				Test Pt #1			**Test Pt #2**			**Test Pt #3**			**Test Pt #4**			Avg loss	**55 Gal**		
				Water		Loss	Water		Loss	Water		Loss	Water		Loss	or gain	Water		Loss
Day	Date	Tester	Time	Temp	Elev	or gain	Temp	Elev	or gain	Temp	Elev	or gain	Temp	Elev	or gain	at all test pts	Temp	Elev	or gain
0																			
1																			
2																			
3																			
4																			
5																			
	Total loss or gain																		
															Average daily loss or gain =				

Weather description when water level readings were taken:

Remarks

Damp spot : _____

Leakage : _____

Seepage : _____

* * * END OF SECTION * * *

SECTION 01457
TESTING PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hydrostatic pressure testing.
2. Low pressure air testing.
3. High pressure air testing.

B. Other sections identify new piping systems to be tested, identify type of test to be performed, specify test pressure, and reference this section for detailed testing requirements.

1.02 SUBMITTALS

A. Test report for each piping system tested.

B. Submit in accordance with Section 1105 of the Standard Specifications.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 GENERAL

A. Pressure test in presence of Engineer.

B. Furnish water required for testing and provide necessary piping connections between section of piping being tested and nearest available source of water or air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to perform specified tests.

C. Provide bulkheads, flanges, valves, bracing, blocking or other temporary sectionalizing devices that may be required.

D. Remove temporary sectionalizing device after tests complete.

E. Perform tests on exposed piping after piping completely installed, including supports, hangers, and anchors.

F. Perform tests on piping before insulation installed.

G. Perform tests on piping that is clean and free of dirt, sand or other foreign material.

H. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.

I. Add test fluid slowly.

J. Include regulator set to avoid overpressurizing and damaging piping.

K. Perform pressure testing in accordance with local, state, and federal requirements.

L. Cost of testing including water, personnel, equipment, and materials shall be Contractor's responsibility.

M. Correct leaks or defects and retest at no additional cost to Contracting Authority.

3.02 HYDROSTATIC PRESSURE TESTING

A. Perform hydrostatic pressure testing for piping systems identified in other sections to be hydrostatically pressure tested. Test pressure shall be as specified in other sections.

B. Open vents at high points to purge air pockets while piping system is filling. Venting may also be provided by loosening flanges or with equipment vents.

C. Testing:

1. After section of piping to be tested has been filled with water, apply test pressure by means of force pump of such design and capacity that required pressure can be applied and maintained without interruption for duration of test.
2. Measure test pressure by means of tested and properly calibrated pressure gauge acceptable to Engineer.
3. Maintain test pressure for sufficient length of time to permit Engineer to observe piping under test but not less than 2 hours.
4. If repairs required, repeat pressure test until pipe installation conforms to specified requirements and is acceptable to Engineer.

D. With exception of buried piping with mechanical joints or push-on joints, piping systems shall show no visual evidence of weeping or leaking.

E. Maximum allowable leakage for buried piping with mechanical joints or push-on joints is as follows.

$$L = \frac{NDP^{1/2}}{7400}$$

Where:

L = Leakage, gallons per hour
N = Number of joints under test
D = Nominal diameter of piping, inch
P = Average pressure during test, pounds per square inch

3.03 LOW PRESSURE AIR TESTING

A. General:

1. Perform low pressure air testing for gravity sewer and drainage piping systems identified in other sections to be low pressure air tested.
2. Air Test Procedure: Test pipes between adjacent manholes. Test time for air pressure to drop 1 psig.
   a. For pipes, 4 inches through 24 inches: Comply with Table 1.
   b. Pipe diameters above 36 inches will not be accepted by means of low pressure air test. In all cases, ignore length of laterals.

TABLE 1
LOW PRESSURE AIR TEST TIME

Specification time (minutes:seconds) required for loss of air pressure From 3.5 psig to 2.5 psig for size and length of pipe

A	B	C	D	E	F
Pipe Dia (inch)	**Time/Foot up to Length in Column C (seconds)**	**Test Length (feet)**	**Test Time for Length Between Columns C & E (minutes: seconds)**	**Length Time in Column F Applies (feet)**	**Time/Foot for Total Length (seconds)**
4	0.18	636	1:54	1,432	0.08
6	0.40	424	2:50	955	0.18
8	0.71	318	3:47	716	0.32
10	1.11	255	4:43	573	0.49
12	1.60	212	5:40	477	0.71
15	2.50	170	7:05	382	1.11
18	3.62	141	8:30	318	1.61
21	4.92	121	9:55	273	2.19
24	6.42	106	11:20	239	2.85
27	8.14	94	12:45	212	3.62
30	10.00	85	14:10	191	4.44
33	12.14	77	15:35	174	5.40
36	14.37	71	17:00	159	6.39

B. Preparation:

1. Isolate pipe section to be tested by plugging each end with air tight plugs. Plug ends of branches, laterals and wyes which are to be included in test section.
2. Brace plugs to prevent slippage and blowout due to internal pressure.
3. One plug shall have inlet tap or other provision for connecting supply air hose.
4. Connect one end of air hose to plug used for air inlet; other end to portable air control equipment.
5. Air control equipment shall consist of valves and pressure gauges to control rate at which air flows into test section and gauges to monitor air pressure inside pipe.
6. Connect air hose between source of compressed air and control equipment.

C. Testing:

1. If pipe to be tested is submerged in groundwater, determine height of groundwater above spring line of pipe at each end of test section and compute average. For every foot of groundwater above pipe's spring line, increase gauge test pressures by 0.43 pound/square inch.
2. Add air slowly to test section until pressure inside pipe is raised to 4.0 psig greater than average back pressure of groundwater that may be over pipe.
3. After pressure of 4.0 psig obtained, control supply of air so internal pressure maintained between 3.5 and 4.0 psig (above average groundwater back pressure) for minimum of 2 minutes to allow temperature of air to come into equilibrium with temperature of pipe walls.
4. Determine rate of air lost by time pressure drop method.
   a. After temperature stabilized for 2 minute period, disconnect air supply. Allow pressure to decrease to 3.6 psig. At this pressure, start stopwatch to determine time

required for pressure to drop 1 psig. Time required for loss of 1.0 psig is then compared to Table 1. If time is equal or greater than times indicated in table, test shall be acceptable.

3.04 HIGH PRESSURE AIR TESTING

A. Perform high pressure air testing for piping systems as specified in other sections. Test pressure shall be as specified in other sections.

B. Perform preliminary test at not greater than 25 psig. Examine for leakage at joints with soap solution and visual detection of soap bubbles. Correct visible leaks.

C. Perform final test at test pressure. Pressure in system shall be gradually increased and in small increments until test pressure reached. Test pressure shall be maintained for minimum of 10 min and additional time necessary to conduct soap bubble examination of each joint for leakage.

D. Piping system shall show no evidence of leakage.

3.05 TEST REPORT

A. Prepare and submit test report for each piping system tested. Include following information in test report.

1. Date of test.
2. Description and identification of piping system tested.
3. Type of test performed.
4. Test fluid.
5. Test pressure.
6. Type and location of leaks detected.
7. Corrective action taken to repair leaks.
8. Results of retesting.

* * * END OF SECTION * * *

SECTION 01458
TESTING ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. Prior to energizing equipment, perform inspections and tests as herein specified.
2. Ensure electrical equipment supplied by Contractor and Contracting Authority is operational within industry and manufacturer's tolerances and installed in accordance with Specifications.

1.02 SUBMITTALS

A. Test Reports:

1. Permanently record checks and tests.
2. Submit seven copies of complete testing report no later than 30 days after testing complete.

B. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Recommendations for acceptance or rejection shall be given upon consultation of Engineer, Contracting Authority, and Contractor.

B. Inspections and tests shall utilize following.

1. Project Specifications.
2. Project plans.
3. Manufacturer's instruction manuals applicable to each particular apparatus.

C. Regulatory Requirements:

1. National Fire Protection Association (NFPA):
   a. National Electrical Code (NEC) (NFPA No. 70) and Iowa amendments thereto.
2. Underwriters Laboratories, Inc. (UL).

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 GENERAL

A. Test Work and equipment installed to ensure proper and safe operation in accordance with intent of contract documents.

1. Check interlocking and automatic control sequences and test operation of safety and protective devices.
2. Correct defects.

3. Cooperate with Power Company, supplier, and manufacturer representatives to achieve proper and intended operation of equipment.

B. Test, adjust, and record operating voltages at each system level before energizing branch circuits.

1. Transformer taps shall be adjusted to obtain as near as possible nominal system voltage.
2. Where transformer is under utility jurisdiction, obtain services of utility to correct voltage.
3. Replace devices and equipment damaged due to failure to comply with this requirement.

C. Balance load among feeder conductors at each panelboard, switchboard or substation and reconnect loads as may be necessary to obtain reasonable load balance on each phase. Electrical unbalance shall not exceed 7 1/2%.

3.02 SWITCHBOARD ASSEMBLIES

A. Visual and Mechanical Inspections:

1. Inspect for physical damage.
2. Verify equipment supplied and connected in accordance with Specifications.
3. Inspect for proper alignment, anchorage, and grounding.
4. Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions for proper foot-pound levels.
5. Doors, panels, and sections shall be inspected for paint, scratches, and fit.

3.03 GROUND FAULT SYSTEMS

A. Visual and Mechanical Inspection:

1. Inspect for physical damage and compliance with contract documents.
2. Inspect neutral main bonding connection to ensure following.
   a. Zero sequence system grounded upstream of sensor.
   b. Ground strap systems grounded through sensing device.
   c. Ground connection made ahead of neutral disconnect link.
3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for following.
   a. Trip test.
   b. No trip test.
   c. Non-automatic reset.
5. Proper operation and test sequence shall be recorded.
6. Zero sequence systems shall be inspected for symmetrical alignment of core balance transformers about current carrying conductors.
7. Ground fault device circuit nameplate identification shall be verified by actuation observation.
8. Pick up and time delay settings shall be set in accordance with settings developed through coordination study and as approved by Engineer.

B. Electrical Tests:

1. Measure system neutral insulation resistance to ensure no shunt ground paths exist, neutral-ground disconnect link removed, neutral insulation resistance measured, and link replaced.
2. Determine relay pickup current by primary injection at sensor and circuit interrupting device operated.
3. Test relay timing by injecting 150% and 300% of pickup current into sensor. Electrically monitor total trip time.
4. Test system operation at 55% rated voltage.

C. Test Parameters:

1. System neutral insulation shall be minimum of 100 ohms, preferably 1 megohm or larger.
2. Relay pickup current shall be within 10% of device dial or fixed setting, and in no case greater than 1200 amps.
3. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves, but in no case longer than 1 second.

3.04 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Inspect ground system for compliance with contract documents.

B. Electrical Tests:

1. Fall of potential test in accordance with IEEE No. 81, Section 9.04 on main grounding electrode or system.
2. 2-point method test in accordance with IEEE No. 81, Section 9.03, to determine ground resistance between main grounding system and major electrical equipment frame, system neutral, and derived neutral points.
3. Alternate to 2-point method.
   a. Ground continuity test between main ground system and equipment frame, system neutral, and derived neutral point.
   b. Test shall be made by passing minimum of 10 amp dc current between ground reference system and ground point to be tested.
   c. Voltage drop shall be measured and resistance calculated by voltage drop method.

C. Test Values:

1. Main ground electrode system resistance to ground shall be no greater than 5 ohms for commercial or industrial systems and 1 ohm or less for generating or transmission station grounds, unless otherwise specified by Engineer.

3.05 INSTRUMENTS AND METERS

A. Voltmeters:

1. Clean glass.
2. Check movement for proper operation.
3. Electrically check calibration of cardinal points with reference to instrument with 1% minimum accuracy.
4. Verify proper switching in all positions.

B. Ammeter:

1. Clean glass.
2. Check movement for proper operation.
3. Electrically test current transformers for ratio and polarity.
4. Electrically check calibration at cardinal points with reference to instrument with 1% minimum accuracy.
5. Verify proper switching in all positions. Verify CT ratio and polarity.

3.06 MOTOR CONTROL CENTERS AND MOTORS

A. Visual and Mechanical Inspection:

1. Inspect for physical damage, proper anchorage, and grounding.
2. Compare equipment nameplate data with plans or starter schedule.
3. Compare overload heaters with motor full load current for proper size.

* * * END OF SECTION * * *

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SUBSTITUTIONS AND "OR EQUAL" ITEMS

A. General:

1. When equipment or material is specified by naming one or more equipment manufacturers or material suppliers and followed by words "no substitution permitted" or similar wording, Contractor shall provide one of named manufacturers or suppliers.

B. Substitutions:

1. For material or equipment specified by naming one or more equipment manufacturers or material suppliers and not followed by words "or equal", Contractor shall submit request for substitution in accordance with General Conditions for equipment or manufacturer not specifically named.
2. Contractor’s requests for changes in equipment and materials from those required by contract documents are considered "requests for substitutions" and subject to Contractor’s representations and review provisions of contract documents when one or more of following conditions are satisfied.

    a. Where required equipment or material cannot be provided within Contract Time, but not as result of Contractor’s failure to pursue Work promptly or coordinate various activities properly.
    b. Where packaging of several items of equipment from single source will provide maintenance and coordination advantages to Contracting Authority.
    c. When Contractor proposes to provide substitute equipment or material to provide Contracting Authority with cost savings.

C. "Or Equal." Whenever a material, article, or piece of equipment is identified in the contract documents by reference to manufacturers' or vendors' names, trade names, catalogue numbers, etc., it is intended merely to establish a standard. Any material, article, or equipment of other manufacturers and vendors that will perform adequately the duties imposed by the general design will be considered equally acceptable provided the material, article, or equipment so proposed is, in the opinion of the Engineer, of equal substance and function. However, such substitution material, article, or equipment shall not be purchased or installed by the Contractor without the Engineer's written approval.

D. Conditions which are not substitutions:

1. Requirements for substitutions do not apply to Contractor options on materials and equipment provided for in Specifications.
2. Revisions to contract documents, where requested by Contracting Authority or Engineer, are "changes" not "substitutions."
3. Contractor’s determination of and compliance with governing regulations and orders issued by governing authorities do not constitute substitutions or basis for Change Orders, except as provided for in contract documents.

1.02 MANUFACTURER'S INSTRUCTIONS

A. Installation of equipment and materials shall comply with manufacturer's instructions. Obtain and distribute printed copies of such instructions to parties involved in installation, including two copies to Engineer.

1. Maintain one set of complete instructions at Site during installation and until completion of Work.

B. Handle, store, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformance with Specifications.

1. If Site conditions or specified requirements conflict with manufacturer's instructions, consult Engineer for further instructions. Do not proceed with Work without written instructions.

1.03 TRANSPORTATION AND HANDLING

A. Arrange deliveries of materials and equipment in accordance with construction Progress Schedule, coordinate to avoid conflict with Work and conditions at site.

1. Deliver materials and equipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
2. Protect bright machined surfaces, such as shafts and valve faces, with heavy coat of grease prior to shipment.
3. Upon delivery, inspect shipments to ensure compliance with contract documents and approved submittals, and materials and equipment have been protected and are undamaged.

B. Provide equipment and personnel to handle materials and equipment by methods recommended by manufacturer to prevent soiling or damage to materials or equipment, or their packaging.

1.04 STORAGE, PROTECTION, AND MAINTENANCE

A. Contracting Authority assumes no responsibility for damage or loss due to storage of materials and equipment.

B. Interior Storage:

1. Store with seals and labels intact and legible.
2. Store materials and equipment subject to damage by elements in weathertight enclosures.
3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

C. Exterior Storage:

1. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment subject to deterioration with impervious sheet coverings. Provide ventilation to avoid condensation.
2. Store loose granular materials in well-drained area on solid surfaces to prevent mixing with foreign matter.
3. Store materials such as pipe, reinforcing steel, structural steel, and equipment on pallets or racks, off ground.

D. Inspection and Maintenance:

1. Arrange storage to provide easy access for inspection, maintenance, and inventory.
2. Make periodic inspections of stored materials and equipment to ensure materials and equipment maintained under specified conditions are free from damage or deterioration, and coverings are in-place and in condition to provide required protection.

3. Perform maintenance on stored material and equipment in accordance with manufacturer's written instructions and in presence of Contracting Authority or Engineer.
    a. Notify Engineer 24 hours before performance of maintenance.
    b. Submit report of completed maintenance and condition of coverings to Engineer with each Application for Payment.
    c. Failure to perform maintenance, to notify Engineer of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

E. Assume responsibility for protection of completed construction and repair and restore damage to completed Work equal to original condition.

F. Wheeling of loads over finished floors, with or without plank protection, is not permitted in anything except rubber-tired wheelbarrows, buggies, trucks or dollies. This applies to finished floors and exposed concrete floors, as well as those covered with composition tile or other applied surfacing.

G. Where structural concrete is also finished surface, avoid marking or damaging surface.

1.05 SPECIAL TOOLS, SPARE PARTS AND LUBRICATING EQUIPMENT

A. Furnish, in accordance with manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those specially designed or adapted for use on parts of equipment, and not customarily and routinely carried by maintenance mechanics.

1. Tools and lubricating equipment shall be of quality compatible to equipment manufacturer has furnished.

B. Deliver to Contracting Authority before operating personnel have been instructed in operation, repair and maintenance of equipment and unit is placed in operation.

C. Mark spare parts and special tools to identify associated equipment by name, equipment, and part number. Package parts for protection against damage during shipping, handling and storage. Ship spare parts and special tools in boxes marked to indicate contents.

1.06 LUBRICATION

A. Where lubrication is required for proper operation of equipment, incorporate necessary and proper provisions in equipment in accordance with manufacturer's requirements. Where possible, lubrication shall be automated and positive.

B. Where oil is used, reservoir shall be of sufficient capacity to supply unit for 24 hour period.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Material and Equipment Incorporated into Work:

1. Conform to applicable specifications and standards.
2. Comply with size, make, type, and quality specified or as approved by Submittal.

B. Manufactured and Fabricated Materials and Equipment:

1. Design, fabricate, and assemble in accordance with engineering and shop practices standard with industry.

2. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.
3. Two or more items of same kind shall be identical, by same manufacturer.
4. Material and equipment shall be suitable for service conditions.
5. Equipment capabilities, sizes, and dimensions shown or specified shall be adhered to, unless variations are specifically approved, in writing.
6. Equipment shall be adapted to best economy in power consumption and maintenance. Parts and components shall be proportioned for stresses occurring during continuous or intermittent operation, and for additional stresses occurring during fabrication or installation.
7. Design so working parts are readily accessible for inspection and repair, easily duplicated, and replaced.

C. Do not use material or equipment for purpose other than for which it is designed or specified.

PART 3 EXECUTION

(NOT USED)

* * * END OF SECTION * * *

SECTION 01740
CLEANING

PART 1 GENERAL

1.01 SUMMARY

A. Execute cleaning during progress of Work and at completion of Work.

B. Refer to specification sections for specific cleaning for Products or Work.

1.02 DISPOSAL REQUIREMENTS

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to property and persons or damage surfaces of material to be cleaned.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

A. Keep premises and adjacent properties free from accumulations of waste materials, rubbish, and other debris resulting from construction operations.

B. Provide on-site containers for collection and removal of waste materials, debris, and rubbish in accordance with applicable regulations.

3.02 CLEANING

A. Complete following cleaning before requesting inspection for certification of substantial completion of entire Project or portion of Project.

1. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight exposed interior and exterior surfaces.
2. Wash and shine glazing and mirrors.
3. Polish glossy surfaces to clear shine.
4. Ventilating Systems:
    a. Clean permanent filters and replace disposable filters if units were operated during construction.
    b. Clean ducts, blowers, and coils if units were operated without filters during construction.
5. Electrical Systems:
    a. Leave electrical equipment rooms broom clean.
    b. Clean interior of panel cabinets, pull boxes, and other equipment enclosures.
    c. Clean lighting fixtures, lamps, and other electrical equipment soiled during installation.
    d. Contractor shall touch-up paint or repaint damaged finishes on electrical items delivered to Project with finish coat of paint. Engineer will make final determination of items to be repainted or touched-up.

6. Broom clean interior hard surface floors and exterior paved surfaces; rake clean other surfaces of grounds.
7. Clean out existing or new sewers to remove sediment and other materials that have entered during construction.
8. Clean haul roads and streets used as haul roads during construction of accumulated material. Clean paved streets with water.

B. Prior to substantial completion or City occupancy, Contractor with Engineer and Contracting Authority**,** shall conduct inspection of sight-exposed interior and exterior surfaces and work areas to verify Work and site is clean.

3.03 CLEANING

A. Wet wells, tanks, and basins shall be washed down and swept before water allowed to enter.

* * * END OF SECTION * * *

SECTION 01788
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Maintain at site one record copy of:

1. Plans.
2. Project Manual.
3. Addenda.
4. Change orders and other modifications to Contract.
5. Engineer's Field Orders, Work Change Directives, Written Amendments, or clarifications.
6. Returned Shop Drawings and other submittals.
7. Field test records.
8. Construction photographs.
9. Associated permits.
10. Certificates of inspection and approvals.

1.02 SUBMITTALS

A. At Substantial Completion:

1. Deliver one marked up set of plans to Engineer for use in preparation of record drawings.

B. Submit with transmittal letter containing following:

1. Date.
2. Project title and number.
3. Contractor's name and address.
4. Title of record document.
5. Signature of Contractor or authorized representative.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Store record documents and samples in Contractor's field office apart from documents used for construction.

1. Provide files and racks for storage of documents.
2. Provide secure storage space for storage of samples.

B. Maintain record documents in clean, dry, legible condition and in good order. Do not use record documents for construction purposes.

C. Make record documents and samples available for inspection by Engineer or Contracting Authority.

D. Failure to properly maintain record documents may be reason to delay portion of progress payments until records comply with contract documents.

3.02 RECORD DOCUMENTS

A. General:

1. Maintain one complete set of plans and Project Manual, including Addenda, legibly annotated to show changes made during construction.
2. Label each document "PROJECT RECORD" in neat, large printed letters.
3. Record information concurrently with construction progress:
   a. Do not conceal Work until information is recorded.
   b. Record changes made by written amendment, Field Order, Change Order or Work Directive Change and identify document number.
4. Give particular attention to concealed equipment and materials that would be difficult to measure and record at later date.

B. Plans:

1. Graphically depict changes by modifying or adding to plans, details, sections, elevations, or schedules.
2. Make changes on each sheet affected by changes.
3. Dimensions:
   a. Depths of various elements of foundation in relation to finish first floor datum.
   b. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
4. Location of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure.
5. Details not on original plans.
6. Location and identification of exposed interior piping, including those shown schematically on plans.
7. Size of equipment and location including connections.
8. Electrical and Instrumentation:
   a. Horizontal and vertical locations and size of underground cable, conduit, and duct runs dimensioned from established building lines.
   b. Plan location and size of interior concealed and exposed feeders.
   c. Size and location of access panels.
   d. Variations from original plans.

C. Specifications:

1. Mark Specification sections to show substantial variations in actual Work performed in comparison with text of Specifications and modifications.
2. Include variations in products delivered to site and from manufacturer’s installation instructions and recommendations.
3. Give particular attention to substitutions and selection of options and similar information.
4. Note related record drawing information and Product Data.

* * * END OF SECTION * * *

SECTION 01814
SYSTEMS DEMONSTRATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. Before Substantial Completion is considered for entire Work, Contractor shall test and demonstrate specific items of equipment and systems in operation. Conduct testing and operation demonstrations on following systems:

1. System 1 – Storm Water Pumping, North Pump Station
   a. Storm Water Pump Nos. 1, 2 and 3 (P-1-5-1, -2, -3).
2. System 2 - Storm Water Pumping, South Pump Station
   a. Storm Water Pump Nos. 1, 2, 3 and 4 (P-2-5-1, -2, -3, -4)
   b. Basin Drain Pump (P-2-7-1)

B. Preliminary:

1. Before Contractor begins testing and system operation demonstrations, Installation Services specified in Section 01600 for each system or equipment shall be completed.

C. Coordination:

1. Designate representative of Contractor to be responsible for testing and operation demonstration of systems.
2. Contractor shall schedule meeting with Contracting Authority and Engineer to assign alarm priorities in accordance with Section 16916.
3. Notify Engineer at least 5 days before tests and system operation demonstrations are to begin so Engineer can make arrangements with Contracting Authority to witness testing and demonstration.
4. Reschedule cancelled tests and operation demonstrations 5 days in advance.

1.02 SUBMITTALS

A. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 1105 of the Standard Specifications, before conducting Instructional Services described in Sections 11312 and 11313.

B. Reports:

1. Testing of Components and Systems.
   a. Prepare report for each system on results and activities encompassing testing as required by this section. Submit report within 2 days of completion of tests.
   b. As minimum, report shall describe findings of inspections; revisions, modifications or replacement of equipment; calibrations; test results; dates and names of persons involved and observing inspections, testing, and other activities pertaining to components and systems; and statement regarding operational condition of components and systems.
2. System Operation Demonstration.
   a. Prepare report for each system on results of activities encompassing operation demonstration as required by this section. Submit report within 2 days of completion of 12 hour demonstration.

b. Report shall describe operational conditions; daily results of systems operation; dates and names of persons involved and observing operation; and statement regarding system ability to meet operational criteria.

C. Submit in accordance with Section 1105 of the Standard Specification.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 TESTING OF SYSTEM COMPONENTS

A. Subject each system, process, mechanical, instrumentation, and electrical equipment components, including related piping and control systems, to individual inspection and testing by Contractor and certified by Contractor to be ready for operations before beginning system operation demonstration.

B. Inspection and tests shall be made to determine if equipment is properly assembled, aligned, adjusted, calibrated, wired or connected. Changes, adjustments or replacements of equipment due to errors or omissions on part of Contractor, or otherwise necessary to comply with requirements of contract documents shall be done without additional cost to Contracting Authority.

C. Complete training required in Sections 11312 and 11313.

D. Complete process control system testing as specified in Section 16916 minimum 30 days before system operation demonstration.

3.02 SYSTEM OPERATION DEMONSTRATION

A. Upon completion of inspection and testing of individual components in each system, demonstrate operation and performance of each system for 12 hours in accordance with requirements of contract documents.

1. Where no specific performance requirements are stated in Specifications, demonstrate to show equipment operates in accordance with acceptable industry standards for application of equipment.
2. System operation demonstration shall show equipment operates within manufacturer's tolerances for noise and vibration, equipment is responsive to manual and automatic controls, control and protective devices are properly set, and equipment runs on controlled or intermittent basis when such operation is intended.
3. System operation demonstration shall include checkout from each remote control point. Demonstrate alarm and safety lockout systems for proper function and process instrumentation and control.
4. Use river water for testing and demonstration of System No. 1, Storm Water Pumping, North Pump Station; and System No. 2, Storm Water Pumping, South Pump Station.

B. During testing and system operation demonstration, Contractor shall arrange for presence of qualified representatives of Suppliers of each piece of equipment and instrumentation included in system necessary to conduct test and demonstration.

C. Temporary facilities and services are Contractor’s responsibility. Contractor shall provide temporary connections if necessary.

D. Successful completion of system demonstration for each system will be when performance requirements established in contract documents are met while running for 120 consecutive hours.

E. If during demonstration system is not meeting performance requirements established in contract documents, Contractor shall stop demonstration, adjust, calibrate or replace equipment or instrumentation and re-start and run demonstration until 120 consecutive hours have been completed.

3.03 DETERMINATION OF SUBSTANTIAL COMPLETION

A. Systems described in Section:

1. Upon successful completion of testing of system components, system operation demonstrations, and delivery of submittals specified in this section, Contractor shall notify Contracting Authority and Engineer in writing that components and system are substantially complete.
2. Provisions of paragraphs 14.04 and 14.05 of General Conditions will apply with respect to procedure for determining substantial completion of that part of Work, certification of Substantial Completion, and division of responsibility in respect to substantially completed work.
3. Retainage will not be reduced at substantial completion of components and system.
4. Substantial completion of system will not entitle Contractor reduction or elimination of liquidated damages.

B. Other Systems:

1. Other identified systems will be considered for substantial completion when Contractor considers Work ready for its intended use.
2. Components and systems will be substantially complete after successful completion of testing of components and systems, system operation demonstration, and delivery of submittals.

* * * END OF SECTION * * *

SECTION 02222
DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

Includes removal of electrical building, including all electrical and mechanical systems, top slab of pump station, interior pump bay walls, upper portion of interior wall and other work associated with these removals.

A. Section Includes:

1. Removal and salvage of electrical, HVAC, plumbing, and process and other mechanical equipment and piping.
2. Rerouting utilities to remain.
3. Shutting off, capping, and abandoning utilities and underground piping.
4. Demolition and removal of structures.

1.02 DEFINITIONS

A. Remove: Remove portions of existing structure or utility above and below grade as specified or noted on plans.

1.03 SUBMITTALS

A. Test Results:

1. Facility condition surveys.

B. Miscellaneous Submittals:

1. Schedule and operational sequence.

C. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Conform to requirements of regulatory agencies and utility companies.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to removal of structures, accomplish following.

1. Contracting Authority release of such structure.
2. Electrical, HVAC, process, and plumbing services rerouted or shut off outside area of demolition.
3. Salvage items scheduled to be delivered to City’s storage facility.

4. Survey and record condition of existing facilities to remain in-place that may be affected by Work. After Work is complete, survey conditions again and restore facilities to original condition at no additional cost to Contracting Authority. Conduct surveys in presence of Engineer.

B. Protection:

1. Do not close or obstruct streets, walks or other facilities occupied and used by Contracting Authority and public without prior written permission from Contracting Authority and other authorities having jurisdiction.
2. Structural stability of structures adjacent to or affected by Work of this Contract shall be Contractor's responsibility.
3. Maintain in service and protect from damage existing facilities, utilities, and equipment to remain.

C. Utilities:

1. Notify utilities prior to removal operations to permit them to disconnect, remove or relocate equipment serving existing facilities.

D. Salvageable Materials:

1. Salvaged material and equipment to be retained by Contracting Authority shall be located on-site where indicated by Engineer.
2. Materials to be salvaged and retained by Contracting Authority include:
   a. Pumps
   b. Gate Stems and Pedestals
3. Equipment and materials not scheduled to be salvaged or reused in new Work shall become property of Contractor and legally disposed of off-site.

3.02 GENERAL

A. Structures to be Removed:

1. Electrical Building
2. Top Slab of Pump Station
3. Interior Pump Bay Walls
4. Upper Portion of Interior Wall
5. Electrical and Mechanical Systems

3.03 REMOVAL OPERATIONS

A. Remove existing concrete, steel and masonry to extent indicated on plans. Provide smooth, straight joint or cut line. Make cuts parallel with walls or floors.

B. Remove utilities and piping to elevations and location shown on plans and plug and seal permanently with steel cap, concrete plug or other approved method in accordance with specified abandonment procedures.

C. Remove abandoned utilities and underground piping within influence zone of proposed underground piping and proposed structures.

D. Provide temporary shoring and bracing to transfer loads of existing construction to remain from construction being removed where noted.

3.04 DISPOSAL

A. Dispose of sludge, debris, and other undesirable and unsalvageable material resulting from demolition operations in accordance with local, state and federal regulations.

* * * END OF SECTION * * *

SECTION 03200
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUBMITTALS

A. Shop Drawings:

1. Conform to ACI SP-66 showing bending diagrams; assembly diagrams; location diagrams; splicing and laps of bars, shapes, and dimensions; and details for bar reinforcing, stirrup spacing, accessories, and openings.
2. Coordinate bar splicing and placement with Contractor’s concrete placing schedule and joint locations.
3. Submit with construction joint submittals required in Section 03300.

B. Product Data:

1. Dowel bar splicer system and reinforcing bar splicer laboratory reports and manufacturer's product data.

C. Miscellaneous Submittals:

1. Welder's certification in accordance with AWS D1.4 prior to welding when welding indicated, specified or approved by Engineer.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Store reinforcing steel on supports above ground; cover and keep clean.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Reinforcing Bars:

1. Deformed bars conforming to ASTM A615, Grade 60.

B. Welded Wire Reinforcement (WWR): ASTM A185.

1. Unless other size noted, whenever welded wire reinforcement is called for, reinforcement shall be 6 x 6 - W2.9 x W2.9.
2. Provide welded wire reinforcement heavier than W2.9 in flat sheets.

C. Reinforcing Supports:

1. Exterior exposed surfaces, surfaces in contact with earth or liquid, and interior exposed surfaces in humid areas shall have all plastic or stainless steel supports.
2. Interior exposed surfaces in dry areas shall have all plastic, stainless steel, or plastic tipped steel supports.

D. Reinforcing Tension Bar Splicers:

1. Manufacturers:
   a. Cadweld or Lenton rebar splicers by Erico Products, Inc.
   b. Dayton Barsplice, Inc.
   c. Or equal.
2. Develop minimum 125% of yield capacity of bars spliced in tension when tested as assembly in accordance with ASTM A370 and A615.

E. Dowel Bar Splicer Systems:

1. Manufacturers:
   a. DB-SAE splicer system by Richmond Screw Anchor Company, Inc.
   b. C2D rebar flange coupler by Williams Form Engineering Corporation.
   c. Lenton Form Saver by Erico Products, Inc.
   d. Or equal.
2. Develop minimum 125% yield capacity of dowels when tested as assembly in accordance with ASTM A370 and A615.

2.02 FABRICATION

A. Fabricate to schedules and details on plans and in accordance with ACI 318.

PART 3 EXECUTION

3.01 PLACEMENT

A. Placement of reinforcing steel shall be approved by Engineer before covered with concrete.

B. Correct displacement of reinforcement prior to and during concrete pouring operations. Maintain clear cover as noted on plans. Tolerances shall be in accordance with ACI 117 and ACI 318, unless noted otherwise.

C. Support reinforcing steel in accordance with CRSI “Placing Reinforcing Bars” with maximum spacing of 4 feet 0 inches.

D. Tie reinforcing steel at intersections in accordance with CRSI “Placing Reinforcing Bars.”

1. Maximum Tie Spacing for Footings, Walls, and Columns: Every third intersection or 3 feet 0 inches.
2. Maximum Spacing for Slabs and Other Work: Every fourth intersection or 3 feet 0 inches.
3. Tie each dowel in-place.

E. Locate reinforcing to avoid interference with items drilled in later, such as concrete anchors.

F. Reinforcement shall be continuous through construction joints.

G. Reinforcement may be spliced at construction joints provided that entire lap is placed within only one concrete pour.

H. Extend welded wire reinforcement to within 2 inches of edges of slab or section. Lap sheets at least 12 inches or two wire spaces, whichever is greater, at ends and edges and wire together. Stagger end laps.

I. Unless shown otherwise on plans, place welded wire reinforcement between upper third point and mid-point of slab. Welded wire reinforcement placement on subgrade and pulling up during concrete placement is not allowed.

J. Use concrete brick for supporting bottom mat reinforcing on grade. Use bolsters or chairs supported on concrete brick or tied to bottom mat for supporting upper reinforcing mat on grade. Use bolsters or chairs for supporting reinforcing on mud slabs, metal deck, and forming.

K. Dowel bar splicer systems may be substituted for dowels at Contractor's option when approved by Engineer.

L. Reinforcing bar splicers may be substituted for lapped splices at Contractor's option when approved by Engineer. Stagger splices.

M. Do not field bend bars, including bars partially embedded in concrete unless indicated or approved by Engineer.

N. Do not place bars having kinks and bends other than shown on approved Shop Drawings.

O. Welding of reinforcing bars is not permitted.

P. Tack welding reinforcement is prohibited.

Q. Reinforcement shall be clean and free from loose mill scale, dirt, grease, oil, form release agent, dried concrete or any material reducing bond with concrete.

3.02 FIELD QUALITY CONTROL

A. Dowel bar splicer system and reinforcing bar splicer load capacity tests.

1. Three tests shall be performed by independent testing laboratory in accordance with Section 01455 for each dowel bar splicer and reinforcing bar splicer size used.
2. Engineer will randomly select splicers to be tested from those delivered to site.

* * * END OF SECTION * * *

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

A. Tolerances:

1. Conform to ACI 117.
2. Concrete slabs for buildings shall be within 3/16 inch of 10 foot straightedge in each direction except where slabs are dished for drains and 1/2 inch of 10 foot straightedge for concrete tankage. Deviations from elevation indicated shall not exceed 3/4 inch.
3. Pitch floor to floor drains minimum of 1/8 inch per foot or as shown on plans. Minimum thickness of slabs and depth of beams shall be as dimensioned on plans. Pitch bottom of slab or beam to match top slope of slab or beam to maintain thickness or depth noted. As an alternate, bottom of slab or beam may be poured level provided that minimum thickness or depth is maintained.

1.02 SUBMITTALS

A. Shop Drawings:

1. Construction Joints: Sequence of placing concrete and location and details of joints, openings, and embedded items not shown on plans. Coordinate sequence of placement and joint location with reinforcement Shop Drawings. Submit with reinforcement submittals required in Section 03200.
2. Verification of Mix Design:
   a. Proposed mix design for each class of concrete to be used as specified using designations indicated. Provide dry weight of cement, saturated surface dry weight of coarse and fine aggregates, brand name and quantity of admixtures when applicable, fly ash or Ground Granulated Blast Furnace slag (GGBF slag) when applicable or in combination and gallons of water required for 1 cubic yard of concrete.
   b. Submit with admixture product data and miscellaneous submittals required herein.
   c. Mix design shall be approved by Engineer before concrete is delivered to site.

B. Product Data:

1. Waterstop**:** Samples of material, splicing details, and manufacturer's literature indicating conformance with these Specifications.
2. Curing Compound and Sealers: Proposed rate of coverage and manufacturer's literature indicating conformance with these Specifications.
3. Concrete Admixtures:
   a. Manufacturer's literature.
   b. Submit with mix design.
4. High Range Water Reducers:
   a. Name of product and manufacturer's literature.
   b. Intended use area.
   c. Submit with mix design.
5. Miscellaneous Materials:
   a. Finishing Grout manufacturer's literature.
   b. Bonding Compound manufacturer's literature.
   c. Control Joint manufacturer's literature.
   d. Epoxy Joint Filler manufacturer's literature.

C. Test Results:

1. Concrete test results.
2. With each load of concrete delivered, provide duplicate delivery tickets, one for Contractor and one for Engineer, with following information.
   a. Date and serial number of ticket.
   b. Name of ready mixed concrete plant, operator, and job location.
   c. Type of cement, admixtures, if any, and brand name.
   d. Cementitious content, in bags/cubic yards of concrete, and mix design.
   e. Truck number, time loaded, and name of dispatcher.
   f. Amount of concrete in load, cubic yards, delivered.
   g. Maximum size aggregate.
   h. Gallons of water added at job, if any, and slump of concrete after water was added.
   i. Temperature of concrete at delivery.
   j. Time unloaded.

D. Miscellaneous Submittals:

1. NRMCA certification or certificate stating plant and equipment complies with NRMCA requirements specified herein.
2. Statement by ready mix supplier giving source and material certificates of cement and fine and coarse aggregates, including sieve analysis, that will be used in manufacture of each class of concrete. Make no changes in sources of materials.
3. Fly Ash: Source and test reports showing fly ash in compliance with these Specifications. Reports shall be for actual fly ash to be used in Work.
4. GGBF Slag: Source and test reports showing slag in compliance with these Specifications. Reports shall be for actual GGBF slag to be used in Work.
5. Method of pumping concrete.
6. Submit with mix design.

E. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Plant Certification: Plant or concrete supplier shall comply with requirements of National Ready Mixed Concrete Association (NRMCA) certification plan as regards material storage and handling, batching equipment, central mixer, truck mixers with counters, agitators, nonagitating units, and ticketing system.

B. Concrete Testing: Testing shall be provided by Contractor in accordance with Section 01455 and this section.

1. Conduct tests on sample material in accordance with applicable ASTM methods listed below.
   a. Slump: ASTM C143.
   b. Air-Entrainment: ASTM C231.
   c. Compressive Strength Test: ASTM C31 (making and cylinders curing) and ASTM C39 (testing).

1.04 PROJECT/SITE CONDITIONS

A. Hot Weather:

1. Comply with ACI 305.1.
2. Concrete temperature shall not exceed 90°F at placement.

3. At air temperatures of 80°F or above, keep concrete as cool as possible during placement and curing. Fog-spray forms, steel reinforcement and subgrade just before placing concrete.
4. When concrete temperatures exceed 80°F, water reducing, set retarding admixtures shall be used in accordance with manufacturer's recommendations.
5. Rate of evaporation from concrete surface shall not exceed 0.2 pound per square foot per hour based on ACI 305R Table 2.1.5 and Figure 2.1.5. Use fog-spray or evaporation retardant to maintain evaporation at 0.2 pound per square foot per hour or less.

B. Cold Weather:

1. Comply with ACI 306.1.
2. Temperature of reinforcement, forms, fillers, and other materials in contact with concrete at time of placement shall not be less than 35°F. Preheat if temperature below 35°F.
3. Maintain air and forms in contact with concrete sections having minimum dimension less than 12 inches at temperature above 50°F for at least first 3 days and at temperature above 32°F for remainder of specified curing period.
4. Maintain air and forms in contact with concrete in more massive sections at temperature above 40°F for at least first 3 days and at temperature above 32°F for remainder of specified curing period.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement:

1. ASTM C150.
2. Type I or II except tricalcium aluminate (C_3A) content of Type I shall not exceed 8%.

B. Fly Ash:

1. ASTM C618, Class C or F including requirements of Table 1A.
2. Supplemental Requirements:
   a. Loss on Ignition (maximum): 3%.
   b. Fineness (maximum retained on No. 325 sieve): 25%.
   c. Expansion at 6 months shall be less than or equal to 0.10% when tested in accordance with ASTM C1012 and ACI 201.2R.

C. Ground Granulated Blast-Furnace Slag:

1. ASTM C989, modified as follows.
   a. Slag activity classification: Grade 100 or 120.

D. Aggregates:

1. ASTM C33, modified as follows.
   a. Fine Aggregate: Natural sand.
   b. Coarse Aggregate: Crushed gravel, crushed stone or gravel Size 467 (1 1/2 inch maximum).

2. Potential reactivity of aggregates shall be determined in accordance with Appendix XI of ASTM C33.

E. Admixtures for Concrete:

1. Air-Entraining: ASTM C260.
2. Chemical Admixtures: ASTM C494, non-corrosive and chloride free.
3. Chemical Admixtures for Flowing Concrete: ASTM C1017.
   a. Type 1, Water reducing, high range.
   b. Type 2, Water reducing and retarding, high range.

F. Water: Potable.

G. Premolded Joint Filler:

1. ASTM D1751.
2. ASTM D1752, Type I, II or III.
3. Closed cell polyethylene.

H. Waterstops:

1. Virgin polyvinyl chloride (PVC) waterstop conforming to CRD C572.
2. Rubber waterstop conforming to CRD C513.
3. Gasket Type Waterstop:
   a. Hydrotite CJ-1020-2K by Greenstreak, Inc.
   b. Ultraseal MC-2010M by Adeka Ultra Seal.
4. Construction Joints: PVC, dumbell or serrated type, 6 inch wide by 3/8 inch thick, at center. If 4 inch wide waterstop indicated on plans, waterstop shall be 3/16 inch thick at center.
5. Use hydrophilic type waterstop only where noted on plans. Glue and nail to waterstop in accordance with waterstop manufacturer's recommendations.
6. Provide factory made prefabricated tees, crosses, and other configurations as required. Splice in accordance with manufacturer's written instructions.

I. Floor Sealer:

1. Manufacturers:
   a. Kure-N-Seal by Sonneborn.
   b. Cure and Seal by Symons.
   c. Dress and Seal WB by L&M Construction Chemicals, Inc.
   d. Day-Chem Tuf-Seal J-35 by Dayton Superior.
   e. AK-2 Achro Kure 1315 or AS-1 Achro Seal 1315 by TK Products (see above floor sealer).

J. Membrane Forming Curing Compound:

1. Manufacturers:
   a. Dress and Seal 30 by L&M Construction Chemicals, Inc.
   b. Super Floor Coat by Euclid Chemical Company.
   c. Masterkure by Master Builders.
   d. Kure-N-Seal 30 by Sonneborn.
   e. Achro Seal AS-30 or AS-1 Achro Seal by TK Products.
2. ASTM C309, and compatible with scheduled finishes and coatings, except permeability shall not exceed 0.2048 pounds per square foot per 72 hours.

K. Finishing Grout:

1. Manufacturers:
   a. Thoroseal with Acryl 60 by Thoro.
   b. Concrete Finisher with AKKRO-7T by Tamms Industries Company.

c. Tri-Mix with TK-225 Liquid Bonding Agent by TK Products.

L. Cement Grout: Mixture of cement and fine sand in proportions used in concrete being finished.

M. Epoxy Bonding Compound:

1. Manufacturers:
   a. Sikadur Hi-Mod by Sika Corporation.
   b. Euco Epoxy 452 MV or 620 by Euclid Chemical Company.
   c. Resi-Bond J-58 by Dayton Superior.
   d. Epobond by L&M Construction Chemicals, Inc.
   f. TK-311 Concrete Bonding Agent by TK Products.
2. Use when joining new to existing concrete.
3. Conforming to ASTM C881.

N. Non-Epoxy Bonding Compound:

1. Manufacturers:
   a. Weld-Crete, by Larsen Products Corporation.
   b. Acryl 60 by Thoro.
   c. Acryl-Set by Master Builders.
   d. Everbond by L&M Construction Chemicals, Inc.
   e. TK-225 Liquid Bonding Agent by TK Products.
2. Use when joining new to existing concrete where bonding compound cannot be placed immediately prior to pouring of new concrete.
3. Conforming to ASTM C1059 Type II.

O. Evaporation Retardant:

1. Manufacturers:
   a. E-CON by L&M Construction Chemicals, Inc.
   b. Confilm by Master Builders.
   c. Eucobar by Euclid Chemical Company.
   d. TK-2120 Tri-Film by TK Products.
   e. SikaFilm by Sika Corporation.

P. Fiber Reinforcement:

1. Manufacturers:
   a. Fibermesh Company.
   b. W.R. Grace & Company.
   c. Euclid Chemical Company.
   d. Forta Corp.
2. 1/2 inch to 3/4 inch collated fibrillated virgin polypropylene fibers.
3. ASTM C1116 Type III.

2.02 CONCRETE MIX DESIGN

A. Concrete Mix: Measure and combine cements, aggregates, water, and admixtures in accordance with ASTM C94 and ACI 211.1.

1. Cement: When used in exposed concrete shall be one brand from one source. Do not mix different cements in same element or portion of Work.
2. Air-Entrainment: Air entrain all concrete. Do not air-entrain interior concrete to be trowel-finished.

3. Chemical Admixtures: Use is optional to aid concrete properties and allow for efficient placement. Manner of use and amount shall be in accordance with manufacturer's written recommendations and as approved by Engineer. Do not use admixtures which increase shrinkage or negatively affect finishing.
4. Fly Ash: Use is optional. Combine fly ash with cement at rate of 1.0 pound fly ash per pound reduction in cement. Amount of fly ash shall not be less than 15% nor more than 20% of weight of cement plus fly ash. When fly ash is used, minimum amount of cement given in table for Class of Concrete may be proportionately reduced. Water to cementitious ratio shall not exceed water to cement ratio given in table for Class of Concrete.
5. Ground Granulated Blast-Furnace Slag (GGBF Slag): Use is optional. Combine GGBF slag with cement at of 1.0 pound GGBF slag per pound reduction in cement. Amount of GGBF slag shall not be less than 25% nor more than 35% of weight of cementitious material. When GGBF slag is used, minimum amount of cement given in table for Class of Concrete may be proportionately reduced. Water to cementitious ratio shall not exceed water to cement ratio given in table for Class of Concrete.
6. Fly Ash and GGBF Slag Mix Ternary Systems: Use is optional. Combinations of portland cement, GGBF slag and fly ash will be allowed. Minimum amount of portland cement shall be 337 pounds per cubic yards of concrete. Total replacement of cement with fly ash and GGBF slag shall not exceed 50%. Total replacement of cement with fly ash shall not exceed 20%. Water to cementitious ratio shall not exceed water to cement ratio given in table for Class of Concrete.
7. Use no admixture other than specified, unless approved by Engineer.
8. Class B concrete, Fill concrete and Slabs on grade shall be fiber reinforced.
   a. Dosage Rate: 1 1/2 pounds per cubic yards minimum.
   b. Comply with manufacturer's recommendations and as specified in ASTM C94.

B. Class of Concrete:

1. Furnish in accordance with table. Cement contents listed are minimum values and shall be increased as required to attain other specified characteristics.
2. Air contents listed are for concrete requiring air-entrainment as specified herein. Contents listed shall be maintained after addition of admixtures.
3. Slumps listed are maximum, except when high range water reducer is used. Maximum slump when high range water reducer is used, 10 inches.
4. Chloride ion content shall not exceed values listed in ACI 318, Table 4.3.1.

Class	Compressive Strength (psi)	Coarse Aggregate (maximum size)	Minimum Cement Factor (pounds/cubic yard)	Air Content (%)	Slump (inch)	Water/Cement Ratio (maximum)
A	4500	1 1/2 inches	517	5.5 ± 1.5	3 ± 1	0.42
B	3000	1 1/2 inches	423	5.5 ± 1.5	3 ± 1	N/A
F	2000	3/4 inch	212	---	---	---
Note: Interior concrete floor with trowel-finished surface, limit air content to 3% max.						

C. Concrete Usage:

1. Class A: Locations, except where Class B and F specified.
2. Class B: Interior equipment bases, fence post piers, concrete or grout fillets in tanks, and where specifically stated.
3. Class F: Mud slabs and backfill below and around structures where noted.

4. Nominal maximum size of coarse aggregate shall be as noted in Table above, nor shall it exceed 3/4 of minimum clear spacing between reinforcing bars, 1/5 of narrowest dimension between sides of forms or 1/3 of thickness of slab.

2.03 MODIFICATION OF MIX DESIGN

A. After sufficient test data available from Project, provisions of ACI 318 may be used to reduce amount by which average strength must exceed specified 28 day compressive strength provided.

1. Probable frequency of strength tests more than 500 psi below specified 28 day compressive strength will not exceed 1 in 100.
2. Probable frequency of average of three consecutive strength tests below specified 28 day compressive strength will not exceed 1 in 100.

B. Do not reduce cement content below minimum amount specified except as allowed in combination with fly ash and/or slag.

C. Submit verification of mix design.

2.04 MIXING AND DELIVERY

A. Use ready mixed concrete.

B. Deliver and complete discharge within 1 1/2 hours of commencing of mixing or before 300 revolutions of drum or blades, whichever comes first. Includes revolutions required by transit mix trucks. Limitations may be waived by Engineer if concrete slump, after 1 1/2 hours or 300 revolution limit reached, that concrete can be placed without addition of water. In hot weather, time or number of revolutions criteria may be reduced by Engineer.

C. Do not add water on-site unless slump and water-cement ratio, after addition of water are below maximum allowed. If water added, mix concrete at site additional 30 revolutions of drum.

D. Deliver concrete to site having temperature not less than 50°F nor greater than 90°F.

E. If high range water-reducing admixture added on-site, mix concrete at site additional 85 revolutions of drum after addition of high range water-reducing admixture.

PART 3 EXECUTION

3.01 FORMS

A. Formwork design, detailing, and installation shall be Contractor's responsibility and shall conform to requirements of ACI 347R.

B. Materials and Construction: Type of forms used is Contractor's option, except as otherwise indicated below or on plans. Plywood and other wood surfaces shall have smooth, level surfaces treated with form oil or sealer to produce clean release of concrete from forms.

1. Where walls remain exposed use plywood, prefabricated metal or wood forms. Do not use boards.
2. Use bolts, rods or other approved devices for form ties. Plastic cone snap ties are approved as form ties. Ties for liquid holding structures or dry structures below grade shall have integral waterstop. Do not use wire ties on exposed concrete.
3. Ties shall be removed minimum of 1 inch from formed surface. Removal of ties shall leave holes clean cut and without appreciable spalling at face of concrete. Provide plastic cone or other approved device.

4. Provide 3/4 inch chamfer on external corners of exposed concrete walls, beams, columns, equipment bases and exposed edges of construction joints. Do not chamfer columns flush with concrete block walls.
5. Provide openings at base of vertical forms as access for cleaning and inspection of forms and reinforcing prior to depositing concrete.

C. Treat or Wet Contact Forms: Coat plywood and wood moldings with non-staining form release agent. Apply release agent before reinforcement is placed.

D. Repairing and Cleaning: Clean, patch, and repair form material before reusing.

E. Quality

1. Formwork shall prevent leakage of mortar, shall not deflect under weight of concrete and workman, and shall withstand fluid pressures of concrete.
2. Removal of wall ties shall leave holes clean cut and without appreciable spalling at face of concrete.

3.02 SUBGRADE PREPARATION

A. Subgrade and bedding shall be compacted and free of frost. If placement allowed at temperatures below freezing, provide temporary heat and protection to remove frost. Do not place concrete on frozen material.

B. Provide mud slabs where noted, where necessary, and when required by Engineer to obtain dry and stable working platform for placement of slabs on grade. Provide vapor barrier between mud slabs and free draining fill.

C. Soak subgrade evening before placement and sprinkle ahead of placement of concrete.

D. Remove standing water, ice, mud, and foreign matter before concrete deposited.

3.03 PLACING CONCRETE

A. Notify ENGINEER and Testing Laboratory 24 hours in advance of placing operation.

B. Place concrete, except as modified herein, in accordance with ACI 304R, Chapter V.

C. Concrete will not be allowed to drop freely where reinforcing will cause segregation of mix.

1. Superplasticized Concrete: 10 foot maximum drop.
2. Other Concrete: 5 foot maximum drop.

D. If pumping is used, do not use aluminum piping for delivery system.

E. When placing of concrete is temporarily halted or delayed, provide construction joints as shown on plans and as specified.

F. Place in lifts not exceeding 24 inches and compact with internal mechanical vibrator equipment.

1. Insert vibrator so area visibly affected by vibrator overlaps adjacent just-vibrated area by few inches.
2. Vibrate beams separately before slab placement. Place slab concrete after vibrating beam, but before beam concrete reaches initial set.
3. Slabs: Insert vibrators for full depth of slab. Allow vibrator to penetrate slab into previously placed beams.

4. Walls: Insert vibrators along each face (i.e., just behind reinforcing) and allow vibrator to sink into previous lifts as deep as will easily penetrate.
5. Along Waterstop: Insert vibrators along full length of waterstop alternating on each side at 12-inch maximum centers.
6. Do not spread concrete with vibrators.

G. Minimum of 2 hours shall elapse after depositing concrete in columns and walls before depositing concrete in adjoining beams, girders or slabs, unless otherwise approved by Engineer.

H. If in process of pouring wall, pour is stopped unexpectedly, leave surface of joint level but rough. Roughened surface shall have amplitude of 1/4 inch minimum. Provide waterstop in locations as specified.

I. Provide bonding compound between new and hardened or existing concrete where shown on plans.

3.05 JOINTS

A. Unless otherwise noted, construction joints shown are optional. Joints not shown on plans shall be approved by Engineer. Locate to miss splices in reinforcement.

B. Limit size of concrete pours. Maximum length of wall and slab pours shall not exceed 60 feet.

C. Before concrete placed, construction joints shall be cleaned and laitance removed and surface wetted. Remove standing water.

D. Locate construction joints in floors within middle third of span. Construction joints in floors supported by walls may be located at center of wall with Engineer’s approval.

E. Construction joints in beams shall be offset minimum distance of two times width of intersecting beams.

F. Locate vertical construction joints in walls minimum of one-half wall height from corners or other intersecting walls or at midpoint between corners or intersecting walls. Locate horizontal joints in walls within middle third of wall height.

G. Beams shall be placed monolithically as part of slab or wall system, unless otherwise indicated on plans.

H. Construction joints shall have keys or roughened surfaces. Where roughened surface used, surface shall have amplitude of 1/4 inch minimum.

I. Install premolded joint filler where noted in accordance with manufacturer's recommendations. Joint filler shall be compatible with sealant and suitable for intended purpose.

J. Clean and prime joints in accordance with manufacturer's written instructions before applying sealant.

3.06 WATERSTOPS

A. Provide waterstop in construction joints of water holding structures.
B. Installation: Secure waterstop utilizing hog rings or grommets spaced maximum 12 inches on center and within 1 inch of edge. Wire tie to adjacent reinforcements.

C. Splice joints in waterstop to form continuous watertight diaphragm. Splice in accordance with manufacturer's recommendations. Spark test joints as required by Engineer.

3.07 EMBEDDED ITEMS

A. Cast pipe and other embedded items into concrete as placement progresses. Do not provide blockouts unless specifically noted on plans.

B. Following restrictions shall be adhered to, except for slabs on grade, unless otherwise noted.

1. No duct, conduit, pipe or fitting placed vertically shall be larger in cross-sectional area than 4% of column into which it is placed.
2. Duct, conduit, pipe, and fittings, when placed within slab and walls, shall not be larger than 1/3 thickness of slab or wall nor placed closer than 3 outside diameters clear from each other.
3. Reinforcing steel shall be in-place before embedded items placed and reinforcing cut or removed shall be replaced with additional reinforcing as indicated on plans or approved by Engineer.
4. Do not pass sleeves through columns without Engineer's approval.

C. Set items such as bolts, anchors, piping, and frames in concrete as shown on plans.

D. Set miscellaneous items according to templates and setting diagrams.

E. Place items constructed of dissimilar metals to avoid physical contact with reinforcing. Secure item and reinforcing to ensure they will not shift and come into contact during pouring. Contact between reinforcing and other metal, other than bare, coated or plated carbon steel not permitted, unless approved by Engineer.

F. Support wall pipes from formwork to prevent contact with reinforcing.

3.08 REPAIR OF SURFACE DEFECTS

A. General:

1. Prior to starting repair work, except as specified otherwise, obtain Engineer's approval of proposed repair techniques and mixes.
2. Develop patching techniques and mixes on portion of as-cast surface selected by Engineer for this purpose. Dress surface of patches remaining exposed to view to match color and texture of adjacent surfaces.

B. Tie Holes:

1. Fill tie holes, except where sealant is indicated, with patching mortar as specified in Section 03605.

C. Defective Areas:

1. Remove honeycombing, stone pockets, spalls, and other defective concrete down to sound concrete. If chipping required, make edges perpendicular to surface. Do not feather edges.
2. Fill defective area with patching mortar as specified in Section 03605.

D. Leaks or Wet Spots:

1. Patch and repair areas where leaks or wet spots have occurred inside of buildings.

2. Patch and repair areas where leaks or wet spots have occurred in wet wells, basins, tanks, reservoirs, and other structures which are to hold water. Test for leakage in accordance with Section 01456.
3. Repair method shall be Contractor's, subject to requirements of these Specifications and review by Engineer.

E. Cracks:

1. All cracks in concrete water holding structures 10 mils or greater in width shall be repaired.
2. All cracks in concrete with exterior exposure, 13 mils or greater in width shall be repaired,
3. All cracks in concrete with interior exposure, 16 mils or greater in width shall be repaired.
4. Repair method shall be Contractor's, subject to requirements of these Specifications and review by Engineer.

3.09 FINISHING SLABS AND FLATWORK

A. Slab Finishes:

Description	Concrete Finish
Submerged and Buried Slabs	Float
Depressed Areas for Floor Mats	One Troweling
Sealer Applied Floors and Slabs	Two Trowelings
Exterior Exposed Slabs	Float and Broom Finish

B. After placement, screed concrete with straightedges, power strike-offs or vibrating screeds.

C. After screeding, bull float or darby surface to eliminate ridges and to fill in voids left by screeding.

D. Float:

1. Use magnesium or aluminum hand floats or power floats with slip on float shoes after concrete has stiffened to point where 1/4- inch maximum indentation can be imparted by normal foot pressure. Do not use combination blades for floating.
2. Float finish shall result in uniform smooth granular texture.
3. After floating, check slab tolerances with 10-foot straightedge. Fill low spots with fresh concrete.
4. Do not sprinkle with dry cement or add water.

E. Trowel:

1. Use steel trowels after floating.
2. Initial Troweling: Power or hand with trowel blade kept flat against concrete surface to prevent washboard or chatter effect.
3. Second Troweling: By power if three trowelings scheduled, by hand if two trowelings scheduled.
4. Third Troweling: By hand and continue until concrete consolidated to uniform, smooth, dense surface free of trowel marks and irregularities.
5. Successively trowel with trowels progressively smaller and tipped more to increase compaction of concrete surface.
6. Allow time between trowelings for concrete to become harder.

F. Broom Finish: Use fine, soft-bristled broom and broom at right angles to direction of traffic to give nonskid finish. Texture shall be approved by Engineer.

G. Floor Sealer:

1. Apply in accordance with manufacturer's written instructions.
2. Apply first coat after final troweling, surface water glaze has dissipated, and when surface is hard enough to sustain foot traffic on same day as pour.
3. When floor has been water cured, apply first coat after curing has been completed. Apply within one day of floor being dry enough for application.
4. Apply second coat after Work is complete and building ready for occupancy.

3.10 FINISHING FORMED CONCRETE

A. Rubbed Finish: Exterior cast-in-place concrete surfaces permanently exposed to view extending to 6 inches below finish grade or liquid level**,** unless otherwise indicated on plans.

1. After removal of forms, patch or point up defects as specified and cure.
2. Remove joint marks, fins, and stains as described for smooth finish.
3. Apply heavy coat of Finishing Grout. After first coat has set, apply finish coat. When finish coat has set, float to uniform texture.
4. Follow manufacturer's written instructions for finishing concrete.
5. Finish color shall be gray.

3.11 PROTECTION AND CURING

A. Protect concrete from frost and keep moist for minimum curing period of 7 days after placing in accordance with ACI 308.

B. Formed Surfaces:

1. Wet cure by spraying surfaces during curing period as frequently as drying conditions may require to keep concrete surfaces moist.
2. Ceilings, walls, columns, and beam sides may be cured by leaving forms in-place. For vertical surfaces, apply water to run down on inside of forms, if necessary, to keep concrete wet.
3. After forms are removed, wet cure for remainder of curing period or apply curing compound.
4. Do not use curing compound where epoxy, urethane, mortar bed, grout, additional concrete or other coatings or adhesives will be applied.

C. Concrete Flatwork:

1. Start curing activities as soon as free water has disappeared from surface of concrete after placing and finishing.
2. Cure flatwork using liquid curing compound or wet cure.
3. Do not use curing compound where epoxy, urethane, mortar bed, grout, additional concrete or other coatings or adhesives will be applied.
4. Cure bottom slab of wet well by ponding water on slab.

D. Curing Compound:

1. Apply curing compound at uniform rate sufficient to comply with requirements for water retention as specified and as measured in accordance with ASTM C156.
2. Cover areas subjected to direct sunlight during curing period with ambient temperature expected to exceed 80°F with white pigmented compound, others may be covered with fugitive dye compound.

E. Protect from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

F. Protect finished concrete surfaces from damage caused by construction equipment, materials or methods, and rain or running water.

G. Do not load self-supporting structures to overstress concrete.

3.12 REMOVAL OF FORMING AND SHORING

A. Do not remove forming or shoring until member supported has acquired sufficient strength to safely support own weight and any imposed loads. Forming shall remain in place for at least minimal time recommended by ACI 347. In addition, forming for horizontal members such as elevated slabs and beams shall remain in place minimum of 7 days. In no case shall forming for horizontal members be removed before concrete has reached at least 70% of its specified design strength.

B. Reshore areas as required to carry additional imposed loads.

C. Repair damage to structure caused by early removal of forming and shoring at no additional cost to Contracting Authority.

3.13 FIELD QUALITY CONTROL

A. Obtain samples of concrete in accordance with ASTM C172. Transport cylinders to place on-site where they can be stored under conditions affecting concrete they represent without being disturbed for first 24 hours.

B. Make slump tests daily and when requested by Engineer, in accordance with ASTM C143. Make slump tests from same batch from which strength tests are made.

C. When air-entrained concrete is used, make air content tests daily and when requested by Engineer in accordance with ASTM C231. Test pumped concrete at pipe discharge.

D. If measured slump or air content falls outside limits specified, make check test immediately on another portion of same sample. In event of second failure, concrete shall be considered to have failed to meet requirements of Specifications and will be rejected.

E. Strength test for each class of concrete consists of four cured standard cylinders made from composite samples secured from single load of concrete in accordance with ASTM C172. Make compressive strength tests on one cylinder at 7 days and two cylinders at 28 days. Test results at 28 days shall be average strength of two specimens as determined in accordance with ASTM C39, except if one specimen in test shows manifest evidence of improper sampling, molding or testing, it will be disregarded. Test remaining cylinder if needed.

F. Make strength test for each following condition for each class of concrete.

1. Each day's pour.
2. Each change of source.
3. Each 100 cubic yards of concrete poured.
4. When temperatures are below or expected to fall below 45°F within 48 hours after concrete placed, make two additional cylinders and cure in field under conditions approximating conditions affecting concrete they represent. Test one at 7 days, other at 28 days.

G. Strength level of individual class of concrete considered satisfactory if following requirements met.

1. Average of all sets of three consecutive strength tests equal or exceed specified 28 day compressive strength.
2. No individual strength test falls below specified 28 day compressive strength by more than 500 psi.

H. If analysis of strength tests indicates above requirements are not being met, make immediate adjustments to mix. Also, if likelihood of low strength concrete is confirmed, make additional tests as required by Engineer to determine strength of concrete in-place in portion of structure identified with deficient cylinders. If tests and analysis verify Work in-place is not in conformance with Specifications, Engineer will determine whether or not Work in-place is adequate for intended use in location. If Work is determined inadequate, Contractor shall follow such remedial or replacement measures which Engineer may require. Contractor shall bear costs in connection with testing, engineering analyses, remedial work, and replacement required under terms of this paragraph.

* * * END OF SECTION * * *

SECTION 03350
CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 DESCRIPTION:

A. Provide and install controlled low strength material as indicated and specified.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 229R: Controlled Low-Strength Materials
2. 301: Specifications for Structural Concrete
3. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
4. 305R: Hot Water Concreting.
5. 306R: Cold Water Concreting
6. 308: Standard Practice for Curing Concrete
7. 318: Building Code Requirements for Structural Concrete and Commentary

B. ASTM International (ASTM):

1. C31: Practice for Making and Curing Concrete Test Specimens in the Field
2. C33: Specification for Concrete Aggregates
3. C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens
4. C94: Standard Specification for Ready-Mixed Concrete
5. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
6. C143: Standard Test Method for Slump of Hydraulic-Cement Concrete.
7. C150: Standard Specification for Portland Cement.
8. C172: Practice for Sampling Freshly Mixed Concrete
9. C231: Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
10. C494: Standard Specification for Chemical Admixtures for Concrete.
11. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
12. C940: Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
13. C1064: Test Method for Temperature of Freshly Mixed Portland Cement Concrete
14. D75: Practice for Sampling Aggregates

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 1105 of the Standard Specifications.

1. CLSM mix design and results of strength tests from trial mixes by the Contractor's testing laboratory firm.
2. Submit manufacturer’s Stable-Air Generator Admixture product data, installation instructions and recommendations for material use.
3. Test and Performance - Submit the following data:
    a. Any required deviations from prescribed tests and special handling instructions for test specimens.
    b. Controlled Low Strength Material shall have a maximum strength of 200 psi according to ASTM C39 at 56 days after placement.

c. Controlled Low Strength Material shall have 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 1/4 inch per foot of depth) as measured in Section 10 of ASTM C940.
d. Controlled Low Strength Material shall have a unit weight of 90 to 110 pounds per cubic foot) measured at the point of placement.

1.04 QUALITY ASSURANCE:

A. Do not place CLSM until design mix, material tests and trial batch mix compression test results are approved by the Engineer. Approvals are required at least 30 days before placing any production CLSM.

B. Employ an independent testing laboratory, acceptable to the Engineer to test conformity of materials to specifications and to design CLSM mixes.

C. Furnish, pay for and deliver representative samples of sufficient quantity of cement, aggregates and admixtures required for trial batch mixes to the testing laboratory. Obtain materials from the batching plant that will be supplying production CLSM in conformance with ASTM D75.

D. Measure all materials for CLSM, including water, with equipment and facilities suitable for accurate measurement and capable of being adjusted in conformance with ASTM C94. Use scales certified by local Sealer of Weights and Measures within one year of use and accurate when static load tested to plus or minus 0.4% of total capacity of scale. Batch all materials by weight except admixtures that may be batched by volume.

E. The testing laboratory will take control test specimens; conduct slump tests and measure air content and temperature in the field.

F. Methods of Sampling and Testing:

1. Fresh Concrete Sampling: ASTM C172.
2. Specimen Preparation: ASTM C31.
3. Compressive Strength: ASTM C39.
4. Air Content: ASTM C231.
5. Slump: ASTM C143.
6. Temperature: ASTM C1064.
7. Unit Weight: ASTM C138.

1.05 DELIVERY STORAGE AND HANDLING:

A. Order CLSM from batching plant so that trucks arrive at discharge locations when material is required.

B. Deliver CLSM to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

C. Reject CLSM not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket

1.06 PROJECT/SITE CONDITIONS:

A. Do not place CLSM until conditions and facilities for making and curing control test specimens are in compliance with ASTM C31 and as specified herein.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Furnish Portland cement conforming to ASTM C150. Use one approved brand from one mill throughout the contract term unless otherwise approved by the Engineer. Use Type II for all work, unless otherwise specified.

B. Water:

1. Use water that is potable and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances, and conforms to the requirements for water in ASTM C94, and as specified herein.
2. The maximum water-soluble chloride ion in the water shall not exceed 0.060% by weight of cement.

C. Aggregates:

1. Use aggregates for CLSM conforming to ASTM C33 and to the following requirements.

D. Admixtures:

1. General Requirements: ASTM C494.

E. Fly Ash: Provide fly ash conforming to the following requirements:

1. Class F fly ash conforming to ASTM C618 for chemical and physical properties.
2. Supplemental requirements in percent:

a.	Maximum carbon content	3%
b.	Maximum sulfur trioxide (SO_3) content	4%
c.	Maximum loss on ignition	3%
d.	Maximum water requirement (as a percent of control)	100%
e.	Fineness, maximum retained on No. 325 sieve	25%

2.02 MIXES:

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

B. Provide mix with compressive strength of maximum 200 psi when measured 56 days after placement.

C. Controlled Low Strength Material shall have 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 1/4 inch per foot of depth) as measured in Section 10 of ASTM C940 “Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory”.

D. The fresh unit weight shall be 90 to 110 pounds per cubic foot, except where specified, and in the absence of strength data the cementitious content shall be a maximum of 150 pounds per cubic yard.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Batch, mix and deliver CLSM in conformance with ASTM C94. Batch all constituents at a central batching or mixing plant.

B. Seasonal Conditions:

1. Conform to ACI 305R and as specified herein for hot weather concreting. Do not add retarder admixture to any concrete.
2. Conform to ACI 306R and as specified herein for cold weather concreting. Do not add accelerator admixture to any concrete.

3.02 TRANSPORTING AND MIXING:

A. Conform to concreting procedures set forth in ACI 304R and as specified herein.

B. Transport CLSM to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

3.03 FIELD TESTING:

A. General:

1. The testing laboratory will use concrete samples taken at the point of agitator or mixer truck discharge to perform slump, air content, and temperature tests and for field control test specimens.

B. Notification of Delivery:

1. Notify the Engineer of concrete deliveries a minimum of 48 hours in advance of the scheduled placement. Include within this notification, the mix design and quantity of concrete, method and location of placement, frequency of trucks, ordered slump and time of initial delivery.
2. Furnish delivery batch ticket to the representative from the Contracting Authority's testing laboratory or to the Engineer representative in the field with each batch delivered to the discharge locations in conformance with ASTM C94.

C. Test Measurements at Discharge:

1. The testing laboratory firm will take measurement of concrete slump, air content and temperature for each 50 cubic yards of each mix design but not less than once a day. The laboratory will conduct the slump, air content and temperature test measurements in conformance with ASTM C143, ASTM C231, and ASTM C1064, respectively.
2. The testing laboratory will submit test reports of field measurements specified above to the Contractor and to the Engineer.

D. Control Test Specimens:

1. The testing laboratory will cast a minimum of one set of three field control test specimens in conformance with ASTM C31 for each 150 cubic yards of each mix design of concrete but not less than once a day.
2. Laboratory personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content, temperature and truck driver's name.
3. Furnish tightly constructed nonabsorbent test cylinder molds. Use molds of same type and manufacture for all test specimens. Leave molds on cylinders until received in testing laboratory.

4. Furnish boxes for initial curing of test cylinders in conformance with ASTM C31 from time of fabrication until they are transported to the testing laboratory.
5. The testing laboratory will compression test one of each set of three specimens at seven days. Immediately notify the Contractor and the Engineer if the seven-day strength is deficient. Test the two remaining cylinders at 65 days for concrete strength acceptance. The acceptance test result is the average of the strengths of the two specimens tested at 56 days. The laboratory firm will submit compression test results of the control test specimens to both the Contractor and the Engineer. Evaluation and acceptance of concrete shall conform to ACI 301 and ACI 318.

3.04 CURING AND PROTECTION:

A. Protect CLSM from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.

B. Comply with curing procedures set forth in ACI 301, applicable portions of ACI 308 and as specified herein.

C. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80°F or above.

D. Perform cold weather concreting in conformance with ACI 306R and as specified herein when the ambient atmospheric temperature is 40°F or below.

E. Protect Controlled Low Strength Material from traffic until sufficient strength has been achieved for further construction operations.

* * * END OF SECTION * * *

SECTION 03603
EPOXY GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material for grouting reinforcing bars into existing concrete, and other uses where noted.

B. Alternatives:

1. Contractor may use premixed adhesive anchor material as specified in Section 05500 when approved by Engineer, rather than using field mixed grout as specified herein.

1.02 SUBMITTALS

A. Product Data:

1. Manufacturer's literature.

B. Submit in accordance with Section 1105 of the Standard Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Epoxy:

1. Manufacturers:
   a. Sikadur Hi-Mod or Sikadur Hi-Mod gel, by Sika Corporation.
   b. Five Star Epoxy Grout, by Five Star Products, Inc.
   c. Master Flow 648 CP Plus, By BASF Admixtures.

B. Sand: Hard, durable, oven dry.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean contact surfaces of oil, grease, and other foreign matter. Chip away unsound concrete.

3.02 MIXING

A. Mix components of epoxy compound as directed by manufacturer's instructions immediately before combining liquid with sand.

B. After binder thoroughly mixed, add sand as recommended by manufacturer.

3.03 PLACING

A. Place in accordance with manufacturer's written instructions following requirements regarding temperature and pot life.

B. Provide suitable materials where necessary to retain grout until hardened.

3.04 CURING

A. Cure as recommended by manufacturer.

* * * END OF SECTION * * *

SECTION 03604
NONSHRINK GROUT

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data:

1. Manufacturer's literature.

B. Submit in accordance with Section 1105 of the Standard Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers:

1. Fluid Grout 100, Five Star Products, Inc.
2. Masterflow 713 Grout. BASF Admixtures.
3. Euco NS Grout, Euclid Chemical Company.
4. Crystex, L&M Construction Materials, Inc.
5. Sika Grout 212 by Sika Corporation.

B. Grout:

1. Cement base, nonmetallic, nongas forming, nonshrink, preblended and ready-to-use requiring only addition of water at Project site.
2. Comply with ASTM C1107 and CRD C621, Grade B.
3. Of moderate fluidity with minimum compressive strength of 5000 psi at 28 days and shall not bleed.

C. Water:

1. Clean and free from injurious chemicals and deleterious materials.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean grout contact surfaces of oil, grease, scale, and other foreign matter. Chip away unsound concrete leaving surface level but rough.

B. Underside of base plates of machinery, rails, and bolts shall be free of grease, oil, dirt or coatings.

3.02 MIXING AND PLACING

A. Mix and place in accordance with manufacturer's written instructions.

B. Provide sealing materials where necessary to retain grout until hardened.

C. Work grout from one side to other. Avoid trapping air under base plates.

D. Remove plastic anchor bolt sleeve tops where used, and fill with grout at same time base plates are grouted.

3.03 CURING

A. Cure with curing compound or as recommended by grout manufacturer.

* * * END OF SECTION * * *

SECTION 03605
PATCHING MORTAR

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Polymer modified, cementitious, fast setting, mortar for repair of concrete surfaces.

1.02 SUBMITTALS

A. Product Data:

1. Manufacturer's literature.

B. Submit in accordance with Section 1105 of the Standard Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers:

1. Sikatop, by Sika Corporation.
2. Duratop, by L&M Construction Chemicals.
3. Gel Patch by BASF Admixtures.

B. Polymer modified cementitious system consisting of two components.

1. Component A: Liquid polymer emulsion of acrylic copolymer base and additives.
2. Component B: Blend of selected Portland cements, specially graded aggregates, organic accelerator, and admixtures for controlling setting time, water reducers for workability, and corrosion inhibitor.
3. System shall not contain chlorides, nitrates, added gypsum, added lime or high alumina cements. System shall be noncombustible, before or after cure.
4. Color: Concrete gray.
5. Minimum Compressive Strength: 5000 psi.
6. Bond Strength: 100% concrete substrate failure (pull off method), minimum 400 psi.
7. System shall not produce vapor barrier, shall be thermally compatible with concrete, and freeze-thaw resistant.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare surface in accordance with manufacturer's written recommendations and Section 03300.

3.02 APPLICATION

A. Apply and cure patching mortar in accordance with manufacturer's written recommendations.

* * * END OF SECTION * * *

SECTION 04810
UNIT MASONRY

PART 1 GENERAL

1.01 SUBMITTALS

A. Shop Drawings:

1. Statement giving source and material certificates, and proportions by weight of cement, fine and coarse aggregates, and admixtures for mortar and grout.

B. Product Data:

1. Manufacturer's literature for decorative masonry unit.
2. Manufacturer's literature for wall reinforcing and anchors.

C. Test Results:

1. Mortar test results.
2. Grout test results.

D. Miscellaneous Submittals:

1. Material certification for concrete masonry units. Test data shall not be more than 1 year old.

E. Submit in accordance with Section 1105 of the Standard Specifications.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units above ground on level platforms which allow air circulation under stacked units.

B. Cover and protect against wetting prior to use.

C. Handle units on pallets or flat bed barrows.

D. Do not permit free discharge from conveyor units or transporting in mortar trays.

E. Deliver cementitious materials in manufacturer's standard packages.

1.03 PROJECT/SITE CONDITIONS

A. Cold Weather Protection:

1. When ambient temperature falls below 40°F or when temperature of masonry units is below 40°F:
   a. Temperature of masonry units shall not be less than 32°F when laid in masonry. Remove visible ice on masonry units before unit is laid in masonry.
   b. Heat mortar sand or mixing water to produce mortar temperatures between 40°F and 120°F at time of mixing. Maintain mortar above freezing until used in masonry.
   c. Use heat sources where ambient temperatures are between 20°F and 25°F, on both sides of masonry under construction and install wind breaks when wind velocity is in excess of 15 mph.

d. Where ambient temperatures are below 20°F, provide enclosure for masonry under construction and use heat sources to maintain temperatures above 32°F within enclosure.
e. Where mean daily temperatures are between 32°F and 40°F, protect completed masonry from rain or snow by covering with weather resistive membrane for 24 hours after construction.
f. Where mean daily temperatures are between 25°F and 32°F, completely cover completed masonry with weather-resistive membrane for 24 hours after construction.
g. Where mean daily temperatures are between 20°F and 25°F, completely cover completed masonry with insulating blankets or equal protection for 24 hours after construction.
h. Where mean daily temperatures are below 20°F, maintain masonry temperature above 32°F for 24 hours after construction by enclosure with supplementary heat, electric heating blankets, infrared heat lamps, or other acceptable methods.

B. Hot Weather Protection:

1. When ambient air temperature exceeds 100°F, or 90°F with wind velocity greater than 8 mph:
   a. Do not spread mortar beds more than 4 feet ahead of masonry.
   b. Set masonry units within 1 minute of spreading mortar.

PART 2 PRODUCTS

2.01 MORTAR AND GROUT

A. Materials:

1. Aggregates:
   a. Mortar: ASTM C144, acceptable in color, 10% passing No. 100 sieve.
   b. Grout: ASTM C404.
2. Portland Cement: ASTM C150, Type I.
3. Masonry Cement: ASTM C91, Type S.
4. Lime: Hydrated lime, ASTM C207, Type S.
5. Water Repellent Mortar Admixture:
   a. Dry-Block by W.R. Grace & Co.
6. Water: Potable.
7. Use no antifreeze compounds.
8. Coloring Pigments: Provide coloring pigments of iron oxide, manganese dioxide or chromium oxide along with either grey or white cement as required to achieve color of mortar selected by Contracting Authority where scheduled.

B. Proportions:

1. Mortar: ASTM C270, property specification: Type S (1800 psi).
2. Masonry Grout: ASTM C476 (3000 psi minimum).
3. Measure materials by volume. Use within 1 hour.
4. Use water repellent mortar admixture for CMU exposed to earth or weather in accordance with manufacturer's written instructions.

2.02 CONCRETE MASONRY UNITS (CMU)

A. Hollow Standard Weight Concrete Block: ASTM C90.

B. Solid Block: ASTM C90. standard weight. Concrete filled hollow standard weight concrete blocks may be substituted.

C. Water Repellent Concrete Block: Hollow, standard weight, concrete block with water repellent mortar admixture added to concrete mix.

D. Decorative Concrete Masonry Units (Full Face Split and Smooth Faced):

1. Hollow standard weight water repellent concrete block.
2. Split simulated stone face and smooth face where indicated on plans as approved by Contracting Authority.
3. Nominal 8 inch by 16 inch face size, width as shown on plans.
4. Color shall be selected by Contracting Authority from manufacturer's complete line of available colors.
5. Mortar color shall be selected by Contracting Authority.
6. Provide application of exterior masonry sealer upon completion of block work.

E. Provide uniform gradation of color for exposed unpainted block.

F. Provide fire rated units where noted.

G. Provide decorative concrete masonry lintels, corners with decorative faces, etc., as required in areas with decorative concrete masonry units. Joints at outside corner are not acceptable.

2.03 REINFORCEMENT AND ANCHORS

A. Horizontal Joint Reinforcement:

1. Manufacturers:
   a. Truss, Ladur, Ladur Tri-Rod, CRT, or Dur-O-Tab by Dur-O-Wall, Inc.
   b. Ladder Type or Truss Type by Heckmann Building Products, Inc.
   c. Ladder-Mesh, Truss-Mesh, Cavity Ladder-Tri-Mesh, Ladder-Box-Mesh with drip, or Truss-Box-Mesh by Hohmann and Barnard, Inc.
2. Two parallel, longitudinal, 9 gauge, galvanized, rods weld-connected to 9 gauge galvanized cross-rods, spaced at 16 inches on center, conforming to ASTM A82 for single wythe construction or for cavity wall construction when cavity ties are used. Three parallel, longitudinal, 9 gauge, galvanized, rods weld-connected to 9 gauge galvanized cross-rods, spaced at 16 inches, on center, conforming to ASTM A82 for cavity wall and multi-wythe construction.
3. Provide special manufactured corner and wall intersection pieces.
4. Electronically weld cross-ties.
5. Zinc Coated.
   a. Interior Walls: ASTM A641 Class I.
   b. Exterior Walls: ASTM A153 Class B2.

B. Reinforcing Bars: In accordance with Section 03200.

C. Dovetail Anchor Slots And Anchors:

1. Manufacturers:
   a. Dur-O-Wall, Inc.
   b. Heckmann Building Products, Inc.
   c. Hohmann & Barnard, Inc.

2. 20 gauge galvanized metal dovetail foam filled anchor slots compatible with masonry anchors.
3. 16 gauge by 1 inch galvanized corrugated, metal anchor straps, hooked, looped, dovetailed or crimped, minimum of 6 inches long.

4. Zinc coated in accordance with ASTM A153 Class B2.

D. Adjustable Wall Ties:

1. 3/16 inch diameter galvanized steel wire (ASTM A82) triangular type, length as required.
2. 16 gauge corrugated, galvanized steel strap anchor, length as required.
3. No. 12 stainless steel self tapping screws.
4. Zinc coated in accordance with ASTM A153 Class B2.

E. Seismic Veneer Anchors:

1. Manufacturers:
   a. Seismic Veneer Anchors, Model No. D/A 213, by Dur-O-Wal, Inc.
2. Pintle shall be 12 gauge and plate 14 gauge.
3. Stainless steel.

2.04 WEEPHOLE MATERIAL

A. Vertical Cell Vent: 3/8 inch W by 2 1/2 inch H by 3 3/8 inch L; gray polypropylene, multi-cell construction.

PART 3 EXECUTION

3.01 GENERAL

A. Lay masonry true to dimensions, plumb, square, in bond, and properly anchored with courses level and joints uniform.

B. Provide full mortar beds for solid and hollow units to be filled with mortar or grout. Other hollow masonry units shall have face-shell mortar beds.

C. Tool joints on exposed walls concave, 1/8 inch maximum depth unless otherwise noted. Wipe joints with burlap or brush with soft brush to remove mortar projecting beyond face of block after joints are tooled. Cut mortar flush with surface of concealed block.

D. Provide reinforced concrete masonry lintels over doors, windows, and other openings where noted and wherever steel lintels not provided. Form lintels by using lintel or bond beam units. Place reinforcing steel and fill with masonry grout. Texture of lintels shall match wall texture. Precast masonry lintels may be used when approved by Engineer. Lintels shall have minimum 8 inches bearing on masonry beyond edges of opening except as noted on plans. Openings less than 4 feet in width not having lintels scheduled shall have 8 inch high reinforced masonry lintels or double steel angle lintels. Reinforce masonry lintels with two No. 5 bars. Steel lintels shall conform to Section 05500. Fill cores under lintels with masonry grout.

E. Provide control joints and expansion joints. Conform to details shown.

F. Install rigid insulation to exterior face of cast-in-place concrete or masonry walls faced with concrete masonry. Butt and stagger joints. Conform to requirements of Section 07210.

G. Unless otherwise shown, provide continuous bond beam around top of buildings at roof bearing elevation. Reinforce with two No. 5 bars.

3.02 TOLERANCES

A. Dimension of Elements:

1. In Cross-Section or Elevation: -1/4 inch to +1/2 inch.
2. Mortar Joint Thickness: ±1/8 inch.

B. Elements:

1. Variation from Level:
   a. Bed joints: ±1/4 inch in 10 feet, ±1/2 inch maximum.
   b. Top surface of walls: ±1/4 inch in 10 feet, ±1/2 inch maximum.
2. Variation from Plumb: ±1/4 inch in 10 feet, ±3/8 inch in 20 feet, ±1/2 inch maximum.
3. True to a Line: ±1/4 inch in 10 feet, ±3/8 inch in 20 feet, ±1/2 inch maximum.
4. Alignment of Columns and Walls (bottom versus top): ±1/2 inch.

C. Location of Elements:

1. Indicated on Plans: ±1/2 inch in 20 feet, ±3/4 inch maximum.
2. Indicated in Elevation: ±1/4 inch in story height, ±3/4 inch maximum.

3.03 CONCRETE MASONRY UNITS

A. Use standard weight concrete block for interior partitions and backing of exterior walls.

B. Use water repellent concrete block where exposed to weather or earth.

C. Exposed inside face of concrete block surfaces shall form finished wall surfaces. Painted walls or special coatings on wall are considered exposed walls.

D. Provide special blocks for corners, expansion joints, control joints, jambs, sills, lintels, and bond beams.

E. Provide bull nose edges where shown and at all interior exposed vertical corners, including door and window openings.

F. Fill cores of hollow units with mortar or grout where bolts, anchors or similar items occur within hollow units.

G. Lay insulated units as recommended by manufacturer.

H. Flashing:

1. Clean surface of masonry smooth and free from projections which might puncture or otherwise damage flashing material.
2. Place through-wall flashing on bed of mortar.
3. Cover flashing with mortar.

I. Provide weepholes by omission of 1 inch of mortar head joints or provide tubes or sash cord at base of flashings, steel lintels, and base of walls. Space not over 2 feet 8 inches with minimum of one weephole between openings. Keep weepholes and area above flashing free of mortar droppings.

J. Keep cavity in cavity walls clean of mortar and debris.

K. Bond Patterns:

1. Decorative CMU: Running bond.
2. Other CMU: Running bond.

3.04 REINFORCEMENT AND ANCHORS

A. Provide masonry anchors, ties, reinforcement, and inserts of type noted on plans and specified herein.

B. Bond intersection of exterior walls and interior load bearing walls by use of horizontal joint reinforcement, extend into wall at least 30 inches. Conform to details shown.

C. Bond intersection of interior nonload bearing walls by use of horizontal joint reinforcement, extend into wall at least 16 inches.

D. Reinforce concrete block walls with continuous horizontal joint reinforcement. Lap reinforcing minimum of 6 inches and stagger splices 32 inches or more. Space reinforcement not over 16 inches on center. Space reinforcement in parapets 16 inches on center.

E. Tie and reinforce cavity walls composed of block and block. Do not use truss type reinforcing in cavity walls.

F. Provide additional bonding ties spaced not more than 8 inches apart around perimeter of and within 12 inches of openings.

G. Provide vertical reinforcement in fully-grouted cores where noted.

3.05 INSTALLATION OF MISCELLANEOUS ITEMS

A. Install steel lintels that bear on masonry. Build into masonry rough frames, bucks, and metal frames for openings in walls and partitions. Fill cores under lintels with masonry grout.

B. Build in items such as anchors, anchor bolts, inserts, sleeves, brackets, bearing plates, furnished under this or other sections.

C. Build in items of mechanical, heating, ventilating, air conditioning, and electrical work including anchors and anchor bolts. Point-up joints between masonry, cabinets, outlet boxes, and metal work.

D. Set units plumb, square, true, and level before building into masonry.

E. Avoid loosening or disturbing temporary bracing holding frames. Set masonry tightly against inside of frames and slush full voids with mortar. Build anchors into joints and fill masonry cores adjacent to frame with grout.

3.06 GROUTING

A. Conform to requirements of ACI 530.1.

B. Spaces to be grouted shall be free of mortar dropping, debris, loose aggregates, and material deleterious to masonry grout.

C. Reinforcement and ties shall be in place prior to grouting.

D. Cleanouts: When grout pour exceeds 5 feet in height, cleanouts shall be provided in bottom course of masonry.

1. Cleanouts shall be provided adjacent to each vertical bar.
2. Size of cleanout openings shall be of sufficient size to permit removal of debris. Minimum opening dimension shall be 3 inches.

3. After cleaning, close cleanouts with closures to match adjacent wall surface and brace to resist grout pressure.

E. Place grout in lifts not exceeding 5 feet.

F. Consolidate grout at time of placement.

1. Consolidate grout pours 12 inches or less in height by mechanical vibration or by puddling.
2. Consolidate pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

3.07 PROTECTION

A. Protect masonry from damage.

B. Cover freshly laid masonry and walls not being worked on to prevent rapid drying and to exclude rain and snow.

C. Cover items susceptible to damage with wood nosings or boxing. Use no lumber or materials susceptible to staining or defacing masonry.

D. Brace walls until roof or floor system in-place. Bond beam grout at roof elevation shall be a minimum of 7 days old prior to removal of bracing.

E. Do not apply superimposed loads until completed masonry reaches design strength.

1. Do not apply uniform floor or roof loading for at least 12 hours after completing masonry.
2. Do not apply concentrated loads for at least 3 days after completing masonry.

3.08 CUTTING AND PATCHING

A. Cut and patch to accommodate Work of other sections. Patch around items such as outlet boxes, piping, and steel work.

3.09 CLEANING

A. Clean and point concrete block surfaces. Clean as units are set, daily, and upon completion. Acid shall not be used.

B. Remove surplus mortar and leave surface of masonry clean and finished. Remove large particles of mortar before cleaning walls. Remove sharp burrs on exposed block mortar joints.

C. Apply one coat of exterior masonry sealer to exposed exterior surfaces of concrete masonry. Protect items: window frames, doors, louvers, light fixtures, during application. Conform to sealer manufacturer's recommendations for temperature, wind, surface conditions, and curing conditions.

* * * END OF SECTION * * *

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Miscellaneous metal fabrications.
2. Concrete anchors.
3. Stairs.
4. Ladders.
5. Steel lintels.
6. Floor access hatches.

1.02 DEFINITIONS

A. Submerged: At or below point 1 foot 6 inches above peak (maximum) water surface elevations in water holding structures.

1.03 SUBMITTALS

A. Shop Drawings:

1. Indicate materials, sizes, connections, anchors, and painting.
2. One reproducible and one print.

B. Product Data:

1. Manufacturer's catalog sheets on premanufactured items.

C. Miscellaneous Submittals:

1. Provide International Conference of Building Officials (ICBO) or other similar building code organization recommendations regarding safe allowable design loads for concrete anchors.
2. Floor access hatch warranty.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Welding:

1. Steel:
   a. Conform to codes for arc and gas welding in building construction of AWS and to AISC Specifications. Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign material, except mill scale which will withstand vigorous wire brushing may remain. No welding shall be done when base metal lower than 0°F.
   b. Qualify welding operators in accordance with AWS D1.1. Qualification tests shall be run by recognized testing laboratory approved by Engineer at Contractor’s expense.
   c. Welding operators shall be subject to examination for requalification using equipment, materials, and electrodes employed in execution of Work. Such requalification, if ordered by Engineer, shall be done at Contractor’s expense.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Tag miscellaneous iron, steel and aluminum including anchor bolts, concrete anchors, sleeves, and bases or otherwise mark for ease of identification at Project site.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conform to following.

1. Structural Steel Shapes:
   a. W Shapes: ASTM A992, 50 ksi.
   b. S, C and MC Shapes: ASTM A36.
   c. L Shapes: ASTM A36.
   d. HSS Square and Rectangular Shapes: ASTM A500, Grade B, 46 ksi.
   e. HSS Round Shapes: ASTM A500, Grade B, 42 ksi
   f. Pipe Shapes: ASTM A53, Grade B, 35 ksi.
   g. Plates and Bars: ASTM A36.
2. Stainless Steel:
   a. Exterior and Submerged Uses: AISI, Type 316.
   b. Industrial Uses: AISI, Type 316.
   c. Interior and Architectural Uses: AISI, Type 304.
   d. Cast-in-Place Anchor Bolts: AISI, Type 302, 303 or 304.
3. Connection Bolts for Steel Members: ASTM A325.
4. Anchor Bolts: ASTM F1554, 1/2 inch minimum diameter; nonsubmerged - galvanized; submerged - stainless steel.
5. Anchor Rods: ASTM F1554 36 ksi.
6. Connection Bolts for Wood Members: ASTM A307, galvanized.
7. Connection Bolts for Aluminum: Stainless steel.
8. Cast Iron: ASTM A48, Class 35B.

2.02 FABRICATION

A. Connections and Quality:

1. Fabricate details and connection assemblies in accordance with contract documenrts, with projecting corners clipped and filler pieces welded flush.
2. Weld shop connections and bolt or weld field connections, unless otherwise noted or specified.
3. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.
4. Use connections of type and design required by forces to be resisted and to provide secure fastening.
   a. AISC standard 2 angle web connections or single plate framing connections capable of supporting minimum of 50% total uniform load capacity of members joined as tabulated in uniform load constants of AISC M016.
   b. Connections shall consist of minimum of two 3/4 inch diameter bolts or welds developing minimum of 10,000 pounds.
   c. Make bearing type bolted connections with minimum 3/4 inch diameter bolts with threads included in shear plane, unless detailed otherwise.
5. Welding:
   a. Grind exposed edges of welds to 1/8 inch minimum radius. Grind burrs, jagged edges, and surface defects smooth.
   b. Prepare welds and adjacent areas so there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or other area to be painted or coated.

3) No sharp peaks or ridges along weld bead.

c. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

6. Bolting:
   a. Draw up bolts or nuts tight in accordance with AISC specifications. Use bolts of lengths required so bolts do not project more than 1/4 inch beyond face of nut. Do not use washers unless specified. Provide hexagonal head bolts with hexagonal nuts.
   b. Provide holes required for connection of adjacent or adjoining Work wherever noted on plans. Locate holes for bolting equipment to supports to tolerance of ±1/16 inch of dimensions indicated.

B. Fit Work together in fabrication shop and deliver complete or in parts, ready to be set in-place or assembled in field.

C. Galvanizing:

1. Galvanize after fabrication.
2. Galvanize by hot-dip process conforming with ASTM A123 and AHDGA specifications.
3. Galvanize in plant having facilities to produce quality coatings and capacity for volume of Work.
4. Ship and handle in manner to avoid damage to zinc coating.

D. Painting or Coating and Finishes:

1. Do not paint or coat ferrous metal surfaces embedded in concrete.
2. Review and comply with Section 09961. Where other finish is not specified, clean ferrous metal after fabrication to remove oil, mill scale, rust, and foreign matter in accordance with SSPC SP 6. Apply one coat of shop primer yielding 1.5 mil dry thickness.
3. Steel lintels and surfaces not accessible after assembly or erection shall be given 2 shop coats using different colors of paint to coating, 3.0 mil total dry thickness.

2.03 CONCRETE ANCHORS

A. Expansion Anchors:

1. Manufacturers:
   a. Liebig Anchor by Liebig.
   b. HSL Expansion Anchor by Hilti.
   c. Power Bolt by Powers Fasteners.
2. Usage: In concrete.
   a. Zinc- or chromate-plated carbon steel may be used where totally embedded, in interior locations with controlled humidity, and other protected locations.
   b. Stainless steel shall be used in other locations such as outside, in tanks, or when attaching aluminum or galvanized steel.
   c. Do not use expansion anchors when submerged or subjected to dynamic loads.

B. Adhesive Anchors:

1. Manufacturers:
   a. PE 1000+ by Powers Fasteners.
   b. EPCON Injection System by ITW Ramset/Red Head.
   c. Sure-Anchor Epoxy (J50) by Dayton Superior.
   d. Epoxy-Tie by Simpson Strong-Tie.
   e. Five Star Epoxy RS Anchor Gel by Five Star Products, Inc.
   f. Set XP by Simpson Strong-Tie.
   g. Acrylic-Tie by Simpson Strong-Tie.
   h. HIT HY by Hilti Corporation.

2. Epoxy adhesive with Type 316 stainless steel stud or anchor rod assembly, nuts, and washers.
3. Usage:
   a. In concrete, submerged. Do not use in overhead applications or in contact with potable water.

2.04 STAIRS

A. Design and fabricate stairs and platforms to support uniformly distributed live load of 100 pounds per square foot, in addition to dead load, but never of less strength than to carry safely moving concentrated load of 1000 pounds.

B. Construct stairs and platforms of structural steel channel headers and framing members. Weld headers to stringers, and weld framing members to stringers and headers. Provide components such as hangers, columns, struts, clips, brackets, bearing plates, support stairs, and platforms. Bolts may be used for erection purposes only, and only where concealed in finish work.

C. Close exposed ends of stringers with plates, continuously weld, and grind smooth joints.

D. Provide treads and landing platforms for stairs. Treads shall be complete with supporting brackets designed to be welded or bolted to stringers.

1. Grating treads and platforms shall conform to Section 05532.

E. Hot-dip galvanize after fabrication.

2.05 LADDERS

A. Ladder shall conform to applicable federal, state, and local safety requirements.

B. Fixed rail ladders shall be steel.

1. Stringers: 1 1/2-inch diameter Schedule 40 pipe, or C 3 x 5 channel. Provide safety cap at top of stringers.
2. Rungs: 1 inch diameter deformed concrete reinforcing rod.
3. Other materials shall be min 1/4-inch thick
4. Punch stringers and pass rungs through stringers and weld on both sides. Fabricate brackets for fastening ladder to wall and weld to ladder.
5. Hot-dip galvanize after fabrication.

2.06 STEEL LINTELS

A. Provide steel lintels over doors, louvers, grille openings, wall recesses, duct openings, and other openings in masonry walls as noted and wherever reinforced concrete or masonry lintels not provided.

B. Fabricate lintels from structural shapes as detailed, selected for straightness of section.

C. Unless otherwise shown, lintels shall have minimum bearing of 8 inches at each side of opening.

D. Fabricate lintels of multiple sections by welding, grind exposed welds smooth.

E. Openings less than 4 feet wide without lintel scheduled shall have reinforced masonry lintels or double steel angle lintels. Total width of horizontal legs shall be 1 inch less than wall thickness. Weld angles together.

F. Masonry Lintels: Comply with Section 04810.

2.07 FLOOR ACCESS HATCHES

A. Prefabricated Standard Type:

1. Manufacturers:
   a. Bilco Type K.
   b. Babcock-Davis Type FC double leaf.
   c. Dur-Red.
   d. Halliday.
2. Provide access hatches and frames of material, type and size as shown on plans.
3. Door leaves shall be 1/4 inch diamond pattern plate with reinforcing on underside to withstand live load of 150 pounds/square foot with maximum deflection of 1/150 of span.
4. Frame shall be 1/4 inch thick with strap anchors around perimeter.
5. Equip doors with cast steel hinges bolted to underside and pivot on torsion bars that counterbalance door for easy operation.
6. Equip doors with hold-open arm with positive locking device with conveniently positioned release handle for easy and controlled closing.
7. Provide snap lock mounted on bottom of leaf with removable topside handle and socket recessed in cover.
8. Hardware shall be cadmium-plated.
9. Factory finish on aluminum surfaces shall be mill finish with coal tar epoxy coating applied to surfaces in contact with concrete.
10. Manufacturer shall warranty in writing against defects in material or quality for 5 years.

2.08 MISCELLANEOUS ITEMS

A. Fabricate miscellaneous steel framing, supports, and items not forming part of structural steel framework or not indicated to be furnished under structural steel work. Use structural steel plates, shapes, bars, and tubing of sizes and arrangement indicated.

B. Partial list follows.

1. Guard posts.
2. Bar screens.
3. Inlet headwall trash rack.

PART 3 EXECUTION

3.01 INSTALLATION

A. Layout and install connectors such as concrete anchors and anchor bolts to secure metal fabrications to structure.

B. Concrete Anchors:

1. Drill holes in concrete and masonry work with rotary driven twist drills only. Fill voids in masonry with grout.
2. Do not install until concrete has reached specified minimum strength (f'c).
3. Do not install closer than 6-bolt dia to edge of concrete or masonry, or closer than 12 bolt diameters to another anchor unless detailed on plans.
4. Minimum embedment shall be 8 bolt diameters.
5. Locate to clear reinforcing bars in concrete.
6. Install in accordance with manufacturer's recommendations.

C. Erect to lines and levels, plumb and true, and in correct relation to adjoining Work. Secure parts using concealed connections when practicable.

D. Plumb and true vertical members to tolerance of ±1/8 inch in 10 feet. Level horizontal members to tolerance of ±1/8 inch in 10 feet.

E. Provide items such as bolts, shims, blocks, nuts, washers, and wedging pieces to complete installation.

F. Drill field holes for bolts. Do not burn holes.

G. New holes or enlargement of unfair holes by use of cutting torch is cause for rejection of entire member.

H. Perform cutting, drilling, and fitting required for installation of metal fabrications.

I. Field welds shall be approved by Engineer before prime painting. Clean slag from welds prior to inspection.

3.02 ADJUSTING AND CLEANING

A. Field repair of damaged galvanized coatings.

1. Repair galvanized surfaces damaged during shipping or erection/construction operations.
2. Repair surfaces using zinc-rich paint.
3. Prepare surfaces and apply in accordance with ASTM A780, Annex A2.

* * * END OF SECTION * * *

SECTION 05520
ALUMINUM HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design railing system to resist load specified in latest edition of IBC and OSHA.

1.02 SUBMITTALS

A. Shop Drawings:

1. Plan showing layout including splices, attachments, and mounting.
2. Identify location and type indicated.
3. Indicate railings in related and dimensional position with scale elevations.

B. Product Data:

1. Manufacturer's literature.
2. Assembly and installation instructions.

C. Test Results:

1. Catalog data or design information.
   a. Submit test data showing load, and deflection due to load, in enough detail to prove handrail system satisfies OSHA requirements.
   b. Provide test data on base connections of types required for Project. Acceptance for use will not be granted without test data.
2. Design calculations for railing system only when requested by Engineer. Engineering calculations shall include transfer of forces from base of railing post, through base connection assembly, into supporting structure.

D. Operation and Maintenance (O&M) Data:

1. Manufacturer's recommendations describing procedures for maintaining including cleaning materials, application methods, and precautions as to use of materials which may be detrimental to finish when improperly applied.

E. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Handrails provided shall be end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle components in manner preventing damage to finished surfaces.

1. Pack tubes and elbows in individual plastic shrink film to protect finish. Do not remove until after installation.

B. Storage of Materials:

1. Store components in dry, clean location, away from uncured concrete and masonry.
2. Cover with waterproof paper, tarpaulin or polyethylene sheeting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wagner, Inc.

B. Alumaguard.

C. Enerco Metal Products, Inc.

D. Rocky Mountain Railings.

2.02 MATERIALS

A. Aluminum alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of alloy and temper designated below for each aluminum form required.

1. Extruded Structural Pipe and Tube: ASTM B429, alloy 6063-T6, Schedule 40, 1 1/2 inch IPS (1.90 inches OD, 0.145 inch wall thickness).
2. Plate and Sheet: ASTM B209 (ASTM B209M), alloy 6061-T6.
3. Die and Hand Forgings: ASTM B247 (ASTM B247M), alloy 6061-T6.

B. Fittings:

1. Fabricate from material similar to railings.
2. Elbows, flanges, sleeves, brackets, and similar items shall be riveted, set screw, bolted or welded.
3. Connections shall be continuous dia type for smooth appearance and to permit continuous sliding of hands.

C. Extensions:

1. Fittings for open handrail extensions shall be of welded construction and welded to vertical posts to comply with OSHA loading requirements. Welds shall be ground smooth and finished to match manufacturer's finish.

D. Chains: 3/16 inch minimum stainless steel link chain with spring actuated stainless steel clasp capable of withstanding 250 pound horizontal force.

E. Toe Plate: 1/4 inch thick by 4 inches high, flat aluminum, alloy 6063-T6, or "S" type aluminum plate, with clamp-on type connection.

2.03 FINISHES

A. Aluminum Association Finish Designation: AA-M12A41 (Mechanical finish, nonspecular, anodic coating, architectural Class I, clear coating 0.7 mil complying with AAMA 607.1 on exposed surfaces.

1. Extruded Components: 0.7 mil anodized.
2. Cast Components: 0.4 mil anodized.

2.04 FASTENINGS

A. Mechanical Fasteners: Stainless steel.

2.05 FABRICATION

A. Field-verify dimensions before fabrication.

B. Form connections and changes in rail direction by using prefabricated fittings or radius bends.

C. Remove burrs from exposed cut edges.

D. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces or use prefabricated bends.

E. Locate intermediate rails between top rail and finish floor as indicated on plans.

F. Space posts as shown on plans. Where spacing not shown, space posts not more than 5 feet on center.

G. Provide base flange mounting base plate.

H. Fabricate joints which will be exposed to weather to exclude water or provide weep holes where water may accumulate.

I. Fabricate gates as shown on plans.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as shown on plans and approved submittals.

B. Set posts plumb and aligned in each direction to within 1/8 inch in 12 feet.

C. Assemble and install in accordance with manufacturer's written instructions.

D. Expansion Joints (Exterior Only):

1. General:
   a. Provide at intervals of not more than 30 feet on center.
   b. Locate joints within 12 inches of posts.
   c. Design for temperature differential of 75ºF.
2. Railings:
   a. Provide slip joint with internal sleeve extending 2 inches beyond each side of joint.
3. Toe Plate:
   a. Provide slip joint in accordance with plans.

E. Install safety chains. Number of chains shall match number of horizontal rails. Chain drape shall not exceed 3 inches.

F. Provide toe board or plate except on stairs and where concrete curb provided. Install with bottom not more than 1/4 inch above walking surface. Match expansion joint location to railing joint location.

G. Railings shall be continuous, without gaps, for entire length of stair, including scissors and right angled stairs.

3.02 CLEANING

A. Wash thoroughly using clean water and soap, rinse with clean water.

B. Do not use acid solution, steel wool or other harsh abrasive.

C. If stain remains after washing, remove finish, and restore in accordance with manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL

A. Remove stained or otherwise defective Work and replace with material meeting Specifications.

* * * END OF SECTION * * *

SECTION 05532
METAL BAR GRATING

PART 1 GENERAL

1.01 SUBMITTALS

A. Shop Drawings:

1. Grating layout, unit dimensions and sections, fastener and weld types, and locations.

B. Product Data:

1. Manufacturer's literature.

C. Submit in accordance with Section 1105 of the Standard Specifications.

1.02 QUALITY ASSURANCE

A. Grating shall be end products of one manufacturer to achieve standardization for appearance and replacement.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store to avoid damage.

B. Replace damaged or deteriorated materials and remove from site.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide shop-fabricated grating in accordance with latest edition of Metal Bar Grating Manual.

B. Unless otherwise noted, grating shall be galvanized steel.

C. Provide accessories such as frames, support angles, and fasteners to complete Work.

D. Provide galvanized steel open grating stair treads.

1. Treads and exposed edges of grating platforms shall have antislip Steel checkered plate, cast iron abrasive, or cast aluminum abrasive nosing.

E. Provide fastening devices for gratings to firmly anchor grating to supports. Minimum of 4 per panel.

F. Devices to fasten sections of grating shall allow for repeated removal of grating.

G. Fasteners for anchoring grating shall be saddle clip type, "G" clip type, or grating clamp type with minimum 1/4 inch bolts and nuts or self-tapping screws. Fasteners shall be galvanized steel.

H. Provide trim banding or load carrying banding on edges and cutouts. Bearing bar ends not resting on support shall have load carrying banding sized to span opening. Minimum banding thickness shall match bearing bars. Banding shall be flush with top of grating. Banding depth shall be 1/4 inch less than depth of bearing bar. Weld banding to grating in accordance with NAAMM requirements.

I. Cross bars shall not project more than 1/8 inch past bearing bars on panel edges.

J. Panels shall have minimum bearing equal to depth of bearing bar, but not less than 1 inch, including removable panels after being offset between support angles or other restraints.

K. Minimum width of individual grating panels shall be 15 inches, except for locations requiring single piece and for designated removable sections. Maximum width shall be 4 foot 0 inches.

L. Grating supports shall conform to Section 05500.

2.03 STEEL GRATING

A. Manufacturers:

1. IKG/Borden, Type W/B.
2. Alabama Metal Industries, Type 194.
3. Klemp Grating, Type KW-19-4.
4. Ohio Grating, Type 19-W-4.

B. Materials:

1. Welded grating.
2. Grating bearing bars shall be at 1-3/16 inch centers with cross-bars at 4 inches.
3. Size bearing bars as follows.

Maximum Clear Span (foot - inch)	Bearing Bar Size (inch)
5 - 4	1 1/4 x 1/8
5 - 7	1 1/4 x 3/16
5 - 10	1 1/2 x 1/8
6 - 8	1 1/2 x 3/16
7 - 10	1 3/4 x 3/16
8 - 11	2 x 3/16
10 - 0	2 1/4 x 3/16
11 - 2	2 1/2 x 3/16

4. Galvanize grating after fabrication.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive grating and notify Engineer of deficiencies resulting in improper installation.

3.02 INSTALLATION

A. Install in accordance with approved submittals and manufacturer's written instructions.

B. Maximum Clearances:

1. 1/4 inch from vertical metal sections.
2. 1/2 inch from concrete and masonry walls.

3. 1/4 inch between sections and at ends.

* * * END OF SECTION * * *

SECTION 06050
ROUGH AND FINISH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rough Carpentry:
   a. Furring nailers, and blocking.
   b. Construction panels.

1.02 DEFINITIONS

A. Rough Carpentry: Carpentry work not specified as part of other sections and generally not exposed, except as otherwise indicated.

1.03 SUBMITTALS

A. Product Data:

1. Manufacturer's specifications and installation instructions for each item of prefinished paneling.
2. Wood Treatment Data: Chemical treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material.

B. Miscellaneous Submittals:

1. Preservative Treatment: For each type specified, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and conformance with applicable standards.
   a. For waterborne treatment, include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Project site.

C. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Lumber Standards: Manufacture lumber to comply with PS 20 and with applicable grading rules of inspection agencies certified by ALSC Board of Review.

B. Grade Stamps:

1. Factory-mark each piece of lumber and plywood with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, and moisture content at time of surfacing, and mill.
2. Omit marking from surfaces to receive transparent finish and submit mill certificate material inspected and graded in accordance with requirements if it cannot be marked on concealed surface.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber and provide air circulation within and around stacks and under temporary coverings including polyethylene and similar material.

1. For lumber pressure treated with waterborne chemicals, provide spacers between each course to provide air circulation

PART 2 PRODUCTS

2.01 GENERAL

A. Nominal sizes indicated except as shown by detail dimensions. Provide actual sizes required by PS 20 for moisture content specified for each use. Provide dressed lumber, S4S, unless otherwise indicated.

2.02 FURRING, NAILERS, BLOCKING, AND MISCELLANEOUS

A. Provide wood for support or attachment of other Work including cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members. Provide lumber of sizes indicated, worked into shapes shown, and as follows.

1. Moisture Content: 19% maximum for lumber items.
2. Grade: Standard grade light framing size lumber of species or board size lumber as required. No. 3 common or standard grade boards per WCLIB or WWPA or No. 3 boards in accordance with SPIB.

2.03 CONSTRUCTION PANELS

A. General:

1. Construction Panel Standards: Comply with PS 1 for plywood panels and for products not manufactured under PS 1 provisions, with APA PRP-108.
2. Trademark: Factory-mark each construction panel with APA trademark evidencing compliance with grade requirements.

B. Plywood Backing Panels:

1. For mounting electrical or telephone equipment, provide fire-retardant treated plywood panels with trade designation, APA C-D plugged interior with exterior glue in thickness indicated, or if not otherwise indicated, not less than 1/2 inch.

C. Plywood Roof Sheathing: Exterior, Structural I sheathing.

1. Span Rating: Not less than 24/0.
2. Thickness: Not less than 5/8 inch.

2.04 MISCELLANEOUS MATERIALS

A. Fasteners and Anchorages:

1. Provide size, type, material, and finish indicated and recommended by applicable standards, complying with applicable FS standards for nails, staples, screws, bolts, nuts washers, and anchoring devices.
2. Where carpentry work, inground contact or area of high relative humidity, provide fasteners and anchorages with hot-dip zinc coating complying with ASTM A153.

B. Adhesive for Field Gluing Panels to Framing:

1. Formulation complying with APA AFG-01.
2. Approved for use with type of construction panel indicated by panel and adhesive manufacturers.

PART 3 EXECUTION

3.01 PREPARATION

A. Condition finish carpentry wood materials to average prevailing humidity conditions in installation areas prior to installing.

3.02 INSTALLATION, ROUGH CARPENTRY

A. Discard units of material with defects impairing quality of Work and units too small to use in fabricating work with minimum joints or optimum joint arrangement.

B. Set to required levels and lines, with members plumb and true to line and cut and fitted.

C. Securely attach carpentry work to substrate by anchoring and fastening as shown and required by recognized standards.

1. Countersink nail heads on exposed carpentry work and fill holes.
2. Use common wire nails, except as otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.

3.03 WOOD NAILERS AND BLOCKING

A. Provide where shown and required for screeding or attachment of other Work. Form to shapes shown and cut as required for true line and level of Work to be attached. Coordinate location with other Work involved.

B. Attach to substrates as required to support applied loading. Countersink bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

C. Provide permanent grounds of dressed, preservative treated, key-bevelled lumber not less than 1/2 inch wide and of thickness required to bring face of ground to exact thickness of finish material involved. Remove temporary grounds when no longer required.

3.04 WOOD FURRING

A. Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finished Work.

3.05 CONSTRUCTION PANELS

A. General: Comply with PS 1 for types of plywood construction panels and, for products not manufactured under PS 1 provision, with APA PRP-108.

B. Fastening Methods:

1. Sheathing: Nail to framing.

2. Plywood Backing Panels: Nail to supports.

3.06 ADJUSTING AND CLEANING

A. Repair damaged and defective finish carpentry work to eliminate defects functionally and visually. Where not possible to repair properly, replace woodwork. Adjust joinery for uniform appearance.

B. Clean finish carpentry work on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

3.07 PROTECTION

A. Protect and maintain conditions necessary to ensure Work shall be without damage or deterioration at time of acceptance.

* * * END OF SECTION * * *

SECTION 07191
MASONRY WATER REPELLENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Masonry water repellent.

1.02 SUBMITTALS

A. Product Data:

1. Manufacturer's product data including technical literature on materials and performance characteristics.
2. Manufacturer's recommended instructions for application of stain and clear water repellents.

B. Miscellaneous:

1. Applicator's list of projects using waterproofing system submitted.
2. Submit certification stating water repellent material to be applied in compliance with federal, state and local environmental Volatile Organic Compounds (VOC) regulations.

C. Samples:

1. Set of 3-inch by 3-inch samples on masonry showing full range of color. Samples to have water repellent coating applied.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer: Firm with no less than 10 years experience in manufacturing products specified.

B. Applicator's Qualifications: Firm with no less than 3 years experience in application of products specified. Persons applying products shall be trained and approved by manufacturer for application of manufacturers products. Applicator shall provide equipment that is proper for intended use and that has been well maintained.

C. Regulatory Requirements: Comply with applicable rules of pollution-control regulatory agency having jurisdiction in Project locale regarding VOC's and use of hydrocarbon solvents.

D. Mock-Up:

1. Apply water repellent per manufacturer's application instructions to substrate material which matches actual job conditions. Determine method of application, acceptability of appearance, optimum coverage rate, and number of coats required for application.
2. After sample treatment has cured in accordance with manufacturer's recommendations, verify substrate has desired color and appearance, water test to verify that substrate is coated with sufficient water repellent to effectively repel liquid water from surface.
3. Obtain Engineer approval prior to full scale application of water repellents.

E. Single Source Responsibility: Obtain stain and water repellent products from single manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Material Delivery: Deliver materials to job site in original sealed containers, clearly marked with manufacturer's name, brand name, type of material, and color or color formula. Verify product matches that of original sample applied on mock-up wall.

B. Storage and Protection: Store materials inside, if possible, away from sparks and open flame. Store in secure area to avoid tampering and contamination. Water based materials must be kept from freezing. Store and handle in accordance with manufacturer's written instructions.

1.05 PROJECT/SITE CONDITIONS

A. Weather and Substrate Conditions: Do not proceed with application under any to following conditions, except with written instructions of manufacturer:

1. Ambient temperature is less than 40°F or below 95°F unless otherwise specified by manufacturer.
2. Masonry surfaces and mortar have cured for less than 28 days.
3. Substrate is frozen or surface temperature is less than 40°F.
4. Rain or temperatures below 40°F are predicted within 48 hours.
5. Application is earlier than 5 days after surface became wet.
6. Windy condition exists that may cause water repellent or stain to be blown onto vegetation or surfaces not intended to be coated.

1.06 WARRANTY

A. Guarantee against defective materials and quality for 5 years from Substantial Completion.

B. Submit completed manufacturer's written "Request for Warranty Form" to manufacturer 10 days prior to application.

C. After completion of specified material, submit manufacturer's written "5 Year Warranty Application" to manufacturer for processing. Upon receiving validated warranty, submit copy to Contracting Authority.

1.07 SCHEDULING

A. Notify Engineer not less that 48 hours before each application of stain and water repellent is applied.

PART 2 PRODUCTS

2.01 WATER REPELLENTS

A. Manufacturers:

1. Prime-A-Pell 200, Chemprobe Technologies, Inc (1-800-760-6776).
2. H&C HB-150 Siloxane Water Repellent, Sherwin-Williams, Inc.

B. Solvent based siloxane penetrating water repellent, no fillers, sterates, or paraffins. Products shall have a range of 3% to 7% solids.

C. Compatible with joint sealers and water repellent admixture in CMU.
D. Exterior breathable water repellent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify joint sealants have been installed.

B. Test for moisture content, according to repellent manufacturer's written instructions to ensure surface is sufficiently dry.

3.02 PREPARATION

A. Surface Preparation: Surface shall be free of cracks, dirt, oils, paint or other contaminants which may affect appearance or performance of water repellent material.

B. Protection: Follow manufacturer's recommendations for protection of adjacent materials and surrounding areas.

3.03 APPLICATION

A. Apply stain and water repellent coatings in accordance with manufacturer's written instructions.

B. Water Repellent:

1. Apply using low pressure application equipment designed for water repellent application.
2. Apply material as supplied by manufacturer. Do not dilute or thin.
3. Apply treatment evenly until surface is totally saturated. Coverage rates and number of coats as recommended by manufacturer for specific surface.

3.04 FIELD QUALITY CONTROL

A. Follow manufacturer's recommended field quality control procedures.

B. After water repellent has cured for 24 hours at low humidity and temperature between 70°F to 90°F or 48 hours. at high humidity and low temperature between 50°F to 69°F, test surfaces with water spray. Recoat areas that indicate water absorption.

3.05 CLEANING

A. At completion of Work, remove protective coverings, excess material, debris, and waste from Site. Clean and repair damage caused by applications. Comply with manufacturer's written cleaning instructions.

B. Dispose of water repellent containers according to state and local environmental regulations.

* * * END OF SECTION * * *

SECTION 07210
BUILDING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Insulation under slabs-on-grade.
2. Foundation wall insulation (supporting backfill).
3. Cavity wall insulation.

1.02 SUBMITTALS

A. Product Data:

1. Submit for each type of insulation product specified.

B. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation from single source.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: ASTM E84.
2. Fire-Resistance Ratings: ASTM E119.
3. Combustion Characteristics: ASTM E136.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition.
3. Do not deliver plastic insulating materials to Project site before installation time.
4. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 INSULATING MATERIALS

A. Provide insulating materials that comply with requirements and with referenced standards.

1. Preformed Units: Sizes to fit applications indicated; selected from manufacturer's standard thicknesses, widths, and lengths.

B. Extruded-Polystyrene Board Insulation (Foundation Insulation):

1. Manufacturers:
   a. DiversiFoam Products.
   b. Dow Chemical Co.
   c. Owens-Corning Co.
   d. Tenneco Building Products.
2. ASTM C578, of type and density indicated below:
   a. Type IV, 1.60 pound/cubic foot, unless otherwise indicated.
3. Maximum flame-spread and smoke-developed indices of 5 and 145, respectively per inch thickness.
4. Thermal Resistance: R=5.0 per 1 inch at 75°F.

C. Foil Faced Polyisocyanurate Board Insulation (Cavity Wall Insulation):

1. Manufacturers:
   a. Apache Products Company.
   b. Celotex Corporation.
   c. Johns Manville Corporation.
2. ASTM Standard: ASTM C1289, Type I, Class 1 or 2.
3. Maximum flame-spread and smoke-developed indices of 25 and 130, respectively, per 1 inch thickness.
4. Thermal Resistance: Aged "R" value of 7.2 per 1 inch thickness.

2.02 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

B. Protection Board: Premolded, semi-rigid asphalt/fiber composition board, 1/4 inch thick, formed under heat and pressure, standard sizes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, for compliance with requirements of Sections in which substrates and related work are specified and to determine if other conditions affecting performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or that interfere with insulation attachment.

3.03 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, unsoiled, and has not been exposed at any time to ice and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.04 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

B. Protect top surface of horizontal insulation from damage during concrete work by applying protection
board.

3.05 INSTALLATION OF CAVITY WALL AND MASONRY CELL INSULATION

A. On units of plastic insulation, install small pads of adhesive spaced approximately 24 inch on center both ways on inside face, as recommended by manufacturer. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Supplement adhesive attachment of insulation by securing boards with two piece wall ties designed for this purpose and specified in Section 04810.

3.06 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.

4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

E. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40% of normal maximum volume equaling density of approximately 2.5 pounds per cubic foot.

3.07 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

* * * END OF SECTION * * *

SECTION 07272
FLUID-APPLIED AIR & WATER-RESISTIVE BARRIER SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Work of this section includes air and water-resistive barrier membrane system, and accessory materials for application to exterior building envelope substrates as indicated on the plans.

B. Apply barrier system to cavity side of interor cmu wythe of exterior masonry cavity wall.

1.02 PERFORMANCE REQUIREMENTS

A. Performance requirements: Comply with the specified performance requirements and characteristics as herein specified.

B. Performance Description:

1. Building envelope shall be constructed with a continuous, air and water-resistive barrier to control water and air leakage into and out of the conditioned space.
2. Joints, penetrations and paths of water and air infiltration shall be made watertight and airtight.
3. System shall be capable of withstanding positive and negative combined wind, stack and HVAC pressures on the envelope without damage or displacement.
4. System shall be installed in an airtight and flexible manner, allowing for the relative movement of systems due to thermal and moisture variations.

1.03 SUBMITTALS

A. Product data: Submit manufacturer’s product data including membrane and accessory material types, technical and test data, composition, descriptions and properties, installation instructions and substrate preparation requirements.

B. Shop Drawings: Provide Installation Guideline Illustrations.

1.04 QUALITY ASSURANCE

A. Applicable standards, as referenced herein: ASTM International (ASTM).

B. Manufacturer’s Qualifications: Air and water-resistive barrier systems shall be manufactured and marketed by a firm with a minimum of 5 years experience in the production and sales of air and water-resistive barrier system.

C. Installer’s Qualifications: The installer shall demonstrate qualifications to perform the work of this section by submitting the following:

1. Verification that installer has been trained by and is approved to perform work as herein specified by air and water-resistive barrier system manufacturer.
2. A firm experienced in applying similar materials on similar size and scoped projects.
3. Evidence of proper equipment and trained field personnel to successfully complete the project.

D. Inspection: Cooperate and coordinate with the Contracting Authority’s inspection agency. Do not cover installed products or assemblies until they have been inspected and approved.

E. Sole Source: Obtain materials from a single manufacturer.

F. Regulations: Provide products which comply with all Pennsylvania and local regulations controlling use of volatile organic compounds (VOC).

G. Pre-Installation Conference: Prior to beginning installation of air and water-resistive barrier system, hold a pre-installation conference to review work to be accomplished.

1. Contractor, Engineer and membrane system manufacturer's representative shall be present.
2. Contractor shall notify Engineer at least seven days prior to time for conference.
3. Contractor shall record minutes of meeting and distribute to attending parties.
4. Agenda: As a minimum discuss:
    a. Surface preparation.
    b. Substrate condition and pretreatment.
    c. Minimum curing period.
    d. Special details and sheet flashing.
    e. Sequence of construction, responsibilities, and schedule for subsequent operations.
    f. Installation procedures.
    g. Inspection procedures.
    h. Protection and repair procedures.
    i. Review and approval of all glazing applications.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from damage, weather, excessive temperatures and construction operations. Remove damaged material from site and dispose of in accordance with applicable regulations.

B. Protect air and water-resistive barrier components from freezing and extreme heat.

C. Sequence deliveries to avoid delays, and to minimize on-site storage.

1.06 PROJECT CONDITIONS

A. Weather conditions: Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used.

1. Apply at surface and ambient temperatures recommended by the manufacturer. See manufacturer’s product data sheets for best practices.
2. Proceed with installation only when the substrate construction and preparation work are complete and in condition to receive the membrane system.
3. Exposure limitations: Schedule work to ensure that air and water-resistive barrier system is covered and protected from UV exposure within 180 days of installation. If air and water-resistive barrier membrane system cannot be covered within 180 days after installation, apply temporary UV protection as recommended by membrane manufacturer.

1.07 WARRANTY

A. Manufacturer's warranty requirements: Submit manufacturer’s written warranty stating that installed air and water-resistive barrier materials are watertight, free from defects in material and quality, and agreeing to replace defective materials and components.

B. Warranty period: 5 years from Date of Substantial Completion.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. PROSOCO, Inc, 3741 Greenway Circle, Lawrence, KS 66046. Phone (800) 255-4255; Fax: (800) 877-2700. E-mail: CustomerCare@prosoco.com.

B. Or equal.

2.02 R-GUARD JOINT & SEAM FILLER FIBER REINFORCED FILL COAT AND SEAM FILLER

A. Acceptable Product: PROSOCO R-GUARD® Joint and Seam Filler.

B. Description: Joint and Seam Filler is a high modulus, gun-grade, crack and joint filler, adhesive and detailing compound that combines the best silicone and polyurethane properties. This single-component, 99% solids, fiber-reinforced, Silyl-Terminated-Poly-Ether (STPE) is easy to gun, spread and tool.

C. Characteristics:

1. Thickness: Apply according to manufacturer’s instructions. See product data sheet.
2. Hardness: Shore A, 45-50 when tested in accordance with ASTM C661.
3. Water vapor permeability: Minimum 14 perms when tested in accordance with ASTM E-96.
4. Tensile strength: 225 psi when tested in accordance with ASTM D412.
5. Lap shear strength: 275 psi when tested in accordance with ASTM D1002.
6. Elongation at break: 275% when tested in accordance with ASTM D412.
7. Peel strength: 30 pli when tested in accordance with ASTM D1781.
8. Shrinkage: None.
9. Form: pale red, gun-grade sealant.
10. Specific gravity: 1.40 to 1.50.
11. pH: not applicable.
12. Weight per gallon: 11.8 pounds.
13. Active content: 99%.
14. Total solids: 99%.
15. Volatile organic content (VOC): 30 grams per Liter, maximum.
16. Flash point: no data.
17. Freeze point: no date.
18. Shelf life: 1 year in tightly sealed, unopened container.

2.03 R-GUARD FASTFLASH® LIQUID-APPLIED FLASHING MEMBRANE

A. Acceptable product: PROSOCO R-GUARD® FastFlash®.

B. Description: FastFlash® is a gun-grade waterproofing, adhesive and detailing compound that combines the best of silicone and polyurethane properties. This single component, 99% solids, Silyl-Terminated-Poly-Ether (STPE) is easy to gun, spread and tool to produce a highly durable, seamless, elastomeric flashing membrane in rough openings of structural walls.

C. Characteristics:

1. Thickness: Apply according to manufacturer's instructions.
2. Water vapor permeability: Minimum 14 perms when tested in accordance with ASTM E96.
3. Water penetration (cyclical static air pressure difference): No uncontrolled water penetration when tested in accordance with ASTM E547.
4. Hardness: Shore A, 40-45 when tested in accordance with ASTM C661.
5. Tensile strength: 180 psi when tested in accordance with ASTM D412.
6. Elongation at break: 400% when tested in accordance with ASTM D412.
7. Peel strength: 25 pli when tested in accordance with ASTM D1781.
8. Form: Brick Red, Gun Grade Sealant.
9. Specific gravity: 1.45 to 1.60.
10. pH: not applicable.
11. Weight per gallon: 12.5 pounds.
12. Active content: 99%.
13. Total solids: 99%.
14. Volatile organic content (VOC): 30 grams per Liter, maximum.
15. Flash point: no data.
16. Freeze point: no data.
17. Shelf life: 1 year in tightly sealed, unopened container.

2.04 R-GUARD MVP (MAXIMUM VAPOR PERMEABILITY) AIR AND WATER-RESISTIVE BARRIER

A. Acceptable Product: PROSOCO R-GUARD® MVP.

B. Description: MVP is a fluid-applied air and water-resistive barrier that stops air and water leakage in cavity wall and masonry veneer construction.

C. Characteristics:

1. Thickness: Apply in accordance with manufacturer's instructions. See product data sheet.
2. Air infiltration: Less than 0.004 cfm per square foot when tested in accordance with ASTM E2178 or ASTM E283.
3. Air Barrier Assembly: pass when tested in accordance with ASTM E2357.
4. Water vapor permeability: Minimum 17 perms when tested in accordance with ASTM E96.
5. Structural performance: Air and water-resistive barrier system shall withstand positive and negative wind pressure loading when tested in accordance with ASTM E330.
6. Water penetration (static pressure): No uncontrolled water penetration when tested in accordance with ASTM E331.
7. Tensile strength: Greater than 15 psi or exceeds strength of substrate when tested in accordance with ASTM C297.
8. Nail Sealability: pass when tested in accordance with ASTM D1970.
9. Flexibility: pass when tested in accordance with ASTM D522.
10. Form: tan viscous liquid, mild odor.
11. Specific gravity: greater than 1.0.
12. pH: 7.5 to 10.0.
13. Weight per gallon: 12.2 pounds.
14. Active content: no data.
15. Total solids: 58.5% by volume, ASTM-D-2369.
16. Volatile organic content (VOC): less than 50 grams per Liter.
17. Flash point: not applicable.
18. Freeze point: 32°F.
19. Shelf life: 1 year in tightly sealed, unopened container.

2.05 R-GUARD AIRDAM® AIR AND WATERPROOF SEALANT FOR DOORS

A. Acceptable Product: PROSOCO R-GUARD® AirDam®.

B. Description: AirDam® is a medium modulus sealant that combines the best silicone and polyurethane properties. This single component, 98% solids Silyl-Terminated-Poly-Ether (STPE) is easy to gun and tool in all weather conditions. AirDam® cures quickly to produce a durable, high performance, high movement elastomeric interior air sealant.

C. Characteristics:

1. Hardness: Shore A, 20-25 when tested in accordance with ASTM C661.
2. Tensile strength: 110 psi when tested in accordance with ASTM D412.
3. Elongation at break: 1300% when tested in accordance with ASTM D412.
4. Peel strength: 30 pli when tested in accordance with ASTM D1781.
5. Type: Type S, Grade NS, Class 50 when tested in accordance with ASTM C920.
6. Shrinkage: None.
7. Form: heavy white paste, mild odor
8. Specific gravity: 1.3 to 1.4.
9. pH: not applicable.
10. Weight per gallon: 11.648 pounds.
11. Active content: 98%.
12. Total solids: 98%.
13. Volatile organic content (VOC): 30 grams per Liter, maximum.
14. Flash point: greater than 200°F.
15. Freeze point: not applicable.
16. Shelf life: 1 year in tightly sealed, unopened container.

D. Backer Rod: Compressible, closed cell rod stock as recommended by manufacturer for compatibility with sealant. Provide size and shape of rod to control joint depth.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions are ready to accept the Work of this section. Notify design professionals in writing of any discrepancies. Commencement of the Work or any parts thereof shall mean acceptance of the prepared substrates.

B. All surfaces must be sound, clean and free of grease, dirt, excess mortar or other contaminants. Fill or bridge damaged surfaces, voids or gaps larger than 1/2 inch with mortar, wood, metal, sheathing or other suitable material, as necessary. Fill voids and gaps measuring 1/2 inch or less with R-GUARD Joint & Seam Filler as necessary to ensure continuity.

1. Surfaces to receive R-GUARD MVP may be dry or damp. Do not apply to surfaces which are sufficiently wet to transfer water to the skin when touched. Surfaces must be protected from rain for 2 hours following application.

C. Where curing materials are used they must be clear resin based without oil, wax or pigments.

D. Condition materials to room temperature prior to application to facilitate extrusion and handling.

3.02 SURFACE PREPARATION

A. Air, water-resistive and waterproofing membrane and accessories may be applied to green concrete 16 hours after removal of forms.
B. Refer to manufacturer’s product data sheets for requirements for condition of and preparation of substrates.

1. Surfaces shall be sound and free of voids, spalled areas, loose aggregate and sharp protrusions.
2. Remove contaminants such as grease, oil and wax from exposed surfaces.
3. Remove dust, dirt, loose stone and debris.
4. Use repair materials and methods that are acceptable to manufacturer of the air and water-resistive barrier system.
5. Prepare structural walls to receive the primary air and water resistive barrier per manufacturer's product data sheets and installation guidelines.

C. Masonry and Concrete Substrates:

1. Masonry head and bed joints should be fully filled and tooled.
2. Mechanically remove loose mortar fins, mortar accumulations and protrusions, and debris.

3.03 INSTALLATION OF JOINT TREATMENT (PREPARE)

A. Apply R-GUARD Joint & Seam Filler for seams, joints, cracks, gaps, primed rough gypsum edges at sheathing, rough openings:

1. Fill or repair cracks larger than one-half inch.
2. Fill surface defects and over driven fasteners with R-GUARD Joint & Seam Filler.
3. Using a dry knife, trowel or spatula, tool and spread the product. Spread one inch beyond seam at each side to manufacturer's recommended thickness. See product data sheet.
4. Allow to skin before installing other waterproofing or air barrier components.
5. Apply in accordance with manufacturer's Application Guideline illustrations.

3.04 R-GUARD FASTFLASH® FLASHING AT DOORS, OPENINGS AND PENETRATIONS

A. Apply R-GUARD FastFlash® over surfaces prepared with R-GUARD Joint & Seam Filler to seal and waterproof rough openings:

1. Apply a thick bead of R-GUARD FastFlash® over any visible gaps in the prepared rough opening.
2. Immediately press and spread the wet product into gaps.
3. Allow treated surface to skin.
4. Starting at the top, apply a thick bead of R-GUARD FastFlash® in a zigzag pattern to the structural wall surrounding the rough opening.
5. Spread the wet product to create an opaque, monolithic flashing membrane which surrounds the rough opening and extends 4 to 6 inches over the face of the structural wall. Apply and spread additional product as needed to create an opaque, monolithic flashing membrane free of voids and pin holes.
6. Apply additional product in a zigzag pattern over a structural framing inside the rough opening.
7. Apply R-GUARD FastFlash® within temperature and weather limitations as required by manufacturer.
8. Apply R-GUARD FastFlash® to perimeters, sills and adjacent sheathing and building face, in accordance with manufacturer's product data sheet and R-GUARD Installation Guidelines illustrations.
9. Extend flashing onto building face 4 to 6 inches.
10. Install preparation products in accordance with manufacturer's Application Guideline illustrations.

3.05 R-GUARD AIR & WATER-RESISTIVE BARRIER INSTALLATION

A. Apply appropriate R-GUARD air and water-resistive barrier to a clean, dry substrate (clean, dry, and/or damp substrates – R-GUARD Cat 5® waterproofing air-barrier membrane), within temperature and weather limitations as required by manufacturer.

1. Apply to recommended thickness. Proper thickness is achieved when coating is opaque.
2. Allow product to cure and dry.
3. Inspect membrane before covering. Repair any punctures, translucent or damaged areas by applying additional material.
4. Specifier Note: If air or surface temperature exceed 95°F, apply to shaded surfaces and before daytime air and surface temperatures reach their peak.
5. On CMU wall construction back roll as necessary to ensure there are no pinholes, voids or gaps in the membrane. Do not back roll R-GUARD TMVP. R-GUARD Cat 5® is roller applied.

3.06 R-GUARD FLASHING TRANSITIONS

A. Apply R-GUARD Joint & Seam Filler and R-GUARD FastFlash® as a liquid flashing membrane to waterproof the transitions in rough opening and between dissimilar materials.

1. Fill any voids between the top of the flashing leg and the vertical wall with R-GUARD Joint and Seam Filler. Tool to direct water from the vertical wall to the flashing.
2. Apply a generous bead of FastFlash® to the top edge of the flashing leg.
3. Spread the wet products to create a monolithic “cap-flash” flashing membrane extending 2 inches up the vertical face of the structural wall and 1 inch over the flashing membrane extending. Apply additional product as needed to achieve a void and pinhole free surface. This “liquid termination bar” helps secure the flashing and ensures positive drainage from the wall surface to the flashing.
4. Allow treated surfaces to skin before installing other wall assembly, waterproofing or air barrier components.

3.07 R-GUARD AIRDAM® AIR AND WEATHER BARRIER SEALANT FOR DOORS INSTALLATION

A. Install R-GUARD AirDam® with professional grade caulking gun in continuous beads without air gaps or air pockets.

1. Apply R-GUARD AirDam® to a clean, dry or damp surface
2. Install Backer rod: Compressible, closed cell rod stock as recommended by manufacturer for compatibility with sealant. Provide size and shape of rod to control joint depth.
3. Install AirDam® to provide uniform, continuous ribbons without gaps or air pockets, with complete wetting of the joint bond surfaces.
4. Tool sealant immediately to ensure complete wetting of joint bond surface and to produce a smooth, concave joint profile flush with the edges of the adjacent surfaces. Where horizontal and vertical surfaces meet, tool sealant to create a slight cove so as to not trap moisture or debris.
5. Do not allow materials to overflow onto adjacent surfaces. Prevent staining of adjacent surfaces.
6. Remove excess and misplaced materials as work progresses. Clean the adjoining surfaces to remove misplaced materials, without damage to adjacent surfaces or finishes.

* * * END OF SECTION * * *

SECTION 07411
METAL ROOF PANELS, GUTTERS AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Factory-formed and field-assembled**,** standing-seam metal roof panels.

1.02 DEFINITIONS

A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for complete weathertight roofing system.

B. Solar Flux: Direct and diffuse radiation from sun received at ground level over solar spectrum, expressed in watts per square meter.

C. Solar Reflectance: Fraction of solar flux reflected by surface, expressed as percent or within range of 0.00 and 1.00.

1.03 PERFORMANCE REQUIREMENTS

A. Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by qualified testing and inspecting agency.

B. Air Infiltration: Air leakage through assembly of not more than 0.06 cubic feet per minute per square foot of roof area when tested according to ASTM E 283 at following test-pressure difference:

1. Test-Pressure Difference: Negative 1.57 pound-force per square foot.

C. Water Penetration: No water penetration when tested according to ASTM E 331 at following test-pressure difference:

1. Test-Pressure Difference: 20% of positive design wind pressure, but not less than 6.24 pound-force per square foot and not more than 12.0 pound-force per square foot.
2. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 pound-force per square foot and greater of 75% of building live load or 50% of building design positive wind-pressure difference.
3. Negative Preload Test-Pressure Difference: 50% of design wind-uplift-pressure difference.

D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift resistance class indicated.

1. Fire/Windstorm Classification: Class 1A-90.
2. Hail Resistance: MH.

E. Structural Performance: Provide metal roof panel assemblies capable of withstanding effects of gravity loads and following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:

1. Wind Loads: Determine loads based on following minimum design wind pressures:
   a. Uniform pressure as indicated on plans.
2. Snow Loads: As indicated on plans.

F. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120°F, ambient; 180°F, material surfaces.

G. Solar Reflectance for Roofs with Slopes of 2:12 or Less: Initial solar reflectance of not less than 0.65 when tested according to ASTM E 903, and maintained, under normal conditions, solar reflectance of not less than 0.50 for 3 years after installation.

H. Solar Reflectance for Roofs with Slopes Steeper Than 2:12: Initial solar reflectance of not less than 0.25 when tested according to ASTM E 903, and maintained, under normal conditions, solar reflectance not less than 0.15 for 3 years after installation.

1.04 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.

B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.

1. Accessories: Include details of following items, at scale of not less than 1 1/2 inches per 12 inches:
   a. Flashing and trim.
   b. Gutters.
   c. Downspouts.
   d. Roof curbs.
   e. Snow guards.

C. Warranties: Special warranties specified in this Section.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Installer's responsibilities include fabricating and installing metal roof panel assemblies and providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of data for metal roof panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Source Limitations: Obtain each type of metal roof panels through one source from single manufacturer.

C. Product Options: Plans indicate size, profiles, and dimensional requirements of metal roof panels and are based on specific system indicated.

1. Do not modify intended aesthetic effects, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.

B. Unload, store, and erect metal roof panels in manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

E. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.07 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.

1.08 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Coordinate metal panel roof assemblies with rain drainage work, flashing, trim, and other adjoining work to provide leakproof, secure, and noncorrosive installation.

1.09 WARRANTY

A. Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of 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: 35 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: 35 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PANEL MATERIALS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by hot-dip process and prepainted by coil-coating process to comply with ASTM A 755/A 755M.

1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
2. Surface: Smooth, flat finish.
3. Exposed Finishes: Apply following coil coating, as specified or indicated on plans.
   a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
      1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70% polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:

2.02 UNDERLAYMENT MATERIALS

A. Felts: ASTM D 226, Type I (No. 15), asphalt-saturated organic felts.

B. Self-Adhering, Polyethylene-Faced Sheet:

1. Products:
   a. Carlisle Coatings & Waterproofing, Div. of Carlisle Companies Inc.; Dri-Start "A."
   b. Grace, W. R. & Co.; Grace Ice and Water Shield.
   c. Henry Company; Perma-Seal PE.
   d. Johns Manville International, Inc.; Roof Defender.
   e. NEI Advanced Composite Technology; AC Poly Ice and StormSeal.
   f. Owens Corning; WeatherLock.
   g. Polyguard Products, Inc.; Polyguard Deck Guard.
   h. Protecto Wrap Company; Rainproof TM.
2. ASTM D 1970, 40 mils thick minimum, consisting of slip-resisting polyethylene-film reinforcing and top surface laminated to SBS-modified asphalt adhesive, with release-paper backing; cold applied.

2.03 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels:

1. Manufacturers:
   a. AEP-Span.
   b. ATAS International, Inc.
   c. Berridge Manufacturing Company.
   d. CENTRIA Architectural Systems.
   e. Merchant & Evans, Inc.
   f. Metal-Fab Manufacturing, LLC.
   g. Perma-Clad Products.
   h. Petersen Aluminum Corporation - Snap Clad.
   i. Or equal.
2. 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, and snapping panels together.
3. Material: Aluminum-zinc alloy-coated steel sheet, 24 gauge thick.
   a. Exterior Finish: Fluoropolymer.
   b. Color: As selected by Engineer from manufacturer's full range.

2.04 ACCESSORIES

A. Roof Panel Accessories: Provide components required for complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, 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 metal as metal roof panels.
2. Clips: Minimum 0.0625 inch thick, stainless-steel panel clips designed to withstand negative-load requirements.
3. Cleats: Mechanically seamed cleats formed from minimum 0.0250 inch thick, stainless-steel or nylon-coated aluminum sheet.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

B. Flashing and Trim: Formed from 0.0179 inch thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. 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, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

C. Gutters: Formed from 0.0179 inch thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. 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." Furnish gutter supports spaced 36-inch on center, fabricated from same metal as gutters. Provide bronze, copper, or aluminum wire ball strainers at outlets. Finish gutters to match metal roof panels.

D. Downspouts: Formed from 0.0179 inch thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; in 10-foot long sections, complete with formed elbows and offsets. Finish downspouts to match metal roof panels.

2.05 FABRICATION

A. Fabricate and finish metal roof panels and accessories at factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Where indicated, fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide tight seal and prevent metal-to-metal contact, in manner that will minimize noise from movements within panel assembly.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

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.
2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.06 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 and painted 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

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.

1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

3.03 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under metal roof panels. Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof, in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3 1/2 inches. Extend underlayment into gutter trough**.** Roll laps with roller. Cover underlayment within 14 days.

B. Install flashings to cover underlayment to comply with Section 07620.

C. Apply slip sheet over underlayment before installing metal roof panels.

3.04 METAL ROOF PANEL INSTALLATION, GENERAL

A. Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of Work securely in place, with provisions for thermal and structural movement.

1. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels.
2. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
3. Locate and space fastenings in uniform vertical and horizontal alignment.
4. Install ridge caps as metal roof panel work proceeds.
5. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid four-panel lap splice condition.
6. Lap metal flashing over metal roof panels to allow moisture to run over and off material.

B. Fasteners:

1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to exterior and galvanized steel fasteners for surfaces exposed to interior.

C. 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.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.

1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.

3.05 FIELD-ASSEMBLED METAL ROOF PANEL INSTALLATION

A. 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.

3.06 ACCESSORY INSTALLATION

A. 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 complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

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 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 on center 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-inch on center in between.

1. Provide elbows at base of downspouts to direct water away from building.

3.07 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal roof panel units 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.

3.08 FIELD QUALITY CONTROL

A. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.

B. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.09 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

* * *END OF SECTION * * *

SECTION 07620
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Manufactured through-wall flashing.
2. Formed wall flashing and trim.

1.02 SYSTEM DESCRIPTION

A. Performance Requirements:

1. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.
2. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from 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 result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   a. Temperature Change (Range): 120°F, ambient; 180°F, material surfaces.

B. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.)

B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include following:

1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Details of expansion-joint covers, including showing direction of expansion and contraction.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Flashing: 12 inches long. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: Full-size Sample.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.06 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide leakproof, secure, and noncorrosive installation.

PART 2 PRODUCTS

2.01 SHEET METALS

A. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

1. Finish: No. 2D (dull, cold rolled).

2.02 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
2. Blind Fasteners: High-strength stainless-steel rivets.

C. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

D. Sealing Tape: Pressure-sensitive, 100% solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

E. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.03 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3 inch intervals along length of flashing to provide an integral mortar bond.

1. Stainless Steel:
   a. Manufacturers:
      1) Cheney Flashing Company, Inc.; Cheney Flashing (Dovetail).
      2) Cheney Flashing Company, Inc.; Cheney Flashing (Sawtooth).
      3) Keystone Flashing Company, Inc.; Keystone Three-Way Interlocking Thruwall Flashing.
   b. 0.0156 inch thick.

2.04 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

1. Seams: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1-inch deep, filled with elastomeric sealant concealed within joints.

F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.05 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 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

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Do not torch cut sheet metal flashing and trim.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Coat side of stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install course of felt underlayment and cover with slip sheet or install course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

1. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inch for nails and not less than 3/4 inch for wood screws.

1. Stainless Steel: Use stainless-steel fasteners.

H. Seal joints with elastomeric sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature

at time of installation is moderate, between 40°F and 70°F, set joint members for 50% movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40°F.

2. Prepare joints and apply sealants to comply with requirements in Section 07920.

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to width of 1 1/2 inches except where pretinned surface would show in finished Work.

1. Pretinning is not required for stainless steel.
2. Stainless-Steel Soldering: Pretin edges of uncoated sheets to be soldered using solder recommended for stainless steel and phosphoric acid flux. Promptly wash off acid flux residue from metal after soldering.
3. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.04 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches and bed with elastomeric sealant.

1. Secure in waterproof manner by means of interlocking folded seam or blind rivets and sealant.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:

1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
2. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.05 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of manufactured formed through-wall flashing is specified in Section 04810.

C. Openings Flashing in Frame Construction: Install continuous head, sill jamb, and similar flashings to extend 4 inches beyond wall openings.

3.06 MISCELLANEOUS FLASHING INSTALLATION

A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.

3.07 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

* * * END OF SECTION * * *

SECTION 07920
JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior joints in vertical surfaces and non-traffic horizontal surfaces.
2. Exterior joints in horizontal traffic surfaces.
3. Interior joints in vertical surfaces and horizontal non-traffic surfaces.
4. Submerged surfaces.

1.02 SUBMITTALS

A. Product Data:

1. Description of proposed product.
2. VOC characteristics to confirm compliance with OTC.
3, Manufacturer's standard color charts for each joint sealant exposed to view.

B. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have successfully completed at least three joint sealant applications similar in type and size to that of Project within last 3 years.

B. Single Source Responsibility of Joint Sealant Materials: Obtain sealant materials from single manufacturer for each different product required.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver material to Project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multicomponent materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.05 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealant under following conditions.

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
2. When joint substrates are wet due to rain, frost, condensation or other causes.

B. Joint Width Conditions: Do not proceed with installation of joint sealant when joint widths exceed limits allowed by joint sealant manufacturer for application indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Compatibility: Provide joint sealants, joint fillers, backer rods, and other related materials compatible with one another and joint substrates under conditions of service and application, as demonstrated by testing and field experience.

B. Colors: Provide color of exposed joint sealants indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

2.02 JOINT SEALANTS

A. Manufacturers:

1. Tremco
2. Or Equal.

B. Exterior Joints:

1. Joints:
   a. Joints between cast-in-place concrete sections and precast concrete sections or each other.
   b. Expansion and control joints in concrete and masonry.
   c. Perimeters of door frames, louvers and similar opening, and where metal, wood or other materials abut or join masonry, cast-place concrete, and precast concrete or each other.
2. Material:
   a. Tremco Dymeric.
   b. Multipart Epoxidized Polyurethane sealant, FS TT-S-00227E, Class A, Type II, or ASTM C920, Type M, Grade NS (non-sag), Class 25, use NT, M, A, and O.

C. Exterior Horizontal Joints:

1. Joints:
   a. Decks and concrete floors driveways.
   b. Where indicated on plans.
2. Material:
   a. Tremco THC-900/901.
   b. Multipart chemically curing Polyurethane, FS TT-S-00227E, Class A, Type I, (Self-Leveling), or ASTM C920, Type M, Grade P, Class 25, use T, M, A, and O.

D. Interior Joints:

1. Expansion and Control Joints:
   a. Tremco Dymeric.
   b. Multipart Epoxidized Polyurethane sealant, FS TT-S-00227E, Class A, Type II, or ASTM C920, Type M, Grade NS, Class 25, use NT,M,A and O.
2. Perimeter of Door Frames:
   a. Tremco Dymonic.
   b. One-part moisture curing, modified Polyurethane sealant. FS TT-S-00230C, Class A, Type II, or ASTM C920, Type S, Grade NS, Class 25, use NT, M, A, and O.
3. Joints between Precast Plank:
   a. Tremco Acrylic Latex Caulk.
   b. One-part acrylic latex sealant.

E. Fire-Stopping System:

1. Sealing Around Pipes in Floors and Walls:
   a. Tremco TREMstop WS Intumescent wrap strip.
   b. Tremco TREMstop MCR prefabricated metal collar.
2. Sealing Around Single and Multiple Cables in Floors or Walls:
   a. Tremco TREMstop FP intumescent putty.
   b. Tremco TREMstop M.
3. Accessory Materials:
   a. Provide wire, packing, and other accessory materials required for installation of fire-stopping sealants as applicable to installation conditions.

2.03 SUBMERGED JOINT SEALANTS

A. Manufacturers:

1. Morton Thiokol Polymer Systems manufactured by PolySpec.
2. Or Equal.

B. Submerged, Non-Potable Water:

1. Primer: Thiokol water-based FEC 415.
2. Sealant:
   a. Thiokol 2282.
   b. Multipart chemical curing, polysulfide sealant. ASTM C920, Type M, Grade NS.
3. Thickener: Cabosil fiberglass powder for vertical surfaces. Coordinate with manufacturer if required.

2.04 COMPRESSION SEALS

A. Preformed Foam Sealant:

1. Manufacturer's standard preformed, precompressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with nondrying, water repellent agent.
2. Factory-produce in precompressed sizes and in roll or stick form to fit joint widths indicated and to develop watertight and airtight seal when compressed to degree specified by manufacturer.
3. Provide products permanently elastic, mildew-resistant, nonmigratory, nonstaining, and compatible with joint substrates and other joint sealants.
4. Backing: Pressure sensitive adhesive, factory-applied to one side, with protective wrapping.

2.05 JOINT FILLERS FOR CONCRETE SLABS (PJF)

A. General: Provide for sidewalks and drives.

B. Bituminous Fiber Joint Filler: Comply with ASTM D1751. Preformed strips of asphalt saturated fiberboard, or granulated cork with asphalt binder encased between two layers of saturated felt or glass-fiber felt of width and thickness indicated.

2.06 JOINT SEALANT BACKING

A. General:

1. Provide sealant backings of material and type which are non-staining; compatible with joint substrates, sealants, primers, and other joint fillers approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Backer Rods:

1. Preformed, compressible, resilient, nonwaxing, non-extruding strips of plastic foam of material indicated below, and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
2. Flexible, open cell Polyurethane foam or nongassing, closed-cell polyethylene foam.

C. Bond Breaker Tape:

1. Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing bond between sealant and joint filler or other materials at back (3rd) surface of joint.
2. Provide self-adhesive tape where applicable.

2.07 MISCELLANEOUS MATERIALS

A. Primer:

1. Provide type recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

B. Cleaners for Nonporous Surfaces:

1. Provide nonstaining, chemical cleaner of type acceptable to manufacturer of sealant and sealant backing materials which are not harmful to substrates and adjacent nonporous materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturers and following.

1. Remove foreign material from joint substrates which could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean concrete, masonry, and similar porous joint substrate surfaces to produce clean, sound substrate capable of developing optimum bond with joint sealants. Do not use acid wash. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
3. Remove laitance and form release agents from concrete.
4. Clean metal and nonporous surfaces by means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealants.

B. Joint Priming:

1. Prime joint substrates where recommended by joint sealant manufacturer.
2. Apply primer to comply with joint sealant manufacturer's recommendations.
3. Confine primers to areas of joint sealant bond, do not allow spillage or migration onto adjoining surfaces.

C. Protection of Adjoining Surfaces:

1. Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contract or by cleaning methods required to remove sealant smears.
2. Remove tape immediately after tooling without disturbing joint seal.

3.02 INSTALLATION OF JOINT SEALANTS

A. Comply with joint sealant manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply and:

1. Elastomeric Sealant: ASTM C962.
2. Latex Sealant: ASTM C790.

B. Installation of Sealant Backings:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.
   a. Do not leave gaps between ends of joint fillers.
   b. Do not stretch, twist, puncture, or tear joint fillers.
   c. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.
2. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where required to prevent third-side adhesion of sealant to back of joint.
3. Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.

C. Installation of Sealants:

1. Sealants shall directly contact and fully wet joint substrates, completely fill recesses provided for each joint configuration and provide uniform, cross-sectional shapes, and depths relative to joint widths which allow optimum sealant movement capability.

D. Tooling of Nonsag Sealants:

1. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint.
2. Remove excess sealants from surfaces adjacent to joint.
3. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
4. Concave joint configuration shall be in accordance with ASTM C962, Figure A, unless otherwise indicated.

E. Installation of Preformed Foam Sealants:

1. Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, and complying with sealant manufacturer's directions for installation methods, materials, and tools producing seal continuity at ends, turns, and intersections of joints.
2. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in conformance with sealant manufacturer's recommendations.

F. Installation of Fire-Stopping Sealant:

1. Install sealant, including forming, packing, and other accessory materials to fill openings around mechanical and electrical services penetrating floors and walls to provide fire-stops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs.

G. Installation of Submerged Sealants:

1. Prime surfaces to receive sealant and install sealant in accordance with manufacturer's instructions.
   a. Vertical Surfaces: Add cabosil to sealant to thicken material so mixture hangs in joint.

3.03 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and reseal joints with new materials to produce joint sealant installations with repaired areas indistinguishable from original Work.

3.04 CLEANING

A. Clean off excess sealants or sealant smears adjacent to joints as Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

* * * END OF SECTION * * *

SECTION 08110
STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1 Steel doors.
2 Steel door frames.
3 Fire-rated door and frame assemblies.

1.02 DEFINITIONS

A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and uncoated base metal of metallic-coated steel sheets.

1.03 SUBMITTALS

A. Product Data:

1. For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.

B. Shop 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.

C. Miscellaneous:

1. Door Schedule: Use same reference designations indicated on plans in preparing schedule for doors and frames.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level, unless more stringent requirements are indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Minor damages may be repaired provided refinished items match new work and are acceptable to Engineer. Remove and replace damaged items that cannot be repaired as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4 inch high wood blocking. Avoid using nonvented plastic or canvas shelters that could create humidity chamber. If door packaging becomes wet, remove cartons immediately. Provide minimum 1/4 inch spaces between stacked doors to permit air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Amweld Building Products, Inc.

B. Benchmark Commercial Doors; a division of General Products Co., Inc.

C. Ceco Door Products; a United Dominion Company.

D. Copco Door Co.

E. Curries Company.

F. Deansteel Manufacturing, Inc.

G. Kewanee Corporation (The).

H. Mesker Door, Inc.

I. Pioneer Industries Inc.

J. Republic Builders Products.

K. Steelcraft; a division of Ingersoll-Rand.

2.02 MATERIALS

A. Cold-Rolled Steel Sheets: (For doors and frames) ASTM A366/A366M. Commercial Steel (CS); ASTM A620/A620M, Drawing Steel (DS), Type B; ASTM A568/A568M, General Requirements; stretcher-leveled standard of flatness.

B. Electrolytic Zinc-Coated Steel Sheet: (For anchors and accessories) ASTM A591/A591M, for light coating mass applications.

C. Hot Dipped Metallic-Coated Steel Sheets:

1. Galvanized Coated: ASTM A924; zinc coated.
2. Galvannealed Coated: ASTM A653; zinc-iron-alloy coated.

2.03 DOORS

A. Provide doors of sizes, thicknesses, and designs indicated.

B. Exterior Doors: Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless**)**; 16 gauge; 0.053 inch face thickness; 1 3/4 inch door thickness.

2.04 FRAMES

A. Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.

B. Exterior Frames (for Level 3 doors): 14 gauge; 0.067 inch thickness.

C. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.

D. Plaster Guards: Provide 0.016 inch thick, steel sheet plaster guards or mortar boxes to close off interior of openings; place at back of hardware cutouts where mortar or other materials might obstruct hardware operation.

E. Supports and Anchors: Fabricated from not less than 0.042 inch thick, electrolytic zinc-coated or metallic-coated steel sheet.

1. Wall Anchors in Masonry Construction: 0.177 inch dia, steel wire complying with ASTM A510 (ASTM A510M) may be used in place of steel sheet.

F. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A153/A153M, Class C or D as applicable.

2.05 FABRICATION

A. Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.

B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from hot dipped metallic-coated, cold-rolled steel sheet. Close top and bottom edges of doors flush as integral part of door construction or by addition of 0.053 inch thick, metallic-coated steel channels with channel webs placed even with top and bottom edges.

C. Core Construction: One of following manufacturer's standard core materials that produce door complying with SDI standards:

1. Polyurethane.
2. Polystyrene.

D. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.

E. Single-Acting, Door-Edge Profile: Square edge.

F. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

G. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

H. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

I. Thermal-Rated (Insulating) Assemblies: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C236 or ASTM C976 on fully operable door assemblies.

1. Unless otherwise indicated, provide thermal-rated assemblies with U-value of 0.16 or better.

J. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.

K. Frame Construction: Fabricate frames to shape shown.

1. Fabricate frames with mitered or coped and continuously welded corners and seamless face joints, unless otherwise indicated.
2. Provide welded frames with temporary spreader bars.

L. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

M. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

2.06 FINISHES

A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install steel doors, frames, and accessories according to submittals, manufacturer's data, and as specified.

B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

1. Place frames before construction of enclosing walls and ceilings.
2. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
3. For openings 90 inches or more in height, install additional anchor at hinge and strike jambs.

C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.

3.02 ADJUSTING AND CLEANING

A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

* * * END OF SECTION * * *

SECTION 08710
FINISH HARDWARE

PART 1 GENERAL

1.01 DEFINITION

A. Finish Hardware: Items known commercially as finish hardware required for swing, sliding doors.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each item of hardware. Include information necessary to show compliance with requirements, and instructions for installation and maintenance of operating parts and finish.

B. Miscellaneous:

1. Hardware Schedule:
   a. Submit final hardware schedule in manner indicated below. Coordinate hardware with doors, frames, and related Work to ensure proper size, thickness, hand, function, and finish.
   b. Hardware schedule to be prepared by an AHC.
   c. Final Hardware Schedule Content: Based on finish hardware indicated, organize hardware schedule into hardware sets indicating complete designations of every item required for each door or opening. Include following information:
      1) Type, style, function, size, and finish of each hardware item.
      2) Name and manufacturer of each item.
      3) Fastenings and other pertinent information.
      4) Location of hardware set cross-referenced to indications on plans both on floor plans and in door and frame schedule.
      5) Explanation of abbreviations, symbols, and codes contained in schedule.
      6) Mounting locations for hardware.
      7) Door and frame sizes and materials.
      8) Contracting Authority’s keying requirements. Provide Kwikset 400T 3-AL entry hardware.
      9) Third party test results for locks, latches, exit devices and closers when requested by Engineer. Third party must be acceptable to Engineer.
2. Templates: Furnish hardware templates to each fabricator of doors, frames, and other Work to be factory-prepared for installation of hardware. Upon request, check Shop Drawings of such other Work, to confirm adequate provisions made for proper location and installation of hardware.

C. Operation and Maintenance (O&M) Data:

1. Furnish complete set of specialized tools and maintenance instructions as needed for Contracting Authority’s continued adjustment, maintenance, and removal and replacement of finish hardware.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer: Obtain each type of hardware (latch and lock sets, hinges, closers, exit devices, etc.) from single manufacturer, although several may be indicated as offering products complying with requirements.

B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA No. 80 and local building code requirements. Provide only hardware which has been tested and listed by UL or FM for types and sizes of doors required and complies with requirements of door and door frame labels.

1. Where emergency exit devices required on fire-rated doors (with supplementary marking on doors UL labels indicating fire door to be equipped with fire exit hardware), provide UL label on exit devices indicating fire exit hardware.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver hardware until detailed schedule, keying diagram, and samples have been approved.

B. Check hardware upon delivery. Correct shortage, defect or damage immediately.

C. Mark each item of hardware as to description and location.

D. Cover and protect exposed surfaces of hardware during installation and until building is accepted by Engineer to avoid damage to finishes and functions.

PART 2 PRODUCTS

2.01 SCHEDULED HARDWARE

A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware indicated on Door Schedule on plans. Manufacturers and products identified are for purposes of establishing minimum requirements, unless noted otherwise.

2.02 MATERIALS AND FABRICATION

A. General:

1. Manufacturer's Nameplate: Do not use manufacturer's products having manufacturer's name or trade name displayed in visible location (omit removable nameplates) except in conjunction with required UL labels and as otherwise acceptable to Engineer.
   a. Manufacturer's identification permitted on rim of lock cylinders only.

2. Base Metals: Provide base metal as indicated by manufacturers model number designated in hardware group.
3. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware prepared for self-tapping sheet metal screws except as specifically indicated.
4. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other Work, to match finish of such other Work as closely as possible, including prepared for paint in surfaces to receive painted finish.
5. Provide concealed fasteners for hardware units exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face exposed in other Work, except where not feasible to adequately reinforce Work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.

2.03 HINGES, BUTTS, AND PIVOTS

A. Manufacturers:

1. PBB.
2. Stanley.
3. Hager.
4. McKinney.

B. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide template-produced units.

C. Screws: Furnish Phillips flat-head or machine screws for installation of units. Finish screw heads to match surface of hinges or pivots.

D. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows.

1. Steel Hinges: Stainless steel pins.
2. Nonferrous Hinges: Stainless steel pins.
3. Exterior Doors: Nonremovable pins.
4. Doors with Locksets and Hinges Exposed on Key Side: Nonremovable pins.
5. Interior Doors: Nonrising pins.
6. Tips: Flat button and matching plug finished to match leaves except where hospital tip indicated.
7. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges for door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.

2.04 LOCK CYLINDERS, KEYING, AND KEY CABINETS

A. Provide standard of lock manufacturer. Meet with City to finalize keying requirements and obtain final instructions in writing.

B. Equip locks with manufacturer's standard 6-pin tumbler cylinders to match City’s system.

C. Metals: Construct lock cylinder parts from brass/bronze, stainless steel, or nickel silver.

D. Comply with City’s instructions for master keying and, except as otherwise indicated, provide individual change key for each lock not designated to be keyed alike with group of related locks.

1. Permanently inscribe each key with number or lock identifying cylinder manufacturer key symbol, and notation "DO NOT DUPLICATE".
2. Key Material: Provide keys of nickel silver only.
3. Key Quantity: Furnish three change keys for each lock and three master keys.
4. Furnish one extra blank for each lock.
5. Deliver keys to City.

2.05 LOCK AND LATCHES

A. Manufacturers:

1. Dorma.
2. Sargent.

B. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set.

1. Provide dustproof strikes for foot bolts, except where special threshold construction provides nonrecessed strike for bolt.
2. Provide roller type strikes where recommended by manufacturer of latch and lock units.

C. Backset: 2 3/4 inches.

D. Lock Throw: Provide 5/8 inch minimum throw of latch and deadbolt used on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.

1. Provide 1/2 inch minimum throw on other latch and deadlock bolts.

E. Exit Device Dogging: Except on fire-rated doors, wherever closers are provided on doors equipped with exit devices, equip units with keyed dogging device to hold push bar down, and latch bolt in open position.

2.06 FLUSH BOLTS

A. Manufacturers:

1. Dorma.
2. Ives.
3. Trimco.

B. Flush Automatic.

C. Minimum of 1/2 inch diameter rods of brass, bronze, or stainless steel, with minimum 12 inch long rod for doors up to 7 feet 0 inches in height. Provide longer rods as necessary for doors exceeding 7 feet 0 inches in height.

2.07 EXIT DEVICES

A. Manufacturers:

1. Dorma.
2. Sargent.

B. Comply with 156.3.

C. All keyed cylinders for time and logging to be interchangeable core type.

D. When doors equipped with closers, equip units with keyed dogging device.

2.08 CLOSERS AND DOOR CONTROL DEVICES

A. Manufacturers:

1. Dorma.
2. LCN.
3. Sargent.

B. Comply with ANSI A156.4.

C. Size of Units: Except as otherwise specifically indicated, comply with manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.

D. Provide closers for door that open greater than 110 degrees with de-acceleration function.

E. Access-Free Manual Closers: Where manual closers indicated for doors required to be accessible to physically handicapped, provide adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing.

2.09 PROTECTION PLATES

A. Manufacturers:

1. Dorma.
2. Hager.
3. Trimco.

B. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units. Machine screws or self-tapping screw.

C. Fabricate protection plates (armor, kick or mop) not more than 1 1/2 inches less than door width on stop side and not more than 1/2 inch less than door width on pull side, by height indicated.

1. Metal Plates: Stainless steel, 0.050 inch (U.S. 18 gauge) beveled edges, with countersunk screw holes of intervals of not over 6 inches on all four sides.

D. Provide UL rated protection plates where dictated by size at rated openings.

2.10 LOCK PROTECTORS

A. Manufacturers:

1. Dorma.
2. Trimco 5002n.
3. Latch Guard.

2.11 WEATHERSTRIPPING AND RAIN-DRIPS

A. Manufacturers:

1. Reese.
2. National Guard.
3. Zero.

B. Provide type, sizes, and profiles shown or scheduled. Provide noncorrosive fasteners as recommended by manufacturer for application indicated.

2.12 THRESHOLDS

A. Manufacturers:

1. Reese.
2. National Guard.
3. Zero.

B. Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.

2.13 HARDWARE FINISHES

A. Provide matching finishes for hardware units at each door or opening, to greatest extent possible, except as otherwise indicated. Reduce differences in color and textures as much as commercially possible where base metal or metal forming process is different for individual units of hardware exposed at same door or opening. In general, match items to manufacturer's standard finish for latch and lock set for color and texture.

B. Provide finishes matching those established by BHMA or, if none established, match Engineer's sample.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified for applicable units of hardware by referenced standards.

D. Provide protective lacquer coating on exposed hardware finishes of brass, bronze, and aluminum, except as otherwise indicated.

E. Designations used in schedules and elsewhere to indicate hardware finishes are industry-recognized standard commercial finishes, except as otherwise noted.

F. Finish Requirements:

1. Locksets: US26D.
2. Hinges: US32D (630).
3. Flushbolts: US26D.
4. Protection Plates: US32D.
5. Closers: 689.
6 Exit Devices: US26D.

PART 3 EXECUTION

3.01 INSTALLATION

A. Locate hardware as follows, unless shown otherwise on plans.

1. Locksets: Centerline 40 inches above finished floor.
2. Exit Device Push Bar: Centerline 40 inches above finished floor.
3. Flush Bolts: Manufacturer's template.
7. Deadlocks: Centerline 60 inches above finished floor.
4. Closure mount to provide maximum opening permitted by building construction or equipment, and note on schedule maximum swing per location for other trades involved in reinforcement or installation.
5. Butts: 5 inch by 10 inch equal-equal.

B. General:

1. Install hardware items in compliance with manufacturer's instructions and recommendations. Wherever cutting and fitting required to install hardware onto or into surfaces which are later to be painted or finished, coordinate removal, storage, and reinstallation or application of surface protections with finishing work specified in Division 9. Do not install surface-mounted items until finishes are completed on substrate.
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
3. Drill and countersink units not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

C. Thresholds:

1. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant.
2. Secure in place with countersunk expansion bolts or to straps with machine screws.
3. Drill holes for shields carefully to avoid cracking or otherwise damaging concrete.
4. Drill and tap straps.
5. Cut to fit profile of jamb.

D. Weatherstrip:

1. Mount on inside face of door frame jambs or stops.
2. Where fastening devices will be exposed to view, provide units with chrome plated or stainless steel heads for fastening metal and stain bronze or dull chrome as selected for fastening through wood.

3.02 FIELD QUALITY CONTROL

A. Instruct City's personnel in proper adjustment and maintenance of hardware and hardware finishes during final adjustment of hardware.

B. Manufacturer's Field Services.

1. Supplier or manufacturer shall direct services to equipment installation and operation.

3.03 ADJUSTING

A. Adjust and check each operating item of hardware and door to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for application made.

B. Final Adjustment: Wherever hardware installation made more than one month prior to acceptance or occupancy of space or area, return to Work during week prior to acceptance or occupancy, and make final check and adjustment of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.04 CLEANING

A. Clean adjacent surfaces soiled by hardware installation.

3.05 DOOR HARDWARE SCHEDULE

A. Provide fasteners, accessories, and other devices required for complete and proper installation for each particular location.

B. See Door Schedule on plans for hardware group application.

* * * END OF SECTION * * *

SECTION 09540
PRELAMINATED CEILING PANELS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Wall and Ceiling Panels.
2. Accessories.

1.02 SUBMITTALS

A. Product Data: Manufacturer's technical data on specified products describing physical and performance characteristics.

B. Shop Drawings: Drawings showing layout, profiles and product components, including anchorage, accessories, finish colors, patterns and textures.

C. Samples:

1. Trim and accessories specified.
2. Panel finishes, color selection, and texture.

D. Miscellaneous:

1. Manufacturer's Installation Instruction: Indicate special procedures and conditions requiring special attention.
2. Include maintenance procedures, recommended maintenance materials and suggested schedules.

E. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver in materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Store materials protected from exposure to harmful weather conditions and at temperatures and humidity recommended by manufacturer.

PART 2 PRODUCTS

2.01 FRP LAMINATED PANELS

A. Manufacturers:

1. Nudo Products, Inc., Fiber-Lite Panels.

B. 0.030 inch thick textured fiberglass reinforced plastic (FRP) factory laminated to 1/2 inch fire rated gypsum.

C. Colors: White.

2.02 ACCESSORIES

A. Sealants: 100% rubberized silicone.

B. Adhesive: Manufacturers standard for application.

C. Vinyl Moldings: Manufacturers standard for application.

D. Fasteners: Nylon rivets, stainless steel nails or screws as selected for manufacturers for application.

PART 3 EXECUTION

3.01 PREPARATION

A. Unwrap and remove ceiling panels and stack on flat, dry surface.

B. Precondition ceiling panels for not less than 48 hours in temperature and humidity conditions of installation areas.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Layout panels to balanced design with edge units no less than 2 feet.

C. Cut moldings as needed for proper fit. Ceiling corner molding shall run continuously around rooms.

D. Seal joints at moldings joining panels, and moldings at walls and other joints and penetrations to provide air tight system.

E. Install ceilings level.

F. Independently support light fixtures, equipment, ductwork, and other ceiling penetrations.

3.02 CLEANING

A. Remove dirt, dust and other foreign material from surfaces before substantial completion.

* * * END OF SECTION * * *

SECTION 09961
COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Coat surfaces to include:
   a. Surfaces described in Room Finish Schedule and notes on plans.
   b. Interior and exterior piping, regardless of type of factory-applied finish
   c. Color coded equipment and piping above suspended ceilings.
   d. Exposed interior and exterior structural steel surfaces.
   e. Exterior and interior equipment, motors, and appurtenances.
   f. Galvanized ductwork exposed in areas scheduled for finishing.
2. Do not coat unless specifically noted otherwise:
   a. Factory-finished electrical motor control panels (MCC) and main instrument panels (MIP), flow indicators, and related equipment.
   b. Underground equipment and piping.
   c. Surfaces above suspended ceiling systems (unless color coding).
   d. Factory-finished trim.
   e. Stainless steel.
   f. Plastic coated pipe insulation.
   g. PVC or reinforced plastic piping.
   h. Aluminum ductwork or aluminum faced duct insulation.
   i. Galvanized surfaces.
   j. Aluminum louvers or trim.
   k. Concrete tanks.
3. Labeling and directional arrows on piping, equipment with valves or electrical connections, valves, and ducts whether coated or not.
4. Do not coat over any code-required labels such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

B. Equipment manufacturer is responsible for surface preparation and coatings of equipment, motors, and appurtenances. Equipment to be coated and coating system are identified in equipment Specification section(s).

1.02 DEFINITIONS

A. Definitions as used in schedules.

1. Coatings: Heavy duty finishes for use on any surfaces, especially surfaces subject to submerged, high moisture, splash or chemical environment.
2. Ambient Conditions:
   a. Chemical: Surface subject to corrosive chemical splash or fumes.
   b. Moist: Surface subject to wet areas such as shower rooms and rooms with open tanks.
   c. Normal: Surface subject to normal temperatures and humidity such as found in offices and corridors.
3. Splash: Surface subject to frequent washing and chemical splash.
4. Submerged P: Surface submerged in potable water plus 1 foot 0 inches above high liquid level.
5. Submerged NP: Surface submerged in nonpotable liquid such as sewage and sludge plus 1 foot 0 inches above high liquid level.

B. First Coat: Field prime, factory prime, or shop prime. When only one coat is required, first coat is finish coat.

C. Second or Third Coats: Successive finish coats applied over first coat.

1.03 SUBMITTALS

A. Product Data:

1. Submit manufacturer's literature stating application recommendations and generic makeup of each type of coating scheduled.
2. Substitutions: For coatings not specified, provide substitute manufacturer's product data sheets, ASTM certified performance criteria, MSDS and other relevant data for Engineer to perform proper evaluation

B. Miscellaneous:

1. Letter of Certification/Shop Painting:
   a. Contractor has option of shop coating materials and equipment partially or totally.
   b. If Contractor applies coatings in factory submit following:
      1) Coatings used.
      2) Manufacturer's written certificate factory-applied coating system is identical to, or exceeds, specified requirements.
      3) Requirements for touch-up or coating.
      4) History of coating performance in same environment.
   c. Submit following for factory-applied first coat.
      1) First coat used.
      2) Contractor's certification factory-applied first coat is compatible with field-applied finish coats.
2. Certification:
   a. Certification that products supplied comply with volatile organic compounds (VOCs) requirements specified herein or local regulations if more restrictive.
3. Schedules:
   a. Submit schedule of proposed coating systems within 60 calendar days of Award of Contract.
   b. Schedule of proposed coating systems shall identify same information as shown in coating schedule.

C. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications:

1. Engage an experienced applicator who has successfully completed coating system applications similar in material and extent to those indicated for Project.

B. Single-Source Responsibility:

1. Provide coating material produced by same manufacturer for each system. Use only thinners recommended by manufacturer and only within recommended limits.

C. Manufacturer shall supply products that comply with OTC controlling use of volatile organic compounds (VOC's) or local regulations if more restrictive.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in original, sealed, unopened packages and containers bearing manufacturer's name. Each container shall have manufacturer's printed label stating type of coating, color of coating, instructions for reducing, and spreading rate.

B. Protect and storage location and maintain temperature ranges recommended by coating manufacturer for most sensitive coating, but not less than 55°F.

C. Keep storage area neat and clean and replace or repair damage thereto or to its surroundings.

D. Avoid danger of fire. Deposit cleaning rags and waste materials in metal containers having tight covers or remove from building each night. Provide fire extinguishers of type recommended by coating manufacturer in areas of storage and where finishing is occurring. Allow no smoking or open containers of solvents. Store solvents in approved safety cans.

E. Empty containers shall have labels canceled and be clearly marked as to use.

F. Upon Substantial Completion, remaining material will become property of City. Seal material as required for storage, marked as to contents and shelf life, and store where required by City.

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. Do not apply exterior coating in cold, foggy, damp or rainy weather.
2. Apply no finish in rooms where dust is being generated.
3. Do not apply exterior coating when temperature is lower than 50°F or as required by manufacturer.
4. Maintain interior temperature and relative humidity of space, as recommended by coating manufacturer, 24 hours before applying and until coating is cured.

B. Protection:

1. Cover materials and surfaces, including floors, adjoining or below Work with clean drop cloths or canvas.
2. Remove hardware, accessories, plates, lighting fixtures, and similar items or provide protection by masking. Upon completion, replace above items or remove protection and clean.
3. Maintain manufacturer's environmental requirements while coating dries.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Coatings:

1. Tnemec.
2. Sherwin - Williams
3. Approved equal.

2.02 MATERIALS

A. Coatings:

1. Color shall be formed of pigments free of lead, lead compounds or other materials which might be affected by presence of hydrogen sulfide or other gases likely to be present at Project.

2. Coatings shall meet surface burning characteristics as required by code and established by ASTM E84.

2.03 COLORS

A. Colors shall be selected and approved by Engineer.

B. Prior to beginning work, Engineer will provide color coordinating schedule. System color coding shall comply with Section 15075.

C. Coat grilles and heating units to match color of adjacent wall or ceiling surfaces.

D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match adjacent or near surfaces, except for color coding.

E. Rooms and spaces will have walls coated different color than ceilings and trim different color or colors than walls.

F. Equipment Colors:

1. Equipment includes equipment, motors, and structural supports, fasteners, and attached portions of electrical conduit.
2. Coat equipment same color as piping equipment serves.

2.04 MIXING AND TINTING

A. Each coat shall be slightly darker than preceding coat, unless otherwise approved.

B. Tint undercoats similar to finish coats.

PART 3 EXECUTION

3.01 EXAMINATION

A. If surfaces to be finished cannot be put into proper condition for finishing by customary cleaning, sanding, and puttying operations or if surfaces were improperly primed by others, report defects to Contractor and Engineer, in writing, or assume responsibility and correct unsatisfactory finish resulting from improper surfaces. Commencement of Work indicates acceptance of surfaces.

B. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor’s expense.

C. Where surface dryness is questioned, test with dampness indicating instrument. Do not apply coatings over surfaces where moisture content exceeds that permitted in manufacturer’s printed instructions.

D. Provide coats compatible with the surface and prior coats.

3.02 SURFACE PREPARATION AND TOUCH-UP

A. General:

1. Surfaces, including floors shall be clean, dry, and free of loose dirt, dust, and foreign matter before applying coating.
2. Comply with coating manufacturer’s recommendations for surface preparation.

B. Ungalvanized Ferrous Metal:

1. General:
   a. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
   b. Prepare welds and adjacent areas to remove undercutting or reverse ridges on weld bead, weld spatter on or adjacent to weld or area to be coated, and sharp peaks or ridges along weld bead. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
   c. Coat surfaces same day prepared. Reprepare surfaces starting to rust before coating.
2. Cleaning Methods:
   a. Quality for metal surface preparation as specified shall conform with SSPC specifications as follows:
      1) SP-1: Solvent Cleaning
      2) SP-2: Hand Tool Cleaning
      3) SP-3: Power Tool Cleaning
      4) SP-5: White Metal Blast Cleaning
      5) SP-6: Commercial Blast Cleaning
      6) SP-7: Brush-off Blast Cleaning
      7) SP-8: Pickling
      8) SP-10: Near-White Blast Cleaning
      9) SP-11 Power Tool Cleaning to Bare Metal
      10) SP 12 Cleaning of Metals by Waterjetting Prior to Recoating
   b. Wherever “solvent cleaning,” “hand tool cleaning,” “wire brushing,” or “blast cleaning,” or similar words of equal intent used in Specifications or coating manufacturer’s specifications, they shall be understood to refer to applicable SSPC specifications listed above.
   c. Use hand tools to clean areas that cannot be cleaned by power tools.
3. Shop Preparation: Equipment, structural steel, metal doors and frames, metal louvers, and similar items may be shop-prepared and first coat applied at Contractor’s option. Centrifugal wheel blast cleaning is acceptable alternate to shop blast cleaning. Clean and prime in accordance with this section.
4. Field Touch-Up: Sandblast items and equipment as specified to restore damaged surfaces previously shop or field blasted and first coat applied. Materials, equipment, procedures, and safety equipment for personnel shall conform to SSPC.

C. Galvanized Metal:

1. Touch-up damaged areas with zinc-rich primer.
2. Prepare galvanized metal surfaces to be coated as required for system being applied.

D. Masonry:

1. Remove loose grit and mortar.
2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent or other suitable cleaning methods.
3. Allow mortar joints to cure for 28 days.

E. Cast-in-Place Concrete/Precast Concrete:

1. Do not begin surface preparation until 30 days after concrete has been placed.
2. Remove grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent or other suitable cleaning methods.
3. Brush-blast all surfaces to be coated to create surface profile similar to medium (60-80) grit sandpaper. Care should be taken not to open up bug holes and voids in concrete by

overblasting substrate. All large bug holes and voids created by blasting objective shall be filled with appropriate filler prior to painting surface. Surface must be clean, dry and free of oil, grease and other contaminants. If brush-off blasting is impractical, acid etch with muriatic acid solution and wash with water or neutralizing agent as required by coating manufacturer. Surface blasting may be done at precast plant or on-site before units are installed.

4. Cleaning Methods: Quality shall conform with SSPC specifications as follows:
   a. SP-13: Surface Preparation of Concrete.
   b. ICRI03732, CSP 1-3.

F. Plastic:

1. Solvent clean pipe in accordance with manufacturer's recommendations.
2. Hand sand with medium grit sandpaper to provide tooth for coating system.
3. Large areas may be power sanded or brush-off blasted, provided sufficient controls employed so surface roughened without removing excessive material.

3.03 APPLICATION

A. General Requirements:

1. Spread evenly and flow on smoothly without runs, lumps or sags.
2. Make edges of coating adjoining other materials or colors sharp and clean without overlapping.
3. Number of coats and film thickness required is same regardless of application method. Do not apply succeeding coats until previous coat has cured as required by manufacturer. Where sanding is required, according to manufacturer's direction, sand between applications to produce smooth, even surface.
4. Finish edges of doors as specified for faces. Apply one coat finish on tops and bottoms of doors after fitting.
5. Term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain system's integrity and provide desired protection.
   a. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   b. Omit first coat on metal surfaces that have been shop-primed and touch-up painted.
6. Manufacturer-Applied Coating Systems:
   a. Repair abraded areas on factory-finished items in accordance with manufacturer's directions.
   b. Blend repaired areas into original finish.
7. Application Procedures:
   a. Apply coatings by brush, roller, spray, or other applicators according to manufacturer's instructions.

B. Priming and Sealing:

1. Refer to Coating Schedule for specific coating material.
2. Shop:
   a. Shop first coat for ferrous metal shall comply with SSPC guidelines, and as specified in Coating Schedules of this Specification.
   b. Hand or power sand chipped, peeled or abraded first coat and feather edges. Spot coat areas with specified first coat.
   c. Prior to application of finish coats, clean shop-first coat surfaces free of dirt, oil, and grease.
   d. Prepare and prime holdback areas as required for specified coating system.

3.04 FIELD QUALITY CONTROL

A. Sampling of Materials:

1. Engineer reserves right to select unopened containers of materials furnished for project and have materials tested at an independent testing laboratory. Contracting Authority will pay for first tests.
2. Retests of rejected materials and tests of replacement materials shall be paid for by Contractor.
3. Remainder of contents of containers not required for testing will be returned to Contractor.

B. Coverage:

1. Before beginning Work, finish one complete room, space surface, or item of each color scheme required, showing selected colors, finished texture, material, and quality. After approval, sample rooms or items shall serve as standard for similar Work throughout building.
2. If coverage is not acceptable to Engineer, Engineer reserves right to require extra application of paint at no extra cost to Contracting Authority.
3. Work at site where coat of material is applied will be inspected by Engineer before application of succeeding specified coat, otherwise no credit for coat applied will be given and Contractor automatically assumes responsibility to recoat Work in question. Furnish Engineer report of particular coat applied and when completed for inspection to comply with above.

3.05 COATINGS SCHEDULE

A. General:

1. Unless otherwise noted, Tnemec products are identified in this schedule to establish quality and type desired only.
2. Scheduled thickness or coverage rate is as recommended by Tnemec. If other manufacturers are proposed and accepted, manufacturer's requirements shall be followed, but in no case may thickness, number of coats, or coverage rate be less.
3. DFT = dry film thickness (mils/coat). DFT shown is for spray application. Additional coats may be required if brushed and rolled.
4. sfpg = square foot/gallon (per coat).
5. Examples of surfaces to be coated are not all inclusive.

B. Standard Coating Schedule:

Example Surfaces	**Surface Preparation**	**Meets CARB, OTC and National AIM Rule**	
SYSTEM 1-C	(PRECAST CONCRETE, CAST-IN-PLACE CONCRETE, NORMAL INTERIOR MOIST/INTERIOR SPLASH, SEMI-GLOSS SHEEN, 2-COAT SYSTEM)		
Walls, Ceilings, Stair Stringers, Columns, Beams Note: This system approved for 38% sodium bisulfite.	SSPC-SP13	"Series 218 MortarClad" epoxy modified mortar to fill bug holes and voids. First Coat - 4.0 to 6.0 DFT/ "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat – 4.0 to 6.0 DFT/"Series N69-Hi-Build Epoxoline polyamidoamine epoxy.	

Example Surfaces	Surface Preparation	Meets CARB, OTC and National AIM Rule	
SYSTEM 2-C	(CONCRETE MASONRY, INTERIOR MOIST/INTERIOR SPLASH SEMI-GLOSS SHEEN, 3-COAT SYSTEM)		
Walls	Masonry, Clean and dry.	First Coat - 166 square foot/gallon sprayed and backrolled. "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat - 8.0 to 10.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Third Coat – 8.0 to 10.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy.	
SYSTEM 3-C	(FERROUS METALS, INTERIOR MOIST/INTERIOR SPLASH, SEMI-GLOSS SHEEN, MAX. TEMP. 250˚F, 3-COAT SYSTEM)		
Equipment, Pipes, Structural Members, Louvers, Pipe Hangers	SSPC-SP6	First Coat - 4.0 to 6.0 DFT/"Series N69 Hi-Build Epoxoline or N140 Pota-Pox Plus" polyamidoamine epoxy. Second Coat - 4.0 to 6.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Third Coat – 4.0 to 6.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy.	
SYSTEM 4-C	(FERROUS METALS, EXTERIOR NORMAL TO SPLASH, GLOSS OR SEMI-GLOSS SHEEN, MAX. TEMP. 250□F, 3-COAT SYSTEM)		
Equipment, Pipe, Structural Members	SSPC-SP6	First Coat - 4.0 to 6.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat – 3.0 to 5.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Third - Coat – 3.0 to 4.0 DFT/"Series 1075 Endura-Shield II" aliphatic acrylic polyurethane.	
SYSTEM 5-C	(FERROUS METALS, INTERIOR-EXTERIOR MOIST/SPLASH, SEMI-GLOSS SHEEN, 2-COAT SYSTEM OVER FACTORY FINISH.)		
Factory Primed Hollow Metal Doors and Frames, Miscellaneous Metals and Equipment, Factory Primed Fiberglass Doors & Frames.	Light Sand	First Coat – 2.0 to 3.0 DFT/ "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat (Interior) - 2.0 to 3.0 DFT/ "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat (Exterior) - 2.0 to 3.0 DFT/"Series 1075 Endura-Shield II" polyurethane.	
SYSTEM 6-C	(FERROUS METALS, CONCRETE, DUCTILE IRON SUBMERGED NP, "COLOR" GLOSS SHEEN, 3-COAT SYSTEM ON METAL, 2-COAT SYSTEM ON CONCRETE)		
Equipment, Pipes, Tanks, Structural Fabrications, Underside of New Digester Covers.	Ferrous Metal SSPC-SP10 Concrete – SSPC-SP13 New Ductile Iron – SSPC-SP10	First Coat – 4.0 to 6.0 DFT/"Series N69 Epoxoline or N140 Pota-Pox Plus" polyamidoamine epoxy. Second Coat - 6.0 to 8.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Third Coat - 6.0 to 8.0 DFT/ "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. (Third coat not required on concrete.)	

Example Surfaces	Surface Preparation	Meets CARB, OTC and National AIM Rule	
SYSTEM 8-C (FRP & PVC, INTERIOR ALL CONDITIONS, SEMI-GLOSS SHEEN, 1-COAT SYSTEM)			
Pipes, Equipment, Vinyl Coated Pipe Insulation	Lightly Sanded	First Coat - 4.0 to 6.0 DFT/ "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. .	
SYSTEM 9-C (FRP & PVC, EXTERIOR ALL CONDITIONS, GLOSS SHEEN, 2-COAT SYSTEM)			
Pipes, Equipment	Lightly Sanded	First Coat - 3.0 to 5.0 DFT/"Series N69-1255 Beige Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat – 2.0 to 3.0 DFT/ Polyurethane "Series 1075 Endura-Shield II" acrylic polyuretahne.	
SYSTEM 10-C (GALVANIZED METAL (not shop primed), INTERIOR SPLASH/INTERIOR MOIST, SEMI-GLOSS SHEEN, 1-COAT SYSTEM)			
Ductwork, Miscellaneous Supports, Conduit, Piping	Sweep blast or mechanically abraid followed by SSPC-SP1.	First Coat - 3.0 to 5.0 DFT/ "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy.	
SYSTEM 13-C (DUCT COVERING, INTERIOR SPLASH/INTERIOR MOIST, SEMI-GLOSS SHEEN, 2-COAT SYSTEM)			
Insulated Ducts and Pipes	As required for insulation surface	First Coat –2.0 to 3.0 DFT/"Series 6-Tneme-Cryl" (matte) acrylic emulsion. Second Coat – 2.0 to 3.0 DFT/"Series 6-Tneme-Cryl" (matte) acrylic emulsion.	
SYSTEM 14-C (DISSIMILAR METAL PROTECTION, 1-COAT SYSTEM)			
Dissimilar Material Protection	As required by material	First Coat - 3.0 to 5.0 DFT "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy.	
SYSTEM 15-C (VINYL-COATED PIPE OR DUCT INSULATION, INTERIOR, ALL CONDITIONS, LOW SHEEN, 1-COAT SYSTEM)			
Vinyl-Coated Pipe and Duct Insulation	Hand Sanded	First Coat - 4.0 to 6.0 DFT "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy.	
SYSTEM 20-C (FERROUS METALS SUBMERGED NP, "COLOR" GLOSS SHEEN, 3-COAT SYSTEM ON METAL)			
Clarifier Steel & Miscellaneous Metals	SSPC-SP10	First Coat - 5.0 to 7.0 DFT/"Series N69–Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat - 6.0 to 8.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Third Coat - - 6.0 to 8.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy.	
SYSTEM 40-C (ALUMINUM - INTERIOR AND EXTERIOR)			
Ductwork Louvers, Trim	SSPC-SP1	First Coat - 3.0 to 4.0 DFT "Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat - 2.0 to 3.0 DFT "Series 1075 Endura-Shield II" acrylic polyurethane.	
SYSTEM 42-C (DUCTILE IRON, INTERIOR MOIST, SPLASH-SEMI-GLOSS SHEEN, MAX. TEMP. 135°F, 2 COAT SYSTEM.)			

Example Surfaces	Surface Preparation	Meets CARB, OTC and National AIM Rule	
Ductile Iron Pipe & Equipment	SSPC-SP6	First Coat – 3.0 to 4.0 DFT/"Series N69 Epoxoline or N140 Pota-Pox Plus" polyamidoamine epoxy. Second Coat – 4.0 to 6.0 DFT/"Series N69 Hi-Build Epoxoline" polyamidoamine epoxy. Third Coat – 4.0 to 6.0 DFT/"Series N69 Hi-Build Epoxoline polyamidoamine epoxy.	
SYSTEM 45-C (FERROUS METALS, INTERIOR/EXTERIOR MOIST, SPLASH SEMI-GLOSS SHEEN, MAX. TEMP. 250°F, 2 COAT SYSTEM OVER FACTORY FINISH)			
Motors and Similar Equipment	Lightly sand, followed by SSPC-SP1.	First Coat - 2.0 to 3.0 DFT "Series 135 Chembuild" modified polyamidoamine epoxy. Second Coat (Interior) - 2.0 to 3.0 DFT "Series N69 Color Hi-Build Epoxoline" polyamidoamine epoxy. Second Coat (Exterior) - 2.0 to 3.0 DFT "Series 1075 Color Endura-Shield II".	
SYSTEM 46-C (DUCTILE IRON, EXTERIOR, SEMI-GLOSS SHEEN, TEMP. 135°F, 3 COAT SYSTEM)			
Ductile Iron Pipe and equipment	SSPC-SP6	First Coat - 4.0 to 6.0 DFT/"Series N140-1211 Pota-Pox Plus" polyamidoamine epoxy. Second Coat - 4.0 to 6.0 DFT/"Series N69-Color Hi-Build Epoxoline" polyamidoamine epoxy. Third Coat - 3.0 to 4.0 DFT/"Series 1075-Color Endure-Shield II". Acrylic polyurethane".	

3.06 SYSTEMS COLOR CODING AND LABELING SCHEDULE

A. Colors for piping and equipment in piping systems are specified in Section 15075.

B. Banding and labels are specified in Section 15075.

3.07 FINAL TOUCH-UP

A. Prior to Substantial Completion, examine coated surfaces and retouch or refinish to leave surfaces in condition acceptable to Engineer.

B. After doors have been fitted and hung, refinish edges, tops, and bottoms.

3.08 CLEANING

A. Before Substantial Completion, remove masking, coating, and other material from floors, glass, and other surfaces and remove rubbish and accumulated materials of whatever nature not caused by other trades from premises and leave in clean, orderly condition, with floors broom clean.

* * * END OF SECTION * * *

SECTION 10520
FIRE-PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Portable fire extinguishers.
2. Mounting brackets for fire extinguishers.

1.02 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.

B. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Source Limitations: Obtain fire extinguishers 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.

1.04 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 quality within specified warranty period.

1. Warranty Period: 6 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 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 (ASTM B 209M).
2. Extruded Shapes: ASTM B 221 (ASTM B 221M).

C. Stainless-Steel Sheet: ASTM A 666, Type 304.

2.02 PORTABLE FIRE EXTINGUISHERS

A. 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. Kidde Fyrnetics.
9. Larsen's Manufacturing Company.
10. Modern Metal Products; Div. of Technico.
11. Moon American.
12. Potter Roemer; Div. of Smith Industries, Inc.
13. Watrous; Div. of American Specialties, Inc.

B. Provide 2 (ONE PER BUILDING fire extinguishers

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.

C. Multipurpose Dry-Chemical Type in Steel Container 4-A:60-B:C, 10 pound nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.03 MOUNTING BRACKETS

A. 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 words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
   a. Orientation: Horizontal.

2.04 FINISHES, GENERAL

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Finish fire-protection cabinets after assembly.

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.

2.05 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. 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

3.01 INSTALLATION

A. Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated below:

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

C. Identification: Apply vinyl lettering at locations indicated.

3.02 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. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged units.

* * * END OF SECTION * * *

SECTION 11312
SUBMERSIBLE NONCLOG PUMPS
(WET INSTALLATION)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Submersible nonclog pump(s).
2. Pump removal mechanism(s).
3. Control Equipment.

1.02 SYSTEM DESCRIPTION

A. Design and Performance Requirements:

1. Pumping equipment shall comply with Schedule 1 to Section 11312.
2. Equipment shall be suitable for pumping raw unscreened municipal stormwater and for service specified in attached Schedule(s).
3. Equipment shall be suitable for continuous operation at maximum fluid temperature of 104°F at all operating speeds specified and without external cooling fluid.
4. Adequately size motor horsepower so each pump is non-overloading within operating range.
5. Design motor for up to 15 evenly spaced starts per hour for motors less than 125 horsepower and up to 10 evenly spaced starts per hour for motors 125 horsepower and larger.
6. Equipment shall be free from shock, vibration, cavitation, overheating, and noise while operating at specified conditions.
7. Equipment shall be capable of continuous operation without damage while operating under load and unsubmerged.
8. Design equipment for continuous submergence under water without loss of watertight integrity to depth of 65 feet.
9. Design equipment for removal and reinstallation of pumps without need to enter wet well and without removal of fasteners.
10. Design pump removal guide mechanism and permanently mounted discharge connection elbow so no part of pump bears on wet well structure.
11. Connection of pump to permanently mounted discharge elbow shall not leak.
12. Design equipment so parts readily accessible for inspection and repair, easily duplicated and replaced, and suitable for service specified
13. Entire pumping unit, including pump, motor and power cable assembly, shall be suitable for installation in a Class I, Division 2, Group D hazardous classified location as approved by Factory Mutual.

1.03 SUBMITTALS

A. General:

1. Submit Product Data and Shop Drawings in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

B. Shop Drawings:

1. Installation drawings and specifically prepared technical data for each pump application.

C. Product Data:

1. Catalog cuts and product specifications for each product specified.
2. Pump Performance Curves and Data:
   a. Show head, capacity, horsepower demand, and pump efficiency curves from shut-off to maximum capacity of pump.
   b. Show head, capacity, horsepower demand, and pump efficiency for points specified in Schedule(s) attached.
3. Proposed coating system. Submit in accordance with Section 09961.
4. Standard wiring diagrams unless wiring diagrams are specially prepared and submitted as Shop Drawings.
5. Catalog cuts and product specifications for control equipment. Submit in accordance with Section 13440.

D. Test Results:

1. Submit factory certified performance curves to Engineer's design office.
2. Submit factory certified results of hydrostatic test to Engineer's design office.
3. Do not ship pumps to site until factory test results approved.
4. Pump shall meet Hydraulic Institute, Level B, performance standard.

E. Submit above in accordance with Section 01340.

F. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 01340.

1.04 QUALITY ASSURANCE

A. System responsibility: To ensure proper operating system(s), pump manufacturer shall provide all products specified in this Section including pump(s), pump removal mechanism(s), and control equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flygt, A Xylem Brand.

2.02 MATERIALS

A. Suitable for application specified:

1. Pump Case: Cast iron, ASTM A48, minimum Class 35B.
2. Motor Housing: Cast iron, ASTM A48, minimum Class 35B.
3. Impeller: ASTM A-532 (Alloy III A) 25% chrome cast iron with hardness of 60 RC.
4. Intermediate Housing: Cast iron, ASTM A48, minimum Class 35B.
5. Discharge Base Elbow: Cast iron, ASTM A48, minimum Class 35B.
6. Pump/motor Shaft: Stainless steel, ASTM A479 S43100.
7. Wear Ring, case: ASTM A-532 (Alloy III A) 25% chrome cast iron with hardness of 60 RC.
8. O-Rings: Nitrile or viton.
9. Fasteners: Stainless steel, ASTM A276, Type 316Ti.

10. Lower Seal Faces: Tungsten carbide vs. tungsten carbide.
11. Upper Seal Faces: tungsten carbide vs. tungsten carbide.
12. Guide Rails and Brackets: Stainless steel, ASTM A276, Type 316.
13. Lifting Chain: Hot-dipped galvanized steel.
14. Oil for all uses: Ecologically safe, paraffin based.
15. Power/control Cable: chloroprene rubber or neoprene.
16. Anchor Bolts: Stainless steel, ASTM A276, Type 316.

2.03 PUMP FABRICATION

A. General:

1. Provide metal-to-metal contact between machined surfaces.
2. Machine and fit mating surfaces with O-rings where watertight sealing is required. Provide sealing by compression of O-rings without specific torque limits.
3. Do not use rectangular cross sectioned gaskets, elliptical O-rings, grease, or secondary sealing compounds.

B. Impeller:

1. Semi-open, screw shaped, multi-vane, non-clog type.
2. Balance statically and dynamically.

C. Wear Rings:

1. Provide case wear ring on all pumps. Plate shall be adjustable and have outward spiraling groove.

D. Shaft:

1. Provide common pump/motor shaft. Pump shaft shall be extension of motor shaft. Pump shaft and motor shaft with connection coupling is not acceptable.

E. Shaft Seals:

1. Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent spring system.
2. Provide one stationary and one positively driven rotating seal ring for each seal.
3. Easily inspected and replaced.
4. Shall not require maintenance or adjustment.
5. Shall not depend on direction of rotation for sealing.
6. Shall not rely on pumped media for sealing.
7. At minimum, install upper seal in oil-filled chamber. Provide drain and inspection plug with positive anti-leak seal easily accessible external to pump.

F. Bearings:

1. Provide upper and lower bearings.
2. Single or double row to provide minimum B-10 life of 40,000 hours at axial and radial loadings while operating at specified operating conditions.
3. Sealed/shielded-non-regreasable or open regreasable type. Provide re-lubrication ports with positive anti-leak plugs external to pump for open regreasable bearings.

G. Motor:

1. Manufactures standard UL listed or labeled definite purpose motor.
2. 460 volt, three phase, 60 Hertz.
3. Environment: Class I, Division 2, Group D.
4. Horsepower: As specified in Schedule 1 to Section 11312.
5. Housed in air-filled, watertight casing.
6. Moisture resistant, minimum Class H insulation rated for 180°C.
7. Embed three thermal switches in windings, one per phase, to provide high temperature shutdown protection. Wire switches in series for connection to control panel.
8. Provide leakage sensor to detect fluid in stator chamber and provide signal for motor shutdown. Wire sensor for connection to control panel.

H. Cooling System: Provide motor cooling to comply with design and performance requirements and as follows:

1. Provide motor with sufficient surface area for ambient only cooling.

I. Power/Control Cable:

1. Size in conformance with National Electric Code (NEC) standards.
2. Provide sufficient length, and supports, to connect to junction box as shown on plans without splicing.
3. Provide watertight cable entry seal to comply with design and performance requirements.

2.04 PUMP REMOVAL SYSTEM

A. Provide guide rail system, discharge base elbow, pump lifting system and secondary lifting chain for pump removal. Provide anchor bolts and accessories for complete system. System shall comply with design and performance requirements and as specified.

B. Guide rail system: Provide two guide rails, upper and intermediate guide brackets for connecting rail(s) to structure, and slide bracket for connecting pump to guide rail(s).

C. Discharge Base Elbow:

1. Provide for automatic, leak-tight connection to pump discharge.
2. ANSI B16.1 Class 125 flange for connection to piping.
3. Provide for connection of guide rails or guide cables.

D. Furnish pump lifting system for each pump. System shall consist of nylon line, short length of chain, and forged “grip-eye” for use with lifting device. System shall be sized for weight of pump.

E. Secondary Lifting Chain:

1. Minimum length: Station depth.
2. Provide shackles and hardware to connect chain to pump at bottom of well and to structure at top of well.

F. Anchor Bolts: Comply with pump manufacturer's requirements and Section 05500.

G. Pump manufacturer shall verify size of access hatch required for pump removal with Contractor.

2.05 CONTROL EQUIPMENT

A. Provide mini CAS (Control and Status) monitoring unit for Sump Pump P-2-7-1. Unit shall be rated for 120 volt supply. Output voltages shall be less than 24 volts.

B. Control unit shall be mounted in motor control center (MCC-1).

2.06 COATING

A. Manufacture is responsible for surface preparation, priming and finish coating of ferrous metal components in plant prior to shipment. Provide manufacturer's standard factory coating for both submerged and non-submerged surfaces.

2.07 SOURCE QUALITY CONTROL

A. Factory Certified Performance Test(s):

1. Perform on each pump in accordance with test requirements of Hydraulic Institute, Level A, performance standard.
2. Determine capacity, head, brake hp and hydraulic efficiency.
3. Test each pump at a minimum of six points including shutoff, at rated capacity specified, and at flow rate greater than maximum capacity specified Schedule(s).
4. Prepare and submit certified performance curves.
5. Test actual assembled pumps to be provided. Results of prior tests on similar or identical pumps are not acceptable.

B. Factory Certified Hydrostatic Test(s):

1. Perform on each pump.
2. Minimum test pressure shall be 1.5 times pump shutoff head.
3. Prepare and submit report of results.
4. Test actual assembled pumps to be provided. Results of prior tests on similar or identical pumps are not acceptable.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturers written instructions and approved submittals.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at the job site or classroom designated by City for minimum man-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of City's personnel for plant operation. Include minimum of:
   a. 2 man-days for Installation Services
   b. 1 man-day for Instructional Services
   c. 1 man-day for Post-Startup Services
2. Supplier of manufacturer shall direct services to specific system and equipment operation, maintenance, and troubleshooting. Process design and philosophy will be presented by Engineer. See Section 01600.

SCHEDULE 1 TO SECTION 11312 SUBMERSIBLE NONCLOG PUMPS (WET INSTALLATION)	
Name of Pump(s)	Basin Drain Pump - NP 3127 MT3
Tag Number(s)	P-2-7-1
Number of Pumps	1
Fluid Pumped	Stormwater
Fluid pH	6.0 – 9.0
Discharge Size (inch)	6.0
Motor Horsepower	7.5
Constant or Adjustable Speed	Constant
Performance Requirement at Rated Speed	
Rated Speed (rpm)	1740
Design Operating Point	
Capacity (gpm)	372
Head (foot)	40
Minimum Efficiency (%)	~~81%~~ 58.8%
Pump Shutoff Head (foot)	52

* * * END OF SECTION * * *

SECTION 11313
SUBMERSIBLE AXIAL FLOW PUMPS
(WET INSTALLATION)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Submersible axial flow pump(s).
2. Control Equipment.

1.02 SYSTEM DESCRIPTION

A. Design and Performance Requirements:

1. Pumping equipment shall comply with Schedules 1, 2 and 3 to Section 11313.
2. Equipment shall be suitable for pumping raw unscreened municipal stormwater and for service specified in attached Schedule(s).
3. Equipment shall be suitable for continuous operation at maximum fluid temperature of 104°F at all operating speeds specified and without external cooling fluid.
4. Adequately size motor horsepower so each pump is non-overloading within operating range.
5. Design motor for up to 15 evenly spaced starts per hour for motors 125 horsepower and larger.
6. Equipment shall be free from shock, vibration, cavitation, overheating, and noise while operating at specified conditions.
7. Design equipment for continuous submergence under water without loss of watertight integrity to depth of 65 feet.
8. Design equipment for removal and reinstallation of pumps without need to enter wet well and without removal of fasteners.
9. Design equipment so parts readily accessible for inspection and repair, easily duplicated and replaced, and suitable for service specified
10. Entire pumping unit, including pump, motor and power cable assembly, shall be suitable for installation in a Class I, Division 2, Group D hazardous classified location as approved by Factory Mutual.

1.03 SUBMITTALS

A. General:

1. Submit Product Data and Shop Drawings in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

B. Shop Drawings:

1. Installation drawings and specifically prepared technical data for each pump application.

C. Product Data:

1. Catalog cuts and product specifications for each product specified.
2. Pump Performance Curves and Data:

a. Show head, capacity, horsepower demand, and pump efficiency curves from shut-off to maximum capacity of pump.
b. Show head, capacity, horsepower demand, and pump efficiency for points specified in Schedules 1, 2 and 3 attached.

3. Proposed coating system. Submit in accordance with Section 09961.
4. Standard wiring diagrams unless wiring diagrams are specially prepared and submitted as Shop Drawings.
5. Catalog cuts and product specifications for control equipment. Submit in accordance with Section 1105 of the Standard Specifications.

D. Test Results:

1. Submit factory certified performance curves to Engineer's design office.
2. Do not ship pumps to site until factory test results approved.
3. Pump shall meet Hydraulic Institute, Level B, performance standards.

E. Submit above in accordance with Section 1105 of the Standard Specifications.

F. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. System responsibility: To ensure proper operating system(s), pump manufacturer shall provide all products specified in this Section including pump(s), pump removal mechanism(s), and control equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flygt, A Xylem Brand.

2.02 MATERIALS

A. Suitable for application specified:

1. Pump Case: Cast iron, ASTM A48, minimum Class 35B.
2. Motor Housing: Cast iron, ASTM A48, minimum Class 35B.
3. Propeller: PL 7061 - ASTM B148, aluminum bronze; PL 7020 and PL 7065 – ASTM A-743 CF8M austenitic stainless steel.
4. Intermediate Housing: Cast iron, ASTM A48, minimum Class 35B.
5. Pump Tube: ASTM A36 steel tube.
6. Pump/Motor Shaft: Stainless steel, AISI 431SS.
7. Wear Ring: PL 7061 and PL 7065 - Stainless steel, ASTM A320, Type 316; PL 7020 – HARD IRON, ASTM A532 (Alloy III A), 25% chrome cast iron.
8. O-Rings: Nitrile.
9. Fasteners: Stainless steel, ASTM A276, Type 316Ti.
10. Lower Seal Faces: Tungsten carbide vs. tungsten carbide.
11. Upper Seal Faces: Tungsten carbide vs. tungsten carbide.
12. Guide Cables and Brackets: Stainless steel, ASTM A276, Type 316.
13. Oil for All Uses: Ecologically safe, paraffin based.
14. Power/Control Cable: Chloroprene rubber.
15. Anchor Bolts: Stainless steel, ASTM A276, Type 316.

2.03 PUMP FABRICATION

A. General:

1. The discharge column shall be permanently installed in the wet well. The pump unit(s) will be automatically and firmly connected to the discharge tube when lowered into place. A locking device, located on the external surface of the pump house, shall prohibit rotational movement of the pump/motor unit(s) within the tube(s) or 45 degree angle and O-ring seat to prevent rotation.
2. The pump(s) shall be easily removable for inspection or service with no need for personnel to enter the wet well. The pump(s) shall not require any bolts, nuts or fasteners for connection to the discharge column.
3. Stiffening and guiding webs shall be provided at the pump support seat to ensure concentric positioning of pump within the discharge column. An O-ring shall be provided on the bottom of the inlet (suction) bellmouth so that the weight of the pump unit, when acting on the O-ring, will provide an effective seal between pump and discharge column.

B. Propeller:

1. Four blade fixed pitch, cast design.
2. Backward curved so that any clogging tendency is minimized.
3. Balance statically and dynamically.

C. Wear Rings:

1. A replaceable wear ring shall be installed in the pump housing to provide sealing between the pump housing and the propeller.

D. Shaft and Shaft Sleeve:

1. Provide common pump/motor shaft. Pump shaft shall be extension of motor shaft. Pump shaft and motor shaft with connection coupling is not acceptable.

E. Shaft Seals:

1. Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent spring system.
2. Provide one stationary and one positively driven rotating seal ring for each seal.
3. Easily inspected and replaced.
4. Shall not require maintenance or adjustment.
5. Shall not depend on direction of rotation for sealing.
6. Shall not rely on pumped media for sealing.
7. At minimum, install upper seal in oil-filled chamber. Provide drain and inspection plug with positive anti-leak seal easily accessible external to pump.

F. Bearings:

1. Provide upper and lower bearings.
2. Single or double row to provide minimum B-10 life of 100,000 hours at axial and radial loadings while operating at specified operating conditions.
3. Sealed/shielded-non-regreasable or open regreasable type. Provide re-lubrication ports with positive anti-leak plugs external to pump for open regreasable bearings.
4. Provide lower bearing temperature sensor. Sensor shall be Resistance Temperature Detector (RTD) type. Wire sensor for connection to control panel.

G. Motor:

1. Manufactures standard UL listed or labeled definite purpose motor.
2. 460 volt, three phase, 60 Hertz.
3. Environment: Class I, Division 2, Group D.
4. Horsepower: As specified in Schedules 1, 2 and 3 to Section 11313.
5. Housed in air-filled, watertight casing.
6. Moisture resistant, minimum Class H insulation rated for 180°C.
7. Embed three thermal switches in windings, one per phase, to provide high temperature shutdown protection. Wire switches in series for connection to control panel.
8. Provide temperature sensor in the stator winding.
9. Provide leakage sensor to detect fluid in stator chamber and provide signal for motor shutdown. Wire sensor for connection to control panel.
10. Provide leakage sensor to detect fluid in the junction chamber and provide signal for motor shutdown wire sensor to control panel.
11. A pump memory module shall be provide and installed in the junction chamber to record pump run time, number of starts, and unit data.

H. Cooling System: Provide motor cooling to comply with design and performance requirements and as follows:

1. Provide motor with sufficient surface area for ambient only cooling.

I. Power/Control Cable:

1. Size in conformance with National Electric Code (NEC) standards.
2. Provide sufficient length to connect to junction box without splicing.
3. Provide watertight cable entry seal to comply with design and performance requirements.
4. Two power cables (1.85 inches Outside Diameter) and one pilot cable (1.18 inches Outside Diameter) shall be provided.

2.04 PUMP TUBE

A. Gusset tube support collar with support plate.

B. Design collar to support weight of pump and tube.

2.05 PUMP POWER CABLE SUPPORT SYSTEM

A. All pump electrical cables that are located in the pump discharge tube shall be equipped with a cable support system. This support system shall ensure that the pilot and power cables are protected from damage due to excessive movement.

B. The system shall consist of a support beam, spring loaded cable holders, cable support grips, guide wire system, cable bundling, and pump tube cable exit.

C. The support beam shall be fabricated from 304 stainless steel rectangular tubing and shall provide the overall support of the entire system, including the pump power and pilot cables. This beam shall be located such that it spans across the diameter of the tube. The beam shall be removable.

D. The cable holders shall be constructed of 304 stainless steel square tubing, which will contain spring-loaded lifting eyebolts. The eyebolts shall be used for attachment to the guide wire(s) and support of the power and pilot cables. The system shall allow the power and pilot cables to be adjusted vertically, until taut, to prevent them from moving.

E. Each cable shall have its own stainless steel cable support grip to aid in the supporting of the cable weight. A cable support grip shall be attached to each cable, and each grip shall be attached to the lifting eye bolt with a shackle.

F. The guide wire shall be 316 stainless steel wire. The guide wire shall be used to stabilize the power and pilot cables between the pump top and the support beam.

G. The power and pilot cables shall be bundled, for the length of the tube, at a spacing of approximately 40 inches.

H. The pump tube cable exit shall provide a watertight exit for the electrical cables. The system shall consist of a cable mounting frame installed on the outside of the tube with rubber modules for the cable seals. All modules are secured in the frame by the tightening of compression wedge and stay plates. The mounting frame shall be installed on the outside of the tube and integrated into the tube cover mounting flange. The frame shall be secured to the tube with stainless steel fasteners and sealing achieved by a gasket located between the frame and tube.

2.06 ANCHOR BOLTS

A. Comply with pump manufacturer's requirements and Section 05500.

2.07 CONTROL EQUIPMENT

A. Pump supplier shall provide monitoring and status system (MAS) for pumps P-1-5-1, 2, 3 and P-2-5-3, 4.

1. All of the pump/motor unit protective and monitoring sensors shall be connected to a MAS (Monitoring and Status) module. Each pump/motor unit shall be equipped with a MAS unit. The MAS shall be a two-piece product including the base module and an operator panel.
2. The operator panel shall be mounted on the dead-front panel. The operator panel shall include soft-touch type navigation keypad, alarm acknowledgement keypad, amber warning lamp, red alarm lamp and a two line by 20-character LCD digital display. The digital display shall provide the local readout of pump/motor sensor and alarm status and aid in navigation through the system during set-up.
3. The base module shall contain a processor unit having a minimum of 2Mb of memory for the logging of measurements and alarm events, two communications ports, sufficient terminals for pump/motor unit sensor connection and a Web tool. The Web tool shall be able to be accessed in the following manners; directly connected at the site with a personal computer, remotely accessed over the City’s LAN or internet or by the use of a telephone modem.
4. Pump supplier shall furnish control transformer of proper size for each pump to be connected to MAS for monitoring amperage. The MAS and control transformer shall be installed in the motor control center for pumps.

B. Provide mini CAS (Control and Status) monitoring unit for Pumps P-2-5-1 and P-2-5-2. Unit shall be rated for 120 volt supply. Output voltages shall be less than 24 volts.

1. Control unit shall be mounted in motor control center (MCC-1).

2.08 COATING

A. Manufacture is responsible for surface preparation, priming and finish coating of ferrous metal components in plant prior to shipment. Provide manufacturer’s standard factory coating for both submerged and non-submerged surfaces.

B. Pump tube coating shall comply with Section 09961, System 20-C.

2.09 SOURCE QUALITY CONTROL

A. Factory certified performance test(s):

1. Perform on each pump in accordance with test requirements of Hydraulic Institute, Level A, performance standard.
2. Determine capacity, head, brake hp and hydraulic efficiency.
3. Test each pump at a minimum of six points including shutoff, at rated capacity specified, and at flow rate greater than maximum capacity specified Schedule(s).
4. Prepare and submit certified performance curves.
5. Test actual assembled pumps to be provided. Results of prior tests on similar or identical pumps are not acceptable.

2.10 FORMED SUCTION INTAKE (FSI) DEVICE

A. Each pump shall be provided with a specially-engineered formed suction intake (FSI) device designed by the pump manufacturer. The FSI shall be constructed of fabricated steel and connected to the inlet of the pump discharge tube. The pump manufacturer shall have unit responsibility for supplying the pump, discharge column, and FSI.

B. The FSI shall be comprised of two sections: diffuser and 90° bend. The diffuser shall incorporate inlet chamfers to minimize pre-swirl. The 90° bend shall be without sharp turns, to prevent turbulence and minimize dynamic losses. The bend shall be reducing in cross-section, with the inlet area not less than the outlet area.

C. The design of the FSI shall have been verified by the pump manufacturer, through both CFD analysis and physical scale model tests. The FSI shall be capable of normalizing lateral approach flows up to 3.3 foot/second, and shall produce a uniform flow distribution -- with pre-swirl not to exceed 3° -- at the pump propeller plane.

D. The dimensions of the FSI shall be smaller than those of a Type 10 FSI design, based on equivalent flow rate and discharge column diameter, with no loss of hydraulic performance.

E. The FSI shall be constructed of A36 structural steel. All welding shall be in accordance with American Welding Society (AWS) D1.1 Structural Welding Code.

F. The formed suction intakes shall incorporate structural ribbing to allow for embedment in concrete.

G. The FSI shall be of a design that has been used by the particular pump supplier on a minimum of at least five pumps currently installed and operating in the United States for at least three years. The required installation list shall include pumps both larger and smaller in diameter than the minimum pump diameter specified to insure that the flow characteristics encountered at this installation are bracketed by both larger and smaller pumps. The pump supplier shall be required to supply a list of the installations, along with the pump model, size, date of initial service, and pump head and flow duty points.

It is the intention of this specification to ensure that the FSI is not a new, experimental or theoretical design. The FSI provided shall have been verified by full-scale operation on the manufacturer’s pumps.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturers written instructions and approved submittals.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at the job site or classroom designated by City for minimum man-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of City's personnel for plant operation. Include minimum of:

   a. 5 man-days for Installation Services
   b. 2 man-days for Instructional Services
   c. 2 man-days for Post-Startup Services

2. Supplier of manufacturer shall direct services to specific system and equipment operation, maintenance, and troubleshooting. Process design and philosophy will be presented by Engineer. See Section 01600.

SCHEDULE 1 TO SECTION 11313 SUBMERSIBLE AXIAL FLOW PUMPS (WET INSTALLATION)	
Name of Pump(s)	Stormwater Pump - PL 7065
Tag Number(s)	P-1-5-1, P-1-5-2, P-1-5-3
Number of Pumps	3
Fluid Pumped	Municipal Stormwater
Fluid pH	6 to 9
Minimum Spherical Solids Size (inch)	N/A
Maximum Motor Horsepower	135
Constant or Adjustable Speed	Constant
Performance Requirement at Rated Speed	
Maximum Rated Speed (rpm)	880
Design Operating Point	
Capacity (gpm)	16,456
Head (foot)	19.6
Minimum Efficiency (%)	79
Head (foot) Operating Range	19-23

SCHEDULE 2 TO SECTION 11313 SUBMERSIBLE AXIAL FLOW PUMPS (WET INSTALLATION)	
Name of Pump(s)	Stormwater Pump - PL 7020
Tag Number(s)	P-2-5-1, P-2-5-2
Number of Pumps	2
Fluid Pumped	Municipal Stormwater
Fluid pH	6 to 9
Minimum Spherical Solids Size (inch)	N/A
Maximum Motor Horsepower	40
Constant or Adjustable Speed	Constant
Performance Requirement at Rated Speed	
Maximum Rated Speed (rpm)	1,750
Design Operating Point	
Capacity (gpm)	~~4,072~~ 3952
Head (foot)	28.2
Minimum Efficiency (%)	83
Head (foot) Operating Range	23-29

SCHEDULE 3 TO SECTION 11313 SUBMERSIBLE AXIAL FLOW PUMPS (WET INSTALLATION)	
Name of Pump(s)	Stormwater Pump - PL 7061
Tag Number(s)	P-2-5-3, P-2-5-4
Number of Pumps	2
Fluid Pumped	Municipal Stormwater
Fluid pH	6 to 9
Minimum Spherical Solids Size (inch)	N/A
Maximum Motor Horsepower	140
Constant or Adjustable Speed	Constant
Performance Requirement at Rated Speed	
Maximum Rated Speed (rpm)	1,775
Design Operating Point	
Capacity (gpm)	11,800
Head (foot)	28
Minimum Efficiency (%)	~~83~~ 76
Head (foot) Operating Range	24-29

* * * END OF SECTION * * *

SECTION 13431
24/26 GHz RADAR LEVEL DETECTION EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Radar Level Sensor with Transmitter

B. Comply with Section 13440.

1.02 SYSTEM DESCRIPTION

A. Design Requirements:

1. Comply with Schedule 1 to Section 13431.
2. Level accuracy of system: ±0.12 inch from 1.6 feet to 32.8 feet, ±0.03% of distance greater than 32.8 feet.

1.03 SUBMITTALS

A. General: If Contractor provides equipment of named manufacturer(s) without deviations submittals are not required. If Contractor is proposing substitute to named manufacturer(s), submittals below are required. O&M date is required for named and substitute manufacturers.

B. Shop Drawings:

1. Drawings showing installation of level sensor.

C. Product Data:

1. Catalog cuts and manufacturers specification for each level sensor and monitoring unit.
2. Standard wiring diagrams.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Endress Hauser FMR51.

B. Siemens SITRANS.

C. Or Equal.

2.02 LEVEL SENSOR

A. Level system shall consist of transmitter/receiver, an antenna horn and a signal processor for continuous measurement of material levels of liquids and slurries in open or closed tanks, in stilling wells, or in standpipes, without contacting medium.

B. Operating temperatures: -40°F to +176°F.

C. Suitable for process media identified in Schedule 1 to Section 13431.

D. Noncontact design with no moving parts or mechanical linkages.

E. Explosion-proof certified by FM and CSA Standards for Class I, Division I, Groups A, B, C and D, and intrinsically safe with suitable barrier when installed in rated area.

F. 24/26 GHz pulsed frequency operation.

G. Four-inch 316L Stainless steel antenna.

H. Measuring Range: Maximum 66 feet.

I. Provide pipe or antenna extension to accommodate slab thickness and standpipe in wet well slab (cover).

J. Mounting shall be as shown on plans. Standard connection shall be 4 inch flange. Other methods of mounting may be considered if recommended by manufacturer.

2.03 TRANSMITTER UNIT

A. Provide minimum two line integral display.

B. Possess the ability to be programmed in hazardous area using handheld programmer.

C. Provide linearized HART 4-20 mA output with an accuracy of ±0.02mA. Selectable span proportional or inversely proportional to level.

D. Second line of display capable of displaying volume in engineering units. Capable of applying 11-point linearization to insure accurate measurement in non-standard vessel configuration.

E. Have advanced signal-processing algorithms including, but not limited to, Auto-False Echo Suppression, Agitator Discrimination, and Empty Vessel Profiling.

F. Enclosure: NEMA Type 4X enclosure, powder coated with potted electronics.

G. Operating Temperature of -40°F to 176°F.

H. Power: Loop-powered.

2.04 TAGGING

A. Provide identification tags and markers in accordance with Section 15075.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved submittals.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's technician for equipment specified herein shall be present at job site or classroom designated by City for man-days indicated, travel time excluded, for

assistance during plant construction, plant startup, equipment calibration, and training of City's personnel for plant operation. Include minimum of:

a. 1/2 man-day for Installation Services.
b. 1/2 man-day for Instructional Services.

2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, and troubleshooting and system-related areas, other than process design and philosophy. See Section 01600.

SCHEDULE 1 TO SECTION 13431
RADAR LIQUID LEVEL DETECTION EQUIPMENT

Tag Number	Description	Process Media	Range	Max. Depth	Remarks
LE/LIT -1-4-1	Storm Water Wet Well	SWR	0 – 27 feet	22 feet	--

* * * END OF SECTION * * *

SECTION 13440
GENERAL PROVISIONS FOR INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements for package and non-package Instrumentation and Control Systems unless otherwise specified in other sections.

1.02 DEFINITIONS

A. Selector Switch: When used under panel component description refers to maintained contact type switches. Loss and return of control power to circuit does not change control mode of requirements in switch position.

B. Push-button: When used under panel component description refers to momentary contact type switches which, unless specified otherwise, shall require electrical interlock. Loss of control power shall, unless specified otherwise, result in loss of electrical interlock and stoppage of previous mode of operations.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Provide run/fail, alarm, and equipment status functions.
2. Unless otherwise specified, "run" signals shall be derived from motor starter normally open auxiliary contacts.
3. Unless otherwise specified, discrete input and output signals shall conform to:
   a. Isolated unpowered (dry) contact closures.
   b. Power contact from panel receiving signal or device receiving signal.
4. Unless otherwise specified, input and output analog signals shall conform to:
   a. 4-20 mAdc.
   b. For two wire transmitter, provide isolated type and power with 24 or 48 vdc at panel or device receiving signal.
   c. Where isolation is required to interface with particular equipment furnished, provide necessary I/I converters.
5. For PLC based systems manual control devices, in panel or field, shall be independent from PLC to provide maintenance and redundancy function.
6. Panels, panel devices, and field devices shall meet or exceed NEMA requirements as follows.
   a. NEMA 4X: Wet locations or outdoors.
      1) Instrumentation and control panels shall be 316 stainless steel.
      2) Instruments and device enclosures shall be 316 stainless steel, fiberglass, or ABS plastic.
   b. NEMA 7: Class I, Division 1 or 2 areas.
   c. NEMA 12: Other areas.
7. Design Life: Design control system for minimum 10 year life at following temperatures:
   a. Permit continuous operation with panel external ambient temperatures of up to +104°F.
   b. Outdoor Panels: Permit operation with panel external ambient temperatures of down to -20°F.

c. Indoor Panels: Permit operation with panel external ambient temperatures of down to +40°F.

8. When motor controller disconnecting means is off, deenergize associated equipment devices powered from panel.
9. Electrical wiring and controls shall conform to Division 16.

B. Identify equipment on panel or screens with indication below:

1. Green Light On: Equipment running.
2. Red Light On: Equipment failure when called to run, but not running due to power failure, overload, breaker, disconnect, or remote switch call for equipment to stop.
   a. Provide parallel "required" contact wired to panel for items such as pumps and valves.
   b. Provide necessary relay logic and adjustable timers to sense discrepancy between "required" and "running" and activate respective "Run" and "Fail" light from these signals. Provide horn when specified.
3. Amber Light On: Indicate equipment status such as valve open or closed.
4. White Light On: Equipment off.

C. Alarm Sequence:

1. Manual Reset Sequence: Alarm condition shall illuminate corresponding visual alarm point. Depressing push-button shall turn off light. Subsequent alarm condition shall repeat above sequence. If alarm condition ceases, steady visual alarm shall not go out until reset push-button depressed. Momentary alarms shall lock-in until reset. Depressing test push-buttons for alarm functions shall turn on visual alarm points simultaneously or use press to test lights.

1.04 SUBMITTALS

A. General:

1. Submit following information tabulated in booklet form for each piece of equipment or system furnished under this section.
2. Table of Contents of Submittals: Include for each booklet when more than 1 item of equipment is included in submittal:
   a. Engineer’s instrument tag number.
   b. Instrument manufacturer's model number.
   c. Related piping, electrical, and dimension drawings.

B. Product Data:

1. Construction materials.
2. Ranges.
3. Output/Input signals.
4. Accessories.
5. Mounting location.
6. Engineer’s tag number on manufacturer's specifications sheets.
7. Interconnect reference for associated field and panel instruments.
8. Component specification sheets.
9. Catalog cuts.
10. Standard instrument wiring diagrams.
11. Installation drawings.

C. Shop Drawings:

1. Panel fabrication and dimension drawings, nameplate legends, Engineer's tag numbers, and wiring and piping schematic drawings. Project specific drawings are required for each panel, typical are not acceptable.
2. Equipment dimension drawings.
3. Equipment terminal and piping connections.
4. Loop-by-loop system electrical schematic showing terminal-to-terminal interconnections between related panel and field instruments.
5. Front of panel layout.
6. PLC I/O module connection diagram for PLC based systems.
7. Ladder/logic system electrical schematic showing wiring of each component, including ranges and set points. Wiring and ladder diagram shall have reference numbers on every line for cross referencing. Each device on ladder shall be cross-referenced with line number as to wherever it is located.
8. Terminal to terminal interconnection drawings showing wiring for panel to panel/MCC and panel to field equipment.

D. Miscellaneous:

1. Certificate of UL or nationally recognized testing laboratory (NRTL) inspection and approval for each completely assembled panel prior to shipment to Project.
2. Include Engineer's tag number when available on each submittal document or page wherever specific component appears.
3. Extra materials list.

E. Operation and Maintenance (O&M) Data:

1. Include O&M data for each panel and field device specified in Division 13 and Division 16:
   a. PLC ladder logic software (electronic and printed) including tags, comments, operational database values and passwords or pass codes.
   b. Configured software on electronic media to install program on spare PLC processors and programmable controller.
   c. Bill of materials.
   d. Instruction Manual: Includes detailed operating sequence descriptions.
   e. Maintenance Manual: Instructions for maintaining equipment to include calibrating, cleaning, and trouble shooting.
   f. Front and rear panel layout drawings.
   g. Name plate data.
2. Submit one package:
   a. Equipment provided under Section 16900.

F. Submit in accordance with Section 1105 of the Standard Specifications.

1.05 QUALITY ASSURANCE

A. Standardization:

1. Contract documents are intended to provide overall system functions. Provide equipment necessary to provide complete and operable system.
2. Contractor is responsible for costs resulting from deviations from contract documents.

B. Items provided under sections referenced to this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

C. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 PRODUCTS

2.01 EQUIPMENT MARKERS

A. Other than for panels provide plastic equipment markers that comply with Section 15075.

2.02 SOURCE QUALITY CONTROL

A. Perform UL inspection and certification for each completely assembled panel before shipment to Project site.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in locations indicated on plans and in accordance with manufacturer's written instructions and approved submittals.

3.02 EQUIPMENT MARKERS

A. Install in accordance with Section 15075.

* * * END OF SECTION * * *

SECTION 13442
INSTRUMENT AND CONTROL PANEL CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Comply with Section 13440.

1.02 SUBMITTALS

A. Shop Drawings:

1. Wiring and wiring identification.
2. Terminal identification.

B. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 MAINTENANCE

A. Extra Materials:

1. Five fuses or 10%, whichever is greater, for each type of fuse.
2. 30% spare unwired terminals; to be shown on panel drawings.
3. Five lamps or 10%, whichever is greater, for each type of lamp.
4. One intrinsically safe relay and intrinsically safe barrier for each type.
5. One control relay for each type.
6. One lightning and surge protection module for each type.
7. Spare PLC I/O points wired to terminal blocks.

B. Panel Space:

1. Include 10% contiguous usable rear of panel area for future components.

PART 2 PRODUCTS

2.01 CONTROL PANELS

A. Factory-fabricate, install instruments, plumb and wire.

B. Make external connections by way of numbered terminal blocks.

C. Separate electrical components from pneumatic components by metal barriers.

D. Conform to ISA standards.

E. Construct panels to external dimensions as specified, required, or shown. Component arrangement and wiring shall be consistent for like panels.

F. Fabrication:

1. Minimum Metal Thickness: 14 gauge.
   a. Construct panels so no seams or bolt heads visible when viewed from front.
   b. Panel cutouts for instruments and other devices, such as lights and switches, shall be cut, punched or drilled, and smoothly finished with rounded edges.
2. Wherever practical, enclosures shall be manufacturer's standard product.
3. Size to adequately dissipate heat generated by equipment mounted in or on panel.

4. Equip panels mounted outside buildings with thermostatically controlled space heaters capable of maintaining internal temperature of 50°F, ±4°F, with 20 mph wind at ambient temperature of -22°F. Heaters shall operate on 120 volt AC, 60 Hertz power.
5. Install rear of panel devices on subpanel.

G. Doors:

1. Provide front doors except on graphic sections and where otherwise specified.
2. Full height, fully gasketed access doors.
3. Provide with three point padlock locking latches.
4. Provide full length, continuous, piano type stainless steel hinges and pins.

H. Service Outlets:

1. Provide 20 amp, 120 volt service outlet circuit fused at 5 amps within back-of-panel area. Fuse separate from control power.

I. Temperature Control:

1. For NEMA 1 and 12 Applications:
   a. Provide louvers or forced ventilation as required to limit internal temperature build-up. Internal panel temperature shall not exceed lowest or highest temperature rating of internal components.
   b. Mount stamped sheet metal louvers on top and bottom in rear of panels.
   c. For panels mounted with backs directly adjacent to wall, mount louvers on sides.
   d. Provide separately fused forced ventilation fans, when required, with washable or replaceable filters. Fan motors shall operate on 120 volt, 60 Hertz power.
2. For NEMA 4 and 4X Applications:
   a. Provide thermostatically controlled heat exchanger and circulation fans as required to limit internal temperature buildup within sealed enclosure. Internal panel temperature shall not exceed lowest or highest temperature rating of internal components.
   b. Heat exchanger shall be of air to air heat pipe type:
      1) Manufacturer: Noren Products Inc.
      2) Components located outside of control center enclosure shall be suitable for outdoor installation.
      3) Fans shall be waterproof and installed in an anodized aluminum enclosure.
   c. Install heat exchanger so that NEMA rating of enclosure is not compromised.
   d. For outdoor application sunshields may be used to limit internal panel temperature.

J. Fusing:

1. Maximum Fuse Size: 5 amp.
2. Group instruments/devices after separate fusing with maximum of eight digital input signals/fuse.
3. Fuse power supplies individually.
4. Where 5 amp capacity is exceeded by load requirements, provide additional fuses.
5. For field devices powered by panel, provide separate fuse for each output.
6. In addition to above where PLCs are used provide a minimum of one fuse per I/O module.

K. Wiring Terminals:

1. Mount and wire panel instruments and components to terminal blocks within panel so installation shall require only setting panel in place and making connections to field wiring and utilities.
2. Provide separately mounted terminal blocks in panel for connection of field wiring to panel.

3. Label with respective loop number as designated on Panel Ladder Logic plans or Loop Diagrams.

L. Intrinsically Safe Components:

1. Provide intrinsically safe shunt barriers and relays as necessary when field components are located in Class I Division 1 or Division 2 hazardous class field locations.

M. Lightning and Surge Protection:

1. Provide on instrumentation and control signals whose source or destination is outside building.
2. Provide on phone lines and copper data network connections located outside building.
3. Provide on 120 volt AC power feeds.

N. Wiring Identification:

1. Label panel wiring at each end of conductor with wire number as designated on Panel Ladder Logic plans or Loop Diagrams.
2. Labels shall be heat shrinkable vinyl sleeve with permanent embossed letters. Emboss label characters on single sleeve. Heat shrink sleeves on conductors at terminal ends.
3. Conductors Color Codes:
   a. 120 volt AC power wiring, line (phase "A"): Black.
   b. 120 volt AC power wiring, neutral/common: White.
   c. 120 volt AC power wiring, ground: Green.
   d. 120 volt AC control wiring, internal power source: Red.
   e. 120 volt AC control wiring, external power source: Yellow.
   f. 24 volt DC control wiring, internal or external power source: Light Blue.
   g. 4-20 MilliAmp DC signal wiring, positive lead: Black.
   h. 4-20 MilliAmp DC signal wiring, negative lead: White or Red.
   i. Data highway cable, signal leads: Manufacturer's standard.

O. Panel Drawing Data Pocket:

1. Mount inside without penetrating panel.
2. Size for holding wiring diagrams.
3. Construct from thermal plastic or metal.
4. Include wiring diagrams.

P. Three Phase and Motor Control Panel:

1. Through door main disconnect or circuit breaker.
2. Control transformer with primary and secondary fuses or circuit breakers.

2.02 ADDITIONAL REQUIREMENTS FOR FREE-STANDING PANEL CONSTRUCTION

A. Fabrication:

1. Fabricate each panel from sheet steel with one piece, 10 gauge steel front and 12 gauge steel sides, back, and top.
2. Provide steel angle stiffeners on back of panel face to prevent panel deflection under instrument loading or operation.
3. Provide internal structural steel framework for instrument support and panel bracing. Internal framework shall permit lifting of panel without racking or distortion.
4. Provide removable lifting rings designed to facilitate rigging and lifting of panel during installation. Provide plugs to fill lifting ring holes after installation to complete and lifting rings have been removed.

5. Where two or more sections of panel are mounted adjacent to one another, bolt together with front faces parallel.

B. Doors:

1. Rear access doors shall extend no further than 24 inches beyond panel when opened to 90 degree position.
2. For panels with no front doors or rear access, provide 36 inch deep panel with side access doors on each side.

C. Lights:

1. Provide separately fused and switched 100 watt incandescent or equivalent cold start fluorescent back-of-panel lights.
2. Provide one light for every 4 feet or less of panel width.
3. Mount inside and in top of back-of-panel area.

D. Service Outlets:

1. Space evenly along back of panel.

a. Panels 4 feet or less: One outlet.
b. Panels greater than 4 feet: Two outlets.
c. Panels greater than 8 feet: Three outlets.
d. Panels greater than 12 feet: Four outlets.

E. Instrument Location:

1. Locate instruments designated for back of panel mounting to allow for maintenance and adjustment.
2. Front of panel instrument mounting height shall not exceed 6 foot 6 inches, minimum height shall be 4 foot 0 inches.

2.03 PANEL FINISH

A. Remove mill scale, rust, grease, and oil. Fill imperfections and sand smooth.

B. Paint interior and exterior with one coat of epoxy metal primer and two finish coats of two component type epoxy enamel.

1. Paint edges of cutouts before installation of instruments and devices.

C. Dry film thickness shall not be less than 3.0 mils.

D. Color: Manufacturer's standard gray for exterior and white for interior.

2.04 NAMEPLATES

A. Provide nameplates for I&C panels and each front-of-panel instrument and device with designations as shown on plans and as listed in Specifications.

B. Panel Designation: Engraved with Engineer’s panel tag number and description with 1/2 inch high characters.

C. Application/Function Nameplate: Locate 3/16 inch characters above or near panel mounted instrument or device consisting of descriptive phrase using nomenclature as listed in Specifications (when available).

D. Laminated white plastic inscribed with black characters.

E. Tag Number: Include Engineer’s tag number as shown on P&ID's and in Specifications on each nameplate.

F. Provide aluminum decal with black 3/16 inch characters identifying tag number or device designation. Locate decal on instrument or device or above instrument or device on panel.

G. Secure front-of-panel and front-of-instrument nameplate with drive screws or self-tapping fasteners.

2.05 SOURCE QUALITY CONTROL

A. Test wiring and plumbing prior to shipment.

1. Test internal wiring and components to ensure panel is operational prior to shipment.
2. When panels are interwired, interconnect panels at factory and test functionality of system.
3. Simulate field component and instrument inputs at panel terminals. Test panel outputs with suitable test instruments.
4. Pressure test internal piping system and components for leaks and repair before shipping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panels in locations indicated on plans and in accordance with manufacturer's written instructions and approved submittals.

B. Paint: Touch up defects in panel finish after installation.

* * * END OF SECTION * * *

SECTION 13452
ELECTRONIC PANEL INSTRUMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Comply with Section 13440.

PART 2 PRODUCTS

2.01 DIGITAL PANEL INDICATORS

A. Manufacturers:

1. Red Lion, PAX Series.
2. Action Instruments, V400 Series.

B. Features:

1. LED display.
2. 0.56-inch digit height minimum.
3. 4-1/2 digit.
4. Selectable decimal point.
5. Scaled in engineering units.

C. Input: 4 – 20 MilliAmp DC isolated.

D. Signal Termination: Ungrounded.

E. Input impedance: 10 ohms maximum.

F. Accuracy: 0.1% of span.

G. Power: 120 volt AC, +/- 10%, 60 Hertz.

H. Construction: NEMA 4.

I. Mounting: Flush panel, 2.1 inch height, 4 inch wide, 6.75 inch depth.

2.02 I/I TRANSDUCER-ISOLATOR (CONVERTER)

A. Manufacturers:

1. Moore Industries. ECT-DIN Series.
2. Rochester Instruments. SC 1300 Series.
3. Or equal.

B. Features:

1. Solid state instrument to electrically isolate one instrument loop from another instrument loop.
2. Converter to accept 4-20 MilliAmp DC input signal and provide equal but isolated and power-boosted output.
3. Signals: Input: 4-20 MilliAmp DC into 50 ohms.

4. Output: 4-20 MilliAmp DC into output load up to 1000 ohms.
5. Isolation: Common mode up to 1500 vrms volt AC between input and output.
6. Accuracy: 0.1% of span.
7. Power: 120 volt AC, ±10%, 60 Hertz with fused internal 24 volt DC power supply.

2.03 POWER SUPPLY

A. Manufacturers:

1. Sola Heavy Duty.
2. Phoenix Contact.
3. Or equal.

B. Features:

1. Solid state converting 120 volt AC, 60 Hertz power into low voltage regulated dc usable for analog instrumentation.
2. Output: 24 volt DC sized for load.
3. Voltage: 120 volt AC, ±10%, 60 Hertz, internally fused.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and wire in accordance with manufacturer's written instructions and approved submittals.

* * * END OF SECTION * * *

SECTION 13453
PANEL AND FIELD DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Comply with Section 13440.

PART 2 PRODUCTS

2.01 PUSH-BUTTON/SELECTOR SWITCH CONTROL UNITS AND PILOT LIGHTS

A. Manufacturers:

1. Square D.
2. Cutler-Hammer.
3. Allen Bradley.
4. Or equal.

B. Construction:

1. Heavy duty.
2. Oil tight, watertight.
3. Base mounting.
4. Flush panel mounting.
5. Size to mount in 30.5 mm opening without adapter. Smaller units are not acceptable.

C. Pushbuttons:

1. Flush head unless specified elsewhere.
2. Contact Blocks:
   a. Double break silver contacts.
   b. ac Ratings: 7200 va make, 720 va break.
   c. Single pole, double throw or double pole, single throw.
   d. Up to six tandem blocks.
3. Momentary contact unless specified elsewhere.
4. Non-illuminated.
5. Padlock attachments where required.
6. Legend plates as required for type of operation or as specified elsewhere.

D. Remote Control Disable (RCD):

1. Jumbo red mushroom head.
2. Contact Blocks:
   a. Double break silver contacts.
   b. ac Ratings: 7200 va make, 720 va break.
   c. Single pole, double throw or double pole, single throw.
   d. Up to two tandem blocks.
3. Push/Pull.
4. Maintained contact.
5. Non-illuminated.
6. Padlock attachments constructed of metal. Plastic material is not acceptable.
7. Legend Plates:
   a. Extra large.

b. Red.
c. Emergency.

E. Selector Switches:

1. Maintained position unless specified elsewhere.
2. Contact Blocks:
   a. Double break silver contacts.
   b. ac Ratings: 7200 va make, 720 va break.
   c. Single pole, double throw or double pole, single throw.
   d. Up to six tandem blocks.
3. Operators:
   a. Number of positions as specified elsewhere.
   b. Standard knob type unless specified elsewhere.
4. Legend plates as required for type of operation or specified elsewhere.

F. Pilot Lights:

1. Transformer type.
2. LED bulb.
3. Colored lenses as specified elsewhere.
4. Interchangeable lenses.
5. Transformer rated for 120 volt, 60 Hertz.
6. Push to test.
7. Legend plates as required for type of operation or specified elsewhere.

G. Nameplates:

1. MCC: Section 16443.
2. I&C Panel: Section 13442.
3. Control Stations:
   a. Engraved laminated plastic.
   b. Letters 3/16 inch high.
   c. Black letters on white background.
   d. Identify per equipment controlled.

2.02 MOTOR STARTER CONTROL RELAYS

A. Manufacturers:

1. Square D.
2. Cutler-Hammer.
3. Or equal.

B. Construction:

1. Industrial type.
2. 300 volt rated.
3. ac operation.
4. Pressure wire connectors.

C. Operating Data:

1. Pickup Time: 11 ms maximum.
2. Dropout Time: 6 ms maximum.

D. Coil:

1. Molded construction.
2. 120 volt AC, 60 Hertz.
3. Continuous rated.
4. 155 va inrush, maximum.
5. 22 va sealed, maximum.
6. Suppress coil transients to 300 volts or less.

E. Contacts:

1. Double break.
2. Silver alloy.
3. Convertible.
4. Color coded to indicate status.
5. Pilot duty.
6. 60 amp make, 6 amp break, (120 volts inducting).

F. Track mounting capability.

G. Accessories:

1. Add-on pole attachment.
   a. Four NO and four NC contacts.
   b. Add-on to 0 to 4-pole relay.
2. Latch attachment.

2.03 GENERAL PURPOSE CONTROL RELAYS

A. Manufacturers:

1. Potter and Brumfield, KU Series.
2. Struthers Dunn.
3. Or equal.

B. Operating Data:

1. Pickup Time: 13 ms maximum.
2. Dropout Time: 10 ms maximum.
3. Operating Temperature: -49°F to 158°F.

C. ac Coil:

1. 120 or 240 volt AC.
2. Continuous rated.
3. 3.5 va inrush.
4. 1.2 va sealed.
5. 50 to 60 Hertz.
6. Minimum Dropout Voltage: 10% of coil rated voltage.

D. dc Coil:

1. 24 or 120 volt DC.
2. Continuous rated.
3. Minimum Coil Resistance:
   a. 24 volt DC: 450 ohm.

b. 100 volt DC: 9,000 ohm.

E. Contacts:

1. Silver cadmium oxide.
2. Gold flashed fine silver, gold diffused for 1 amp or less resistive loads.
3. 4 Form C.
4. 120 volt AC.
5. 10 amp make, 15 amp break, (inductive).

F. Rated at 10 million operations.

G. Plug-in sockets.

H. Enclosed and protected by polycarbonate cover.

I. Provide relay retaining clips.

2.04 TIMERS

A. Elapsed Time Meters:

1. Manufacturers:
   a. Engler.
   b. Danaher (Eagle Signal).
   c. Or equal.
2. Mounting flush panel.
3. Digits: 5, nonreset.
4. Power: 120 volt AC, 60 Hertz.

B. Interval/Duration Timer (Rear of Panel):

1. Manufacturers:
   a. Potter and Brumfield.
   b. Danaher (Eagle Signal).
   c. Or equal.
2. Mounting: Plug-in with dust-tight cover.
3. Type: Integrated circuit.
4. Timing Range: 0.5 second to 99 minutes. Field selectable.
5. Contacts: DPDT contacts rated 10 amp.
6. Power: 120 volt AC, 60 Hertz.

B. On-Off Delay Timer (Rear of Panel):

1. Manufacturers:
   a. Potter and Brumfield, CN1 series.
   b. Danaher (Eagle Signal), DG 100 miniflex series.
   c. Or equal.
2. Mounting: Plug-in with dust-tight cover.
3. Type: Integrated circuit.
4. Range: 0.1 second to 9.990 hours. Field selectable.
5. Contacts: DPDT contacts rated 10 amp.
6. Set Points: 288 per 24 hours.
7. Power: 120 volt AC, 60 Hertz.

2.05 FLOAT SWITCHES

A. Manufacturers:

1. Consolidated 9GEF.
2. Anchor Scientific GP.
3. Or equal.

B. Float: 316 stainless steel.

C. Provide sufficient length of nitrile PVC jacketed cable.

D. For Class I, Divisions 1 or 2, hazardous areas, provide intrinsically safe relays in corresponding control panel.

E. Mounting Hardware: 316 stainless steel.

F. Switch: Non-Mercury tilt type switch with minimum rating of 10 million cycles.

2.06 TERMINAL BLOCKS FOR CONTROL WIRING

A. Manufacturers:

1. Phoenix Contact. UK-5N.
2. Allen Bradley, Bulletin 1492.

B. General:

1. 600 volt rating.
2. Marker labels on each terminal.
3. Clip-mount on DIN rails.
4. Insulating end caps to support each terminal block assembly.
5. Touchsafe terminal block and accessories.
6. Connection: Captive screw and pressure plate. Connection shall not cause deformation of wire.
7. Contact material and surface: Nickel or tin plated copper alloy. Do not use ferrous metals.

C. Switched Knife Disconnect (when specified):

1. Non-fused.
2. Single-pull, single throw (SPST).
3. Hinged disconnect lever.

D. Fused Indicating (when specified):

1. LED blown fuse indicating light.
2. Hinged disconnect lever.
3. Size fuse for load.
4. 15 amp capacity fuse holder.

2.07 TAGGING

A. Provide Type 316 stainless steel tag on field-mounted units and permanently affix tag to unit.

B. Engrave with process application as listed in Specifications.

C. Include Engineer’s tag number as listed in Specifications and on P&ID's.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation," and recognized industry practices.

B. Control Relays:

1. Provide control relays for general purpose logic circuits.
2. Provide motor starter control relays when load exceeds rating of general purpose control relays.

* * * END OF SECTION * * *

SECTION 13464
PROGRAMMABLE LOGIC CONTROLLER (PLC)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. PLC hardware and programming software.

B. Comply with Section 13440.

1.02 SYSTEM DESCRIPTION

A. Medium PLC Design Standards:

1. UL 508 and CSA C22.2 No. 142 for Dielectric Withstand.
2. NEMA Standard ICS –230 for Noise Immunity and Showering Arc Levels.
3. IEEE Std. 472 - 1974/ANSI C37.90/90A-1974 for Surge Withstand Capability.

PART 2 PRODUCTS

2.01 COMMON DESIGN REQUIREMENTS

A. Total minimum I/O interface capability as specified and shown on plans.

B. Expandable.

C. Modular.

D. Accept digital and analog input signals.

E. Control digital and analog output signals.

F. Monitor signal status of input and output devices.

G. Mounting hardware and interconnecting cables.

H. Include status and fault monitoring.

2.02 COMMON PROCESSOR WITH MEMORY REQUIREMENTS

A. Internal diagnostics shall be available to user for troubleshooting.

B. Halt if any of following occur:

1. Memory error.
2. Communications error between CPU and I/O modules.
3. Detection of application error.

C. Battery backup to prevent program loss on power failure.

D. Features/Functions:

1. Contact/coil status.
2. Latching/unlatch.
3. Force I/O.
4. Data transfer.
5. Four function math.
6. Counting.
7. Timing.
8. Self-monitoring diagnostics.
9. Shift registers.
10. Transitional coils.
11. Master control relay.
12. Subroutines.
13. Matrix operations.
14. Data comparisons.
15. Internal diagnostics available to user.
16. PID control.
17. Network capabilities.

2.03 COMMON POWER SUPPLY REQUIREMENTS

A. 120 volt AC, 60 Hertz power input.

B. Fused input.

C. 0.2% load regulation.

D. Sized for minimum of 125% of load.

2.04 COMMON PROGRAMMING SOFTWARE REQUIREMENTS

A. Manufacturer’s software compatible with programmable logic controllers and PC hardware and software specified.

B. PLC Programming Software shall provide capability to:

1. Program PLC features/functions off-line.
2. Display on-line status of I/O and registers.
3. Symbols similar to conventional relay logic symbols.
4. Search function.
5. Edit program.
6. Display error code registers.
7. Connect programming PC to PLC through network.
8. Security via user-defined password.
9. Printout program.
10. Programming annotation.
11. Load and record contents of memory.

2.05 MEDIUM PLCS

A. Manufacturers:

1. Allen Bradley, CompactLogix Series.
2. Siemens, S7300.
3. General Electric VersaMax Modular Series.
4. No substitution is permitted.

B. Additional Design Requirements

1. Capable of:
   a. Operating in temperatures of 32°F to 140°F.
   b. Operating in humidity of 5% to 95%, non-condensing.

C. Chassis:

1. Modular.
2. Integral or remote power supply.
3. Capability to accept:
   a. Processor with memory.
   b. I/O modules.
   c. Communications hardware.

D. Additional Processor With Memory Requirements:

1. Size memory with reserve capacity of 30%.
2. Additional Features/Functions:
   a. Clock and Date.

E. Additional Power Supply Requirements:

1. Short circuit current limit protection
2. Crowbar over-voltage protection.

F. I/O Modules:

1. General:
   a. Shield against electrical noise and RF.
   b. Provide optical isolation to give 1500 volts DC isolation from wiring on other I/O modules.
   c. Provide I/O wiring screw terminals:
      1) I/O wiring screw terminals shall be removable so as not to disturb user wiring when replacing defective module.
2. Analog Input Modules:
   a. Accept 1-5 volts DC or 4-20 MilliAmps DC analog signals.
   b. 16 bit converter:
      1) Current Resolution: 1 microamp per bit.
      2) Voltage Resolution: 1 microvolt per bit.
   c. Accuracy:
      1) Current: $\pm$0.05%.
      2) Voltage: $\pm$0.10%.
   d. Point to point isolation.
3. Analog Output Modules:
   a. Output 1-5 volts DC or 4-20 MilliAmps DC analog signals.
   b. 14 bit converter:
      1) Current Resolution: 2.56 microamp dc per least significant bit.
      2) Voltage Resolution: 1.22 MilliVolt DC per least significant bit.
   c. Point to point isolation.
   d. Over-voltage protection.
   e. Short circuit protection.
4. Discrete Input Modules:
   a. Monitor contact openings and closures from panel and field devices.
   b. Individually isolated 120 volt AC type.
   c. LED lights for each input to indicate status.

5. Discrete Output Modules:
   a. Provide contact openings and closures to panel and field devices.
   b. Each output to have indicator light to show output status.
   c. Individually isolated.
   d. Rating: 1 amp at 120 volt AC, inductive.

G. Additional Programming Software Requirements:

1. Program PLC functions on-line and off-line.

2.06 CABLES

A. Interconnecting cables.

B. Serial cable to connect programming PC to PLC.

2.07 SOURCE QUALITY CONTROL

A. UL, CUL, and CSA approved. CE compliant for all applicable directives.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and wire in accordance with manufacturer's written instructions and approved submittals.

* * * END OF SECTION * * *

SECTION 13476
UNINTERRUPTIBLE POWER SUPPLY (UPS)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Each operator interface unit (OIU).
2. Each programmable logic controller (PLC).

1.02 SUBMITTALS

A. In addition to submittal requirements of Section 16900, provide:

1. Load sizing data for equipment connected to UPS.
2. Descriptive literature and catalog cut sheets.
3. Installation details.

1.03 PROJECT/SITE CONDITIONS

A. Input power: 120 volt AC utility grade power.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Powerware.

B. APC.

C. Or equal.

2.02 EQUIPMENT

A. Isolation: Complete isolation from line, with less than 2 pF of effective coupling capacitance.

B. Voltage Spike Suppression: Greater than 2000:1. Meets or exceeds IEEE No. 587 requirements. UPS shall maintain specified output voltage when IEEE No. 587 voltage spike applied to input.

C. Noise Rejection: Common mode greater than 120 dB; transverse mode greater than 60 dB.

D. Voltage Regulation: $\pm$3% from 10% load to full load, with nominal line input.

E. Output Ratings:

1. Overload capability, when operating from line, with nominal ac input voltage applied, UPS shall support overload of 25% above full rating (i.e., 125% of rating) for 10 minutes. Surge capability shall be 150% for 10 seconds.
2. Overload capability, when operating from battery, with nominal dc input, from fully charged battery, UPS shall support overload of 110% for 10 minutes. Surge capability shall be 150% for 10 seconds.
3. Continuous monitoring of output load va by microprocessor protects UPS and load before excessive overheating or loss of output voltage regulation occurs.

4. Power Rating: Various from 1 to 10 kVa as required by connected loads.

F. Output Wave Shape: Computer-grade sine wave. Less than 5% total harmonic distortion at 50% load to full load.

G. Output Frequency:

1. 60 Hertz on-line with nominal power line grid stability of ±0.005 Hertz.
2. 60 Hertz, ±0.003 Hertz average, 0.05 Hertz peak for no more than half cycle. Output frequency tracks input line frequency up to ±0.5 Hertz limits, or ±3 Hertz if wider limit selected for use with motor generator ac source. Inverter turns on if line frequency exceeds selected limit.

H. UPS bypass selector switch.

I. UPS shall provide 30 minutes of backup power to PLC and OIU.

PART 3 EXECUTION

3.01 PREPARATION

A. Condition power as required to provide stable process control system operation.

3.02 INSTALLATION

A. Enclose power conditioners not mounted in panel within NEMA 12 rated enclosure.

* * * END OF SECTION * * *

SECTION 13478
OPERATOR INTERFACE UNIT (OIU)

PART 1 GENERAL

1.01 SUBMITTALS

A. In addition to submittal requirements of Section 16900, provide:

1. Data sheets and catalog literature.
2. Keyboards, including legends and key placement.
3. Interface and cable data.

PART 2 PRODUCTS

2.01 PROGRAMMABLE DISPLAY BASED

A. Manufacturers:

1. Xycom.
2. Nematron.
3. Allen Bradley Panelview.
4. GE Fanuc.
5. Or equal.

B. Hardware:

1. Configuration: Programmable Display.
2. For use with 120/240 volt AC single phase 50/60 Hertz power source.
3. Application Memory: Minimum 4Mb Flash EPROM.
4. Minimum 1 RS-232 serial port.
5. 10Base T Ethernet port: If Required.
6. Operating temperature: 32°F to 122°F.
7. Storage Temperature: -4°F to 140°F.
8. Operating/Storage Humidity: 10 to 90% RH (Non-condensing).
9. Data highway communication hardware as shown on plans or specified elsewhere.

C. Display:

1. Size and type: 15 inch XGA (1024x768).
2. Construction: Industrialized NEMA 4X faceplate, panel mount TFT flat panel.
   a. Industrial quality raster, scan type color monitor.
   b. Number of Colors: 256 screen colors minimum.
   c. Character Display: Alphanumeric and pixel graphic.
   d. Refresh and Scanning: Sufficient to provide flicker-free display.
   e. Duty: Continuous.
   f. Touchscreen.

D. Software:

1. Provide windows based graphical editor software and licensing as required to design screens for OIU. Software to contain minimum of preconfigured symbols to provide pushbuttons, selector switches, pilot lights, and displays (text, numeric, bar-graph) along with static and dynamic bit-mapped images.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

* * * END OF SECTION * * *

SECTION 15012
DUCTILE IRON
PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Detailed requirements for various ductile iron piping products. Some products specified in this Section may not be required for this Contract. Refer to piping system specification section(s) and plans to determine particular ductile iron piping products to be provided under this Contract.

1.02 SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, catalog cuts, and literature:

a. Pipe.
b. Inside linings.
c. Mechanical and push-on joints.
d. Flanged joints.
e. Grooved joints.
f. Standard fittings.
g. Special fittings.
h. Wall pipe and floor pipe.
i. Polyethylene encasement.

B. Submit outside coating system for buried, interior, exterior, and submerged piping locations. Include submittal information specified in Section 09961.

C. Submit product data and coating system information specified above in one complete submittal.

D. Submit in accordance with Section 1105 of the Standard Specifications.

E. Shop drawings showing layout for ductile iron piping systems shall be submitted in accordance with and transmitted under appropriate piping system specification section.

PART 2 PRODUCTS

2.01 PIPE

A. Liquid and air service pipe: AWWA C151, ductile iron.

B. Gas Service Pipe: ANSI A21.52, ductile iron. In addition to pipe marking required by ANSI A21.52, conspicuously stamp each pipe with words "AIR TESTED".

C. Minimum Thickness Class:

1. Mechanical and push-on joint pipe: Thickness Class 52, unless specified otherwise in piping system specification section.

2. Flanged joint pipe: Thickness Class 53.
3. Grooved joint pipe:

Pipe Size (inch)	Thickness Class
4 to 16	53
18	54
20	55
24	56

2.02 INSIDE LINING

A. Pipe and fittings shall be provided unlined or with inside lining as specified in piping system specification section.

B. Cement lining shall be in accordance with AWWA C104.

C. Glass Lining:

1. Glass-lined products shall be furnished to Contractor by glass lining manufacturer. Glass lining manufacturer shall supply pipe, fittings, fabrication, glass lining and outside coating.
2. Manufacturers:
   a. VITCO Corporation, Waterford, PA.
3. Special glasses and inorganic materials applied in minimum of two coats. Apply base coat and fire to temperature above 1,400□F to fuse glass to metal. Process subsequent coats in similar manner to form integral molecular bond with base coat. Finished lining shall be as follows:
   a. Thickness: 0.008 to 0.012 inch.
   b. Hardness: 5 to 6 on Mohs Scale.
   c. Density: 1.5 to 1.7 ounces per cubic inch.
   d. Sufficiently bonded to metal surface to withstand strain of 0.001 inch per inch without damage to glass lining.
   e. Resistant to corrosion by solutions of between pH-3 and ph-10 at 125°F.
   f. Withstand thermal shock of 350°F without crazing, blistering or spalling.
   g. No visible loss of surface glass after immersion in 8% sulphuric acid solution at 148°F for 10 minues.
   h. Weight loss not more than 3 mg per square inch when tested according to ASTM C283.
   i. Visually free of pinholes, crazing or fish scales which expose metal.
4. Fabrication of glass lined pipe shall be performed by glass lining manufacturer. Fabrication or cutting of pipe outside of glass lining manufacturer's shop is unacceptable.

D. Ceramic Epoxy Lining:

1. Manufacturers:
   a. Protecto 401.
2. Amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment.
3. Thickness: 40 mils nominal.
4. Surface preparation and application in accordance with coating manufacturer’s recommendations.

E. Pipe and fittings for air and gas service shall be unlined.

2.03 JOINTS

A. Joint Type:

1. Liquid and air services in buried locations shall be mechanical or push-on joint.
2. Gas service in buried locations shall be mechanical joint.
3. Gas service in locations other than buried shall be flanged joint.
4. Liquid and air service in locations other than buried shall be flanged or grooved end joint.
5. As shown on plans or as specified in system Specification if different than specified above for services and locations.

B. Mechanical and Push-on Joints:

1. AWWA C111.
2. Gasket material:
   a. Suitable for service and maximum operating temperature of piping system as specified in piping system specification section.
   b. Selected by pipe manufacturer.
3. Restrained Joints:
   a. Manufacturers:
      1) American Cast Iron Pipe Company, Flex-Ring, and Lok-Ring.
      2) U.S. Pipe and Foundry Company, TR-Flex.
   b. Provide restrained joints for buried piping systems specifically identified to have restrained joints and for buried piping systems where use of concrete thrust blocks is not practical.
   c. Mechanical locking type to provide positive restraint from joint separation without use of restraining rods, straps, clamps, or setscrew retainer glands.
   d. Minimum pressure rating: 250 psi.

C. Flanged Joints:

1. Flanged pipe for liquid and air service shall be in accordance with AWWA C115.
2. Flanged pipe for gas service shall be in accordance with AWWA C115 and ANSI A21.52. In addition to pipe marking specified in AWWA C115 and ANSI A21.52, conspicuously stamp each flanged pipe with words "AIR TESTED".
3. Fabrication of flanged pipe, including assembly of flange on pipe shall be performed by pipe manufacturer in accordance with AWWA C115. Assembly of flange on pipe outside of manufacturer's shop is unacceptable.
4. Flange material for flanged pipe shall be ductile iron. Flanged pipe with gray iron flanges is not acceptable.
5. Gasket material shall be suitable for service and maximum operating temperature of piping system as specified in piping system specification section. Torque requirement of gaskets shall be less than torque rating of flange, bolt, and nuts.
6. Gaskets shall be ring or full face, 1/8 inch thick, and conform to dimensions shown in Appendices to AWWA C110 and AWWA C115.
7. Bolts:
   a. Size, length, and number as shown in AWWA C110 and AWWA C115.
   b. Material: Carbon steel, ASTM A307, Grade B.
   c. Dimensions: ANSI B18.2.1, heavy hex.
8. Nuts:
   a. Size, length, and number as shown in AWWA C110 and AWWA C115.
   b. Material: Carbon steel, ASTM A307, Grade B.
   c. Dimensions: ANSI B18.2.2, heavy hex.

D. Grooved Joints:

1. AWWA C606.
2. Rigid joint. Pipe ends radius cut grooved to rigid groove specifications.
3. Grooved couplings shall be Victaulic Style 31, or equal.
4. Grooved joint adapter flanges shall be Victaulic Styles 341 or 342, or equal.
5. Gasket material:
   a. Suitable for service and maximum operating temperature of piping system as specified in piping system specification section.
   b. Selected by grooved coupling manufacturer.
6. Coatings for grooved couplings and adapter flanges shall be same product as coatings for pipe.

2.04 FITTINGS

A. Pressure rating shall be 250 psi, minimum.

B. Standard fittings for liquid and air service:

1. Mechanical and push-on joint fittings:
   a. Ductile iron.
   b. AWWA C110 or AWWA C153.
2. Flanged joint fittings:
   a. Ductile iron.
   b. AWWA C110.
   c. Flange dimensions in accordance with AWWA C115.
3. Grooved joint fittings:
   a. Ductile iron.
   b. AWWA C110 except end preparation and wall thickness.
   c. End preparation in accordance with AWWA C606, rigid radius groove.
   d. Minimum wall thickness in accordance with AWWA C153.

C. Special fittings for liquid and air service, not included in AWWA standards, shall be manufacturer's standard, based on AWWA design principles, and in compliance with applicable requirements of AWWA standards.

D. Standard fittings for gas service:

1. Mechanical joint fittings: ANSI A21.14, ductile iron.
2. Flanged joint:
   a. ANSI A21.14, ductile iron.
   b. Flange dimensions in accordance with AWWA C115.

E. Special fittings for gas service, not included in ANSI standard, shall be manufacturer's standard, based on ANSI design principles, and in accordance with applicable requirements of ANSI standard.

F. Wall Pipe and Floor Pipe:

1. Ductile iron.
2. Wall thickness of body equal to or greater than wall thickness of connecting pipe.
3. Flanges set flush with face of concrete shall be tapped for stud bolts.
4. Collar dimensions as shown on plans.
5. Collar cast integral with pipe or fabricated by welded attachment of collar to pipe.
6. Fabricated wall pipe and floor pipe shall be as follows:
   a. Rated for dead end thrust due to 250 psi internal pressure.
   b. Ductile iron collar welded continuously around pipe on both sides of collar.

c. Weld in pipe manufacturer's shop by qualified welder.
d. Electrodes: AWS A5.15, Class ENiFe-CI or AWS 5.6, Class ECuAl-2.
e. Manufacturer: American Cast Iron Pipe Company, or equal.

G. Miscellaneous Fittings:

1. Provide miscellaneous fittings, such as cutting in sleeves, tapping sleeves, caps, plugs, and other fittings, as required for complete system.
2. Manufacturer of miscellaneous fittings shall be same manufacturer as pipe.
3. Miscellaneous fittings shall be suitable for service.

2.05 OUTSIDE COATING

A. Provide buried piping with asphaltic coating in accordance with applicable AWWA and ANSI standards.

B. Surface preparation, priming, and finish coating of non-buried piping shall be compatible and in accordance with Section 09961 as follows:

1. Interior piping: System 42-C except use System 3-C if maximum operating temperature of piping system exceeds temperature rating of System 42-C.
2. Exterior piping: System 46-C except use System 4-C if maximum operating temperature of piping system exceeds temperature rating of System 46-C.
3. Submerged piping in non-potable liquid: System 6-C.
4. Submerged piping in potable water: System 21-C.

C. Finish color for interior and exterior piping shall be as specified in piping system Specification section.

D. Coating for piping embedded in concrete is not required.

2.06 POLYETHYLENE ENCASEMENT

A. Provide polyethylene encasement for buried piping in accordance with AWWA C105.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with piping system Specification section.

B. Buried Piping: In accordance with Section 02316.

3.02 JOINT ASSEMBLY

A. Push-on, mechanical, and grooved joint in accordance with manufacturer's written instructions.

B. Flanged joint in accordance with piping system specification section, flanged pipe manufacturer's written instructions, and gasket manufacturer's written instructions.

3.02 WALL PIPE

A. Support by formwork to prevent contact with reinforcing steel.

B. Install in accordance with Section 03300.

3.03 POLYETHYLENE ENCASEMENT

A. Install in accordance with AWWA C105.

3.04 TAPPING

A. Do not tap polyethylene-lined and glass-lined pipe.

B. Taps for cement-lined and unlined pipe shall be in accordance with pipe manufacturer's instructions.

C. Provide service saddles for tap sizes greater than 1 inch. Service saddles are not required for tap sizes 1 inch and smaller.

* * * END OF SECTION * * *

SECTION 15060
PIPE HANGERS, SUPPORTS, AND ANCHORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. System of pipe supports and anchors with necessary inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, and other accessories.

1.02 DEFINITIONS

A. Submerged: At or below point 1 foot 6 inches above peak (maximum) water surface elevations in water holding structure.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design, detail and installation of pipe support system shall be responsibility of Contractor.
2. Pipe support system components shall withstand dead loads imposed by weight of pipes filled with water plus insulation, plus live loads due to thermal expansion, vibration, internal test pressures, and have minimum safety factor of 5.
3. Absence of pipe supports and details on plans shall not relieve Contractor of responsibility for providing them throughout building.
4. Supply design loading criteria to precast concrete manufacturer for piping supported from precast members.

1.04 SUBMITTALS

A. Shop Drawings:

1. Pipe supporting system, including manufacturer's product data, dimensions, sizes, types, location, maximum loadings, thrust anchorage, and installation instructions.
2. Stamped by Professional Engineer registered in State of Iowa.

B. Submit in accordance with Section 1105 of the Standard Specifications.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. B-Line.

B. Anvil, International, Inc.

C. Carpenter-Patterson.

D. Unistrut.

E. Superstrut.

F. Or equal.

2.02 GENERAL

A. MSS types indicated are typical of types and quality of standard pipe supports and hangers to be employed.

B. Provide factory fabricated piping hangers and supports, clamps, hanger rod attachments, building attachments, saddles, shields, thrust anchorage, and other miscellaneous products of MSS SP-69 type indicated or shop fabricated supports; comply with MSS SP-58 and manufacturer's published product information. Where MSS type not indicated, provide proper selection for installation requirements and comply with MSS SP-69, MSS SP-89 and manufacturer's published product information.

2.03 MATERIALS

A. Hangers, rods, clamps, protective shields, metal framing, support components, and hanger accessories shall be galvanized unless otherwise noted.

B. Hangers, rods, clamps, protective shields, metal framing, support components, and hanger accessories in submerged locations in wet wells, tanks, channels or tank covers shall be Type 316 stainless steel.

2.04 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General:

1. Unless otherwise shown or specified, hangers for 2 1/2 inch and smaller pipe shall be split-ring, adjustable swivel, clevis or roller type, hangers for 3 inch pipe or greater shall be clevis or roller type.
2. Hangers for use with spring supports shall be split-ring or clamp type.
3. Hangers for fiberglass reinforced pipe shall be saddle type.
4. Each hanger shall be designed to permit at least 1 1/2 inch vertical adjustment after installation.

B. Adjustable Swivel Split-Ring Hanger: MSS Type 6.

C. Adjustable Clevis Hanger: MSS Type 1, fabricated from steel.

D. Adjustable Band Hanger: MSS Type 7, fabricated from steel.

E. Adjustable Swivel-Band Hanger: MSS Type 10.

F. Clamp: MSS Type 4.

G. Single Roll Support: MSS Type 41, including axle roller and threaded sockets.

H. Adjustable Roller Hanger: MSS Type 43, including axle roller and clevis.

I. Roll/Stand: MSS Type 44, including roller, stand, and axle.

J. Adjustable Roll/Base: MSS Type 46, including roller, adjustable base, and stand.

K. Steel Brackets: Welded structural steel shapes complying with following.

1. Light Duty: MSS Type 31.
2. Medium Duty: MSS Type 32.
3. Heavy Duty: MSS Type 33.

L. Adjustable Saddle Support:

1. MSS Type 38, including saddle, pipe, and reducer.
2. Fabricate base support from steel pipe and include cast iron flange or welded steel plate.

M. Stanchion Saddle Support:

1. MSS Type 37, including saddle and U-bolt.
2. Fabricate base support from steel pipe and include cast iron flange or welded steel plate.

N. Strap or wire hangers not acceptable.

2.05 VERTICAL PIPING CLAMPS

A. Two Bolt Riser Clamp: MSS Type 8, galvanized or plastic coated.

B. Four Bolt Riser Clamp: MSS Type 42, include pipe spacers at inner bolt holes, galvanized or plastic coated.

2.06 HANGER RODS AND ATTACHMENTS

A. Hanger Rods:

1. ASTM A36, threaded both ends or continuous threaded.
2. Rods shall conform to following sizes.

Pipe Size	Minimum Rod Dia (inch)
Up to 2 inch	3/8
2 1/2-inch and 3 inch	1/2
4 inch	5/8
6 inch	3/4
8 inch to 12 inch	7/8
14 inch and Up	1
Trapeze Hangers	As Required

B. Turnbuckles: MSS Type 13.

C. Weldless Eye Nut: MSS Type 17.

D. Eye Socket: MSS Type 16.

E. Clevis: MSS Type 14.

2.07 BUILDING ATTACHMENTS

A. Individual Concrete Inserts:

1. MSS Type 18, malleable iron.
2. MSS Type 19, steel.

3. Minimum Safe Load: 1,100 pounds.

B. Continuous Concrete Inserts:

1. B-Line.
2. Unistrut.
3. Anvil, International, Inc.
4. Superstrut.
5. Or equal.

C. Top Beam C-Clamp: MSS Type 19.

D. C-Clamps: MSS Type 23, steel.

E. Single-Side Clamp: MSS Type 25.

F. Top I-Beam Clamp: MSS Type 25.

G. Side Beam Clamp: MSS Type 20.

H. Concrete Anchors:

1. Comply with Section 05500.
2. Minimum Safety Factor: 5.

2.08 SADDLES AND SHIELDS

A. Protection Saddles: MSS Type 39.

B. Protection Shields: MSS Type 40.

C. Wood Insulation Saddle:

1. Elcen Metal Products Company.
2. Or equal.

2.09 MISCELLANEOUS MATERIALS

A. Metal Framing Systems:

1. B-Line, galvanized.
2. Unistrut, galvanized.
3. Anvil, International, Inc., galvanized.
4. Superstrut, galvanized.
5. Or equal.

B. Shop-Fabricated Anchors and Supports:

1. Steel Plates, Shapes, and Bars: ASTM A36.
2. Restraining Rods: ASTM A307.
3. Fabricate in accordance with Section 05500.

C. Concrete: Class B in accordance with Section 03300.

PART 3 EXECUTION

3.01 GENERAL

A. Proceed with installation of hangers, supports, and anchors after required building structural work is complete and concrete support structure has reached 28 day compressive strength as specified in Section 03300.

B. Install hangers, supports, clamps, and attachments from building structure. Comply with MSS SP-69. Group parallel runs of horizontal piping to be supported together on trapeze type hangers where possible.

C. Install supports to provide indicated pipe slopes and maximum pipe deflections allowed by ANSI B31.1 are not exceeded.

D. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

E. Do not support piping from other piping.

F. Prevent contact between dissimilar metals. Where concrete or metal pipe support is used, place 1/8 inch thick teflon, neoprene rubber or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and support.

G. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, plastic coated or by other recognized industry methods. Electrician's tape not acceptable isolation method.

H. Apply anti-seize compound to nuts and bolts.

3.02 INSTALLATION OF BUILDING ATTACHMENTS

A. Support piping from structural framing, unless otherwise noted.

B. Concrete Inserts:

1. Locate inserts so total load on insert does not exceed manufacturer's recommended maximum load. Location of inserts shall be approved by Engineer.
2. Where necessary to anchor supports to hardened concrete or completed masonry, use concrete anchors.

C. Attach to structural steel with beam clamps.

3.03 THRUST ANCHORS AND GUIDES

A. Thrust Anchors:

1. For suspended piping, center thrust anchors as closely as possible between expansion joints and between elbows and expansion joints. Anchors shall hold pipe securely and be sufficiently rigid to force expansion and contraction movement to take place at expansion joints or elbows and preclude separation of joints.
2. Provide thrust anchors as required to resist thrust due to changes in dia or direction or dead ending of pipe lines. Anchorage shall be required wherever bending stresses exceed allowable for pipe. Wall pipes may be used as thrust anchors.

B. Pipe guides shall be provided adjacent to sliding expansion joints in accordance with recommendations of National Association of Expansion Joint Manufacturers.

3.04 PIPE SUPPORT

A. Spacing:

Type of Pipe	Maximum Pipe Support Spacing (foot)
Steel	
10 inch and over	22
8 inch	19
6 inch	17
5 inch	16
4 inch	14
3 1/2 inch	13
3 inch	12
2 1/2 inch	11
2 inch	10
1 1/2 inch	9
1 inch	7
3/4 inch	6
1/2 inch	5
Copper	
4- nch	12
3 1/2 inch	11
3 inch	10
2 1/2 inch	9
2 inch	8
1 1/2 inch	8
1 1/4 inch	7
1 inch	5
3/4 inch	5
1/2 inch	5
Plastic (Schedule 80 at 100°F)	
8 inch	9-1/2
6 inch	9
4 inch	7-1/2
3 inch	7
2 inch	6
1 1/2 inch	5 1/2
1 inch	5
3/4 inch	4 1/2
1/2 inch	4 1/2
(For plumbing application plastic piping shall be supported at maximum of 4 foot 0 inch spacing.)	
Stainless Steel	
1 inch and smaller	6
1 1/2 inch through 4 inch	8
6 inch	8
8 inch and 10 inch	10

Type of Pipe	Maximum Pipe Support Spacing (foot)
12 inch	10
14 inch	12
16 inch	12
18 inch and larger	14
Cast Iron and Ductile Iron	
1 inch and smaller	6
1 1/4 inch through 2 1/2 inch	8
3 inch and 4 inch	10
6 inch	12
8 inch	12
10 inch and 12 inch	14
14 inch	16
16 inch and 18 inch	16
20 inch	18
24 inch and larger	18
(For cast iron soil pipe plumbing applications, support at 5 ft 0 in. spacing.)	

B. Where piping of various sizes is to be supported together, space supports for smallest pipe size or install intermediate supports for smaller dia pipe.

C. Provide minimum of two pipe supports for each pipe run.

D. Where piping connects to equipment, support by pipe support and not by equipment, unless approved by equipment manufacturer.

E. Unless otherwise shown or authorized by Engineer, place piping running parallel to walls approximately 1 1/2 inches out from face of wall and at least 3 inches below ceiling.

F. Pedestal pipe supports shall be adjustable with stanchion, saddle, and anchoring flange.

G. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps.

H. Piping passing through sleeves or openings in interior wall sleeves shall be carried by supports or hangers. Do not rest on wall.

I. Support piping in manner preventing undue strain on valve, fitting or equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to nonrigid joints, and where otherwise shown. Do not install pipe supports and hangers in equipment access areas.

J. Install supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Piping shall be free to move when expands or contracts, except where fixed anchors are indicated. Where adequate hanger rod swing length cannot be provided or where pipe

movement based on expansion of 1 inch per 100 feet for each 100°F change in temperature exceed 1/2 inch, provide approved roller supports.

L. Support piping 6 inches and larger on trapeze hangers with rollers.

M. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

N. Coat hangers, clamps, protective shields, metal framing support components, and hanger accessories in accordance with Section 09961.

O. Support plumbing in accordance with COMM 82 of Wisconsin Administrative Code.

3.05 INSULATED PIPING

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8 inches and over, install wood insulation saddles.

C. Where insulation without vapor barrier is indicated, install protection saddles on piping 2 inches and larger.

3.06 BURIED PIPING

A. Provide unlugged bell and spigot or bell tees, Y-branches, and bends deflecting 11 1/4 degrees or more and plugs with reaction blocking, anchors, joint harness or other acceptable means for preventing movement of pipe and joints caused by internal pressure.

B. Concrete Blocking:

1. Extend from fitting to solid undisturbed earth and installed so joints accessible for repair.
2. Bearing area of concrete reaction blocking shall be as shown on plans.
3. If adequate support against undisturbed ground cannot be obtained, install metal harness anchorages consisting of steel rods across joint and securely anchored to pipe and fitting or other adequate anchorage facilities to provide necessary support.
4. Should lack of solid vertical excavation face be due to improper trench excavation, cost of furnishing and installing metal harness anchorages in excess of Contract value of concrete blocking replaced by such anchorages shall be borne by Contractor.

C. Provide reaction blocking, anchorages or other supports for fittings installed in fills or other unstable ground or above grade as shown on plans.

* * * END OF SECTION * * *

SECTION 15075
PIPING AND EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plastic pipe markers.
2. Underground type plastic line marker.
3. Valve tags.
4. Plastic equipment markers.
5. Piping system color coding schedule.

B. Identification furnished as part of equipment is specified as part of equipment assembly in other sections and shall comply with requirements of this section.

C. Refer to Division 16 sections for identification requirements of electrical and instrumentation work, not work of this section.

D. Refer to Division 10 for identification and signage requirements of architectural work, not work of this section.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Regulatory Requirements:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Allen Systems, Inc.

B. Brady (W.H.) Company, Signmark Division.

C. Marking Services, Inc.

D. Industrial Safety Supply Company, Inc.

E. Seton Name Plate Corporation.

F. Or equal.

2.02 MECHANICAL IDENTIFICATION MATERIALS

A. Provide manufacturer's recommended products as specified for each application.

B. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category.

C. Bands, markers, and identification materials used in mechanical rooms and process locations shall be rated for exterior application and suitable for withstanding occasional washdown.

2.03 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations, and other designations used in mechanical identification work with corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or if not indicated, as recommended by manufacturers or required for proper identification and operation and maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown or specified, provide identification indicating individual system number as well as service (i.e., Boiler No. 3, Air Supply Unit No. 10-ASU-2, etc.).

2.04 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide preprinted, semi-rigid snap-on, color coded pipe markers complying with ANSI A13.1.

B. Pressure Sensitive Type: Provide preprinted, permanent adhesive, color coded, pressure sensitive vinyl pipe markers complying with ANSI A13.1. Dot matrix printing is not acceptable.

C. Small Pipes: For external diameters less than 6 inches (including insulation, if any), provide full band pipe markers, extending 360 degrees around pipe at each location, fastened by one of following methods:

1. Snap-on application of pretensioned, semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Taped to pipe (or insulation) with color coded plastic adhesive tape not less than 4 inches wide, full circle at both ends of pipe marker, tape lapped 1 1/2 inches.

D. Large Pipes: For external dia 6 inches and larger (including insulation, if any), provide either full band or strip type pipe markers not narrower than 3 times letter height (and of required length), fastened by one of following methods:

1. Taped to pipe (or insulation) with color coded plastic adhesive tape, not less than 4 inches wide, full circle at both ends of pipe marker, tape lapped 3 inches.
2. Strapped to pipe (or insulation) application of semi-rigid type with manufacturer's standard stainless steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled or shown and abbreviate only as necessary for each application length, and only with approval of Engineer. Lettering height shall be as follows:

Outside Pipe Dia (inch)	Minimum Letter Height (inch)	Minimum Length of Marker (inch)
3/4 to 1 1/4	1/2	8
1 1/2 to 2	3/4	8
2 1/2 to 6	1 1/4	12
8 to 10	2 1/2	24
over 10	3 1/2	32

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

G. Label and band colors in accordance with ANSI A13.1, Pipe Identification Schedule Section 15200 and following:

1. Lettering and arrows:
   a. Black on yellow background for inherently hazardous materials.
   b. White on blue (gaseous) or green (liquid) for low hazard materials.
2. Banding: Colors and band spacing as scheduled or as shown on plans.

2.05 UNDERGROUND TYPE PLASTIC LINE MARKERS

A. Permanent, bright colored, continuous printed plastic tape, intended for direct burial service; not less than 6 inch wide by 4 mils thick. Provide tape with printing most accurately indicating type of service of buried pipe.

B. Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic tape.

2.06 VALVE TAGS

A. Process Valve Tags: Fiberglass valve tags with printed embedded lettering; piping system abbreviation in approximately 3/16 inch high letters, valve numbers approximately 3/8 inch high, and 5/32 inch hole for fastener.

1. Provide 2 1/2 inch by 4 inch square white tags with black lettering.

B. Valve Tag Fasteners: Solid brass chain (wire link or beaded type) or solid brass S-hooks of sizes required for proper attachment of tags to valves, manufactured specifically for purpose.

2.07 PLASTIC EQUIPMENT MARKERS

A. Two ply, 1/8 inch thick laminated engraved plastic.

1. Color: Black letters on white background.

B. Nomenclature: Include following, matching terminology on schedules as closely as possible:

1. Equipment name (i.e. chilled water pump No. 1).
2. Equipment Tag No. (i.e. 30-P-1).

C. Size: Provide approximate 3 inch by 6 inch (minimum) for equipment.

1. 1 inch high letters for equipment tag number.
2. 1/2 inch high letters for descriptive equipment name.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification are to be applied to surfaces requiring insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

A. Locate pipe markers with arrows and color bands as follows wherever piping exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums), and exterior non-concealed locations.

1. Near each valve and control device.
2. Near locations where pipes pass through walls or floors, ceilings or enter non-accessible enclosures.
3. At access doors, manholes, and similar access points permitting view of concealed piping.
4. Near major equipment items and other points of origination and termination.
5. Spaced intermediately at maximum spacing of 30 feet along each piping run, except reduce spacing to 20 feet in congested areas of piping and equipment.
6. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
7. Provide minimum of two pipe labels per pipe run in each area per requirement of NR 110.15(5)(i)(2).

B. Locate color bands at each marker and at intermediate spacing not to exceed 10 feet between bands, and at lesser spacing as indicated or as required by local codes.

C. Locate directional arrows at each marker. Provide two arrows at each tee or branch fitting.

D. Where piping is normally visible from more than one side, provide two or three labels and arrows spaced at 120 degree intervals around pipe in accordance with ANSI A13.1.

E. Painting or Coating:

1. Painting of piping and equipment is work of Section 09961.
2. Colors listed are general. Actual colors will be selected at later date based on approved manufacturer and listed on color coordinating schedule.
3. For piping scheduled to be color-coded, but not scheduled for complete painting (such as some plastic piping or aluminum jacked insulation) provide additional banding to represent background color. At each banding location provide following sequence:
   a. 8 inch wide tape of scheduled pipe color.
   b. 4 inch wide tape of scheduled band color.
   c. 8 inch wide tape of scheduled pipe color.

3.03 UNDERGROUND PIPING IDENTIFICATION

A. During backfilling/top soil placement of each exterior underground piping systems, install continuous underground type plastic line marker located directly over buried line at 6 inch to 8 inch below finished grade. Where multiple small lines buried in common trench and do not exceed overall width of 16 inches, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.04 PROCESS VALVE IDENTIFICATION

A. Install engraved plastic marker or fiberglass tag at each process valve, gate, or flow control device as identified by P&ID tag numbers on plans.

3.05 MECHANICAL EQUIPMENT IDENTIFICATION

A. Install engraved plastic sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, if not otherwise specified for each item or device. Provide signs for each unit having equipment tag number on plans or in Specifications.

3.06 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device visually blocked.

B. Cleaning: Clean face of identification devices and glass frames of valve schedules.

3.07 FIELD QUALITY ASSURANCE

A. Final Survey and Repairs:

1. 1 year after date of substantial completion, Contractor shall perform walk-through survey of mechanical identification systems and shall remove and replace any bands, labels, tags or markers that are loose, discolored, or defective.
2. Replacement materials shall be provided by Contractor, not drawn from Contracting Authority's extra material.

* * * END OF SECTION * * *

SECTION 15120
PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe escutcheons.
2. Dielectric unions.
3. Mechanical sleeve seals.
4. Pipe sleeves and wall collars.
5. Sleeve seals.

1.02 SUBMITTALS

A. Schedule below identifies information required for each item of material or equipment.

Unit Type	Submittal Information Item
Pipe Escutcheons	1
Dielectric Unions	1
Mechanical Sleeve Seals	1
Pipe Sleeves and Wall Collars	1
Sleeve Seals	1

B. Submittal Information:

1. Product Data: Submit manufacturer's technical product data including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

C. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer's equipment used as basis of design for Project is first name indicated in Specification for particular type of equipment or application contained in these contract documents. If no manufacturer listed, basis of design is industry standard indicated.

B. Subject to compliance with requirements above, provide equipment of one of following manufacturers to greatest extent possible.

2.02 PIPING SPECIALTIES

A. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or, if not indicated, provide proper selection as determined by Contractor to comply with installation requirements. Provide sizes as indicated and connections which properly mate with pipe, tube, and equipment connections. Where more than one type indicated, selection is Contractor's option.

2.03 PIPE ESCUTCHEONS

A. Manufacturers:

1. Frost Company.
2. Jones Manufacturing Co., Inc.
3. Or equal.

B. Provide pipe escutcheons with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls or ceilings and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas. Prime paint finish for unoccupied areas.

C. Pipe Escutcheons for Moist Areas: For waterproof floors and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.

D. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.04 DIELECTRIC UNIONS

A. Manufacturers:

1. B&K Industries, Inc.
2. Capital Manufacturing Company, Division of Harsco Corporation.
3. Eclipse, Inc.
4. Epco Sales, Inc.
5. Perfection Corporation.
6. Rockford, Eclipse Division.
7. Or equal.

B. Provide standard products recommended by manufacturer for use in service indicated which effectively isolate ferrous from nonferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.

2.05 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Corporation.
2. Or equal.

B. Modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve.

1. Connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
2. Rated for 40-foot hydrostatic head of water.
3. Stainless steel bolts and nuts.

2.06 FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves and Wall Collars: Provide pipe sleeves and wall collars of one of following.

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from following gauges; 3 inches and smaller, 20 gauge; 4 inch to 6 inch 16 gauge; over 6 inch 14 gauge.
2. Steel Pipe: Fabricate from Schedule 40 carbon steel pipe. Provide welded center flange and hot-dipped galvanized finish for water stoppage.
3. Iron Pipe: Provide cast iron or ductile iron pipe with integrally cast intermediate collar in exterior, water supporting, and water retaining walls and slabs.
4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
5. Mechanical Joints: Provide cast iron or ductile iron wall pipe for exterior locations with tapped holes for follower bolts where shown on plans.
6. Flanged Joints: Provide cast iron or ductile iron wall pipes with flanges tapped for stud bolts set flush with wall face where shown on plans.

B. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade or in exterior walls, of one of following.

1. Elastomeric Joint Sealant: Seal annular space between sleeve and pipe.
2. Mechanical Sleeve Seals: Installed between sleeve and pipe.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SPECIALTIES

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration exposed to view and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole and is flush with adjoining surface.

B. Dielectric Unions: Install at each piping joint between ferrous and nonferrous piping. Comply with manufacturer's installation instructions.

3.02 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves and Wall Collars: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Verify size, location, and type of penetration prior to pouring concrete or placing masonry. Do not install sleeves through structural members of work, except as shown on plans or as reviewed by Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion but not less than pipe sizes larger than piping run. Where insulation includes vapor barrier jacket, provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface except floor sleeves. Extend floor sleeves 2 inches above level floor finish. Provide temporary support of sleeves during placement of concrete and other work around sleeves and provide temporary closure to prevent concrete and other materials from entering sleeves. Center sleeve intermediate collar seepage ring in wall or slab and align

with bolt holes in flanges straddling centerlines horizontally and vertically. Do not allow reinforcing steel to contact wall pipes.

1. Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
2. Install iron pipe sleeves at exterior penetrations; above and below grade before concrete or masonry placed.
3. Install steel or plastic pipe sleeves except as otherwise indicated.

B. Sleeve Seals: Install one of following in annular space between pipes and sleeve walls in exterior water supporting, retaining walls or slabs to form watertight seal.

1. Elastomeric Joint Sealant: Fill and pack annular space between sleeve and pipe with joint filler, seal with sealant, on both sides.
2. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Lighten bolts uniformly until links have expanded to form watertight seal.

3.03 PAINTING AND COATING

A. Do not paint or coat embedded surfaces of wall pipes or sleeves in contact with concrete or masonry.

B. Coat exterior surfaces of wall pipes and sleeves extending beyond embedded surfaces with same system as pipe passing through sleeve or connecting to wall pipe.

* * * END OF SECTION * * *

SECTION 15123
COUPLINGS, FLANGED COUPLING ADAPTERS, AND SERVICE SADDLES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Couplings, flanged coupling adapters, and service saddles required for piping connections on ductile iron or steel piping. Some products specified in this Section may not be required for this Contract. Refer to piping system specification section(s) and plans to determine particular products to be provided under this Contract.

1.02 SUBMITTALS

A. Not required for products identical to those specified by name of manufacturer and model type.

B. For products other than those specified by name of manufacturer and model number, submit information in accordance with requests for substitutions or "Or Equal" items in Section 1105 of the Standard Specifications.

C. Submit information for products that vary from specified requirements regardless of manufacturer name.

PART 2 PRODUCTS

2.01 COUPLINGS

A. Couplings for connecting plain-end steel or ductile iron pipe of same outside diameter:

1. Dresser Style 38.
2. Smith-Blair Product No. 411.

B. Transition couplings for connecting plain-end steel or ductile iron pipe of different outside diameter:

1. Dresser Style 162.
2. Smith-Blair Product No. 413.

C. Insulating couplings for connecting plain-end steel or ductile iron pipe and stopping flow of electrical current:

1. Dresser Style 39.
2. Smith-Blair Product No. 416.

D. Pressure rating shall be greater than test pressure of piping system.

E. Materials:

1. Middle Ring and Gaskets: As selected by manufacturer. Suitable for fluid service and maximum operating temperature of piping system.
2. Followers: Ductile iron or steel.
3. Bolts and Nuts: Manufacturer's standard.

2.02 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters for connecting plain-end steel or ductile iron pipe to flanged pipe, fitting, valve, instrument, or equipment item:

1. Dresser Style 128.
2. Smith-Blair Product No. 913.

B. Pressure rating shall be greater than test pressure of piping system.

C. Materials:

1. Flange: Steel, faced and drilled to 150 pound class in conformance with ANSI B16.5.
2. Body: Steel.
3. Follower: Ductile iron or steel.
4. Gasket: As selected by manufacturer. Suitable for fluid service and maximum operating temperature of piping system.
5. Bolts and Nuts: Manufacturer's standard.

2.03 SERVICE SADDLES

A. Service saddles for tapping pipe sizes 18 inches and smaller shall be double strap design.

1. Dresser Style 91.
2. Smith-Blair Product No. 313.

B. Service saddles for tapping pipe sizes larger than 18 inches shall be triple strap design.

1. Smith-Blair Product No. 366.

C. Materials:

1. Body: Malleable iron or ductile iron.
2. Straps: Steel.
3. Nuts and Washers: Manufacturer's standard.
4. Gasket: As selected by manufacturer. Suitable for fluid service and maximum operating temperature of piping system.

D. Pressure rating greater than test pressure of piping system.

2.04 ANCHORS

A. Provide anchors including, but not limited to, tie rods, lugs, harness assemblies, flanged spool pieces, friction collars and hardware for each coupling, and flanged coupling adapter. Anchors shall restrain pipe to prevent movement out of each coupling and flanged coupling adapter.

B. Design each anchor to sustain force developed by test pressure of piping system.

C. Anchor studs placed perpendicular to longitudinal axis of pipe is unacceptable.

D. Anchorage with welded attachments to ductile iron piping is unacceptable.

2.05 COATINGS

A. Coatings for couplings, flanged coupling adapters, and service saddles shall be same material as coatings for connected pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

* * * END OF SECTION * * *

SECTION 15728
ELECTRICAL ROOM AIR CONDITIONING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Self-contained, vertical, exterior wall mount, through-the-wall air conditioner. Unit shall be factory assembled, pre-charged, pre-wired, tested, and ready to operate.

B. Performance:

1. For air-conditioner unit performance, see Schedule on plans.

1.02 SUBMITTALS

A. Product Data:

1. Submit manufacturer's technical product data including rated capacities of selected model indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and startup instructions.
2. Motors: For poly-phase motors 5 hp and larger, submit in accordance with requirements of Section 16220. For single-phase, definite purpose, special purpose and general purpose poly-phase motors less than 5 hp, submit NEMA design types, construction, insulation class, NEMA frame size, horsepower, voltage and amp draw characteristics, and service factor for each common application.

B. Shop Drawings:

1. Submit manufacturer's product data, accessories, assembly drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
2. Wiring Diagrams:

    a. Manufacturers electrical requirements for power supply wiring to terminal units.
    b. Ladder type wiring diagrams for interlock and control wiring. Differentiate between portions of wiring factory-installed and portions to be field-installed.

C. Operation and Maintenance (O&M) Data:

1. Operating instructions and, maintenance procedures including lubrication instructions, control motor and drive replacement, and spare parts lists.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of condensing units of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Regulatory Requirements:

1. ARI Compliance: Provide capacity ratings for single package vertical air-conditioning units in accordance with ARI 390-2003.
2. ASHRAE Compliance: Construct refrigerating system of condensing units in accordance with ASHRAE 15.
3. Intertek ETL Compliance: Provide air-conditioning units approved and listed by Intertek ETL Listed (ETL US/C).

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handle air-conditioning units and components to prevent damage, breaking, denting, and scoring. Do not install damaged condensing units or components; replace with new.

B. Store air-conditioning units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Rig air-conditioning units to final location under supervision of manufacturer's representative, who shall approve entire rigging operation.

PART 2 PRODUCTS

2.01 TERMINAL AIR CONDITIONING UNIT

A. Manufacturers:

1. Bard Manufacturing Company, Inc.
2. Liebert.
2. Or equal.

B. Cabinet: Construction shall be single, enclosed, weatherproof casing constructed of 20-gauge galvanized steel. Unit base is constructed of 16 gauge galvanized steel. Each exterior casing panel to be bonderized and finished with baked-on exterior polyester enamel paint prior to assembly. Provide manufacturer standard color; beige. Cooling section shall be fully insulated with 1 inch fiberglass. Openings shall be provided for power connections. Access openings appropriate for outside structure to all fan motors and compressor for making repairs and for removing internal components without removing unit from its permanent installation. Fresh air intake and outdoor coil shall be protected from intrusions by sturdy metal grating with less than 1/4 inch openings. Provide supply air plenum and return air acoustical plenum to be mounted to wall inside.

C. Drain Pan: Drain pan shall be constructed of 20 gauge stainless steel.

D. Insulation: Portions of unit that come in contact with indoor air steam shall be insulated with high density 1-inch fiberglass, foil faced insulation.

E. Mounting Brackets: Full-length side mounting brackets shall be integral part of cabinet.

F. Refrigeration System: High efficiency scroll compressor with step capacity providing 2 stages of control. Compressor shall be covered by a 5 year parts warranty. Refrigeration circuit shall be equipped with factory installed high and low pressure controls. Refrigeration control shall be factory installed TXV. Compressor shall be mounted on isolation rails with double grommets. Insulated sound cover shall be provided to reduce compressor noise. Crankcase heater shall be provided. Unit shall be provided with R-410A (HFC) non-ozone depleting refrigerant. Unit shall be provided with liquid line filter/drier. Current sensing relay shall be used to detect high amps caused by high ambient and/or low voltage and to shift compressor to 1st stage operation until conditions corrected.

G. Condenser Fan Motor: Condenser fan motor shall be permanent split capacitor, outdoor motor. Condenser fan and motor shall be in slide out configuration for easy access.

H. Indoor Blower Motor: Indoor blower motor shall be high efficiency, variable speed (ECM) type motor. Motor shall provide soft start, slowly ramping up to speed to provide quiet operation. Motor shall be self-adjusting to provide proper airflow at high static pressures without user adjustment or wiring changes by user. Motor shall be programmed for 20 second ramp up and 60 second down rate for quiet, smooth starting and stopping.

I. Electrical Components: Electrical components are easily accessible for routine inspection and maintenance through front service panels. Circuit breaker is standard on all 208/230 volt models and rotary disconnect standard on all 460 volt models. Circuit breaker/rotary disconnect access is through lockable access panel. Phase rotation monitors shall be installed on all three phase units to prevent reverse rotation.

J. Control Circuit: Internal control circuit shall consist of current limiting 24 volt AC type 50 va transformer. To prevent rapid compressor short cycling, five-minute time delay circuit shall be factory installed. Low-pressure bypass shall be factory installed to prevent nuisance tripped during low temperature start-up.

All units with three phase power shall include factory mounted phase rotation monitor. This advice shall protect scroll compressor from reverse rotation and also protect unit from phase failure. If three phase power is incorrectly connected at field power connections, phase monitor shall lock out unit and red light will illuminate indicating incorrect phase. Also if power leg is lost, phase monitor will lockout unit due to phase imbalance. Once condition is corrected, turning power off at circuit breaker or disconnect will reset phase monitor.

Compressor Control Module shall be factory installed with: built in delay-off timer adjustable from 30 seconds to 5 minutes, 2 minute on-delay if power is interrupted, 120 second bypass for low pressure control and soft and manual lockouts for high and low pressure control.

K. Electric heat shall have factory installed electric resistance heater available that is designed specifically for application in WA S-Series air conditioning units and shall include automatic limit safety controls. See equipment schedule for heating capacity.

L. Filter: Provide 2-inch fiberglass, pleated, disposable filters located within cabinet, filter shall be easily accessible.

M. Warranty: Packaged air-conditioning units shall be free from defects in materials and quality for period of 5 years for compressor, and for period of 5 years for all parts. Warranty period shall start from date of installation as stated on warranty card; or from date of shipment if no warranty card is returned to manufacturer.

N. Controls: Provide complete factory provided control package, complete with following:

1. High pressure control is auto reset.
2. Low pressure control is auto reset.
3. Compressor control module has adjustable 30 second to 5 minute delay-on-break timer. On initial power-up, or any time power delay-on-make will be 2 minutes plus 10% of delay-on-break setting. There is no delay-on-make during routine operation of unit provides lockout feature (with one retry) for high and/or low-pressure controls, and 2 minute timed bypass for low pressure control.
4. Low ambient control permits cooling operation down to 0°F. Alarm relay has set of normally open and normally closed dry contacts to provide ability to signal condition of shutdown on either high or low pressure controls.

5. Incorporates four additional sensors: Discharge air temperature, indoor blower airflow, compressor current, and dirty filter. These sensing devices function to input analog data such as temperature, as well as digital data such as airflow, compressor status or filter status.
6. Digital, programmable, low-voltage thermostat to be mounted within room to maintain interior room temperature of 80°F (field adjustable).
7. Dry bulb economizer control; 100% outside air intake/exhaust.

O. Accessories:

1. Motorized fresh air damper.
2. Free blow acoustical plenum.
3. Return air acoustical plenum.
4. Economizer air intake hood.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which condensing units to be installed. Do not proceed with Work until unsatisfactory conditions corrected.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's installation instructions. Install units plumb and level. Maintain manufacturer's recommended clearances.

B. Support:

1. Install wall-mounted units using manufacturer’s standard mounting components and hardware, securely fastened to building structure.

C. Route condensate PVC piping to grade as required.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas. See Section 01600.
2. Startup air conditioning units in accordance with manufacturer's startup instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

* * * END OF SECTION * * *

SECTION 16050
BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Raceway Systems.
2. Wire, Cables and Connectors.
3. Wiring Devices.
4. Motor and Circuit Disconnects.
5. Fuses.
6. Panelboards.
7. Transformers.

1.02 SUBMITTALS

A. Approval of equipment supplied in this section is contingent upon Contractor verification of available fault current from electric utility.

1. Notify Engineer if available fault current is higher than specified equipment.

B. Product Data:

1. Submit for disconnects, motor starters, panelboards, circuit breakers, overcurrent protective devices, and transformers**.**
2. Product data sheets with printed installation instructions.

C. Shop Drawings:

1. Submit for motor starters.
2. Show enclosure dimensions, nameplate nomenclature, electrical ratings, and thermal unit schedule.
3. Wiring diagrams and schematics.

D. Operation and Maintenance (O&M) Data:

1. Maintenance data for materials and products for inclusion in Operating and Maintenance Manual.

E. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

B. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 PRODUCTS

2.01 METAL CONDUIT AND TUBING

A. Galvanized Rigid Steel Conduit: ANSI C80.1.

B. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

C. Flexible Metal Conduit: Zinc-coated steel.

D. Liquidtight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.

2.02 NONMETALLIC CONDUIT

A. Rigid Nonmetallic Polyvinyl Chloride (PVC) Conduit: NEMA TC 2, Schedule 40 or 80 PVC.

2.03 FITTINGS

A. Fittings for steel conduits:

1. Steel or malleable iron, zinc galvanized or cadmium plated.
2. Do not use set screw or indentor type fittings.
3. Do not use aluminum or die cast fittings.
4. Connectors and Couplings:
   a. Threaded.
   b. Insulated throat.
   c. Gland compression type.
   d. Rain and concrete type.
5. Comply with ANSI C80.4.
6. Comply with NEMA FB 1, compatible with conduit materials.

B. Conduit bodies:

1. Malleable iron with galvanized finish.

C. Fittings for flexible metal conduit.

1. Insulated throat type.
2. Threaded.
3. Grounding type.
4. Liquidtight: One piece sealing "O" rings with connectors when entering boxes or enclosures.

D. PVC Conduit Fittings:

1. NEMA TC 3; match to conduit type and material.

E. Expansion Joints:

1. Conduit expansion fittings complete with copper bonding jumper, Cooper Crouse-Hinds Type XJ.
2. Conduit expansion/deflection fittings with copper bonding jumper, Cooper Crouse-Hinds Type XD.

F. Seals:

1. Wall entrance, OZ/Gedney Type FSK or FSC.

G. Drain Fittings:

1. Automatic Drain Breather:
   a. Explosionproof.
      1) Safe for Class I, Groups C and D.
   b. Capable of passing minimum 25 cc water per minute and minimum 0.05 cubic foot air per minute at atmospheric pressure.
2. Condensate Drain:
   a. Conduit outlet body, Type T.
   b. Threaded, galvanized plug with 3/16 inch drilled holed through plug.

H. Hazardous Areas:

1. Explosionproof.
2. Horizontal seal fittings, Cooper Crouse-Hinds Type EYS.
3. Vertical seal fittings, Cooper Crouse-Hinds Type EYD.
4. Vertical seal fittings shall have drain plug.

2.04 BOXES

A. Of indicated types, sizes and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for use and location. Provide items complete with covers and accessories required for intended use. Provide gaskets for units in damp or wet locations.

B. Fasteners:

1. General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
2. Damp or Wet Locations: Stainless steel screws and hardware.

C. Outlet Boxes:

1. Boxes shall be of type, shape, size, and depth to suit each location and application.
2. Steel Boxes: Sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.
3. Cast Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.

D. Pull and Junction Boxes:

1. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
2. Galvanized Steel Boxes: Flat rolled, code gauge, sheet steel with welded seams. Hot-dip galvanized after fabrication. Cover shall be gasketed.
3. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 304 of ASTM A167. Cover shall be gasketed.
4. Galvanized Cast-Iron Boxes: Molded of cast iron alloy with gasketed cover and integral threaded conduit entrances.

5. Boxes Approved for Classified Locations: Cast metal or cast nonmetallic boxes conforming to UL 886 listed and labeled for use in specific location classification, and with specific hazardous material encountered. Conduit entrances shall be integral threaded type.

2.05 WIRES, CABLES, AND CONNECTORS

A. Building wires and cables with insulation type, cable construction, and rating as required to meet application and NEC requirements.

B. Manufacturers:

1. Wire and Cable:
   a. Southwire.
   b. Houston Wire and Cable.
   c. Belden.
   d. American Insulated Wire Corp.
   e. Republic Wire.
   f. Superior Essex.
2. Connectors:
   a. FCI-Burndy.
   b. Thomas and Betts.
   c. Blackburn, Thomas and Betts.

C. Copper wire only.

D. 600 volt insulation (ASTM standard compounds) and color code conductors for low voltage (secondary feeders and branch circuits) as required by NEC.

1. Type THWN Stranded: Single conductor No. 12 AWG minimum for branch circuit and feeder conductors size No. 8 AWG and smaller.
2. Type XHHW Stranded: Single conductor for branch circuits, feeders, and service conductors larger than No. 8 AWG.
3. Provide grounding conductor when run with circuit conductors with same insulation as circuit conductors.
4. Type THWN Stranded: Single conductor No. 12 AWG minimum for 120 volt control wiring and No. 14 AWG minimum for graphic indication, nonshielded instrumentation and other control wiring operating at less than 120 volt unless otherwise noted on plans.
   a. Provide high density polyethylene jacketed multi-wire cable assemblies in underground conduit or duct.
5. PVC insulation, tinned copper (19 by 27) stranded, No. 16 AWG, twisted pair cabled with aluminum mylar shielding, stranded, tinned, No. 18 AWG copper drain wire, and overall black FR-PVC, 90°C, 600 volt jacket for interference sensitive instrumentation wiring.
   a. Provide high density polyethylene jacket on cables installed below ground and in duct encasements.
6. Vinyl insulated, tinned copper, solid, twisted pair, cabled conductors and silver gray vinyl jacket for telephone inter-communications.
   a. Up to four conductors per cable, No. 22 AWG solid wire.
   b. Over four conductors per cable, No. 24 AWG solid wire.
   c. Provide high density polyethylene jacketed multi-wire cable assemblies in underground conduit or duct.

E. Joints, Taps, and Splices:

1. Joints, Taps, and Splices in Conductors No. 10 AWG and Smaller: UL listed preinsulated compression spring-type solderless connectors.

2. Joints, Taps, and Splices in Conductors No. 8 AWG and Larger: Solderless two or four bolt compression type connectors of type that will not loosen under vibration or normal strains.

F. Terminations:

1. Power Conductors: Compression crimp type lugs. Do not splice.
2. Control and Instrumentation Conductors: Compression crimp type fork tongue, insulated support type lugs on terminal strips. Do not splice.

2.06 WIRING DEVICES

A. Manufacturers:

1. Hubbell Wiring Device Division.
2. Pass and Seymour/Legrand
3. Appleton Electric Company.
4. Cooper Crouse-Hinds Company.

B. Color: Ivory unless otherwise indicated or required by NEC.

C. Switches:

1. General Use Lighting Switches: 20 amp toggle, equal to Hubbell No. 1221-I series.
2. Switches controlling equipment, operation of which is not evident from switch position, shall include flush neon pilot light in conjunction with proper switch. Each switch shall be complete with engraved plate to identify equipment being controlled (white letters on black, 1/8 inch high minimum).

D. Receptacles:

1. General use duplex receptacles: NEMA No. 5-20R, grounding type, 20 amp Hubbell No. 5362 Specification Grade.
2. Special purpose receptacles as shown on plans and schedules.

E. Ground-Fault Circuit Interrupter Receptacles (GFCI).

1. Ratings: 120 volt AC., 20 amp.
2. Tripping Requirement: UL Class A.
3. Construction:
   a. Shallow depth.
   b. Line and load terminal screws.
   c. Noise suppression.
   d. Feed through.
   e. Standard duplex wall plates shall fit.
   f. NEMA 5-20R configuration.
4. Meet requirements of UL 943 ground-fault circuit interrupters.

F. Wiring Device Plates and Covers:

1. Wall plates for wiring devices with ganging and cut-outs as indicated, provided with metal screws for securing plates to devices, screw heads colored to match finish of plate.
2. Plates for Flush Mounted Devices:
   a. Hubbell high-impact smooth nylon in Ivory color.
3. Telephone outlet configuration to match telephone outlet jack or cable, when indicated on plans.

4. Device plates for surface mounted Type FS or FD boxes to be Type FSK galvanized steel.
5. Device plates for surface mounted, 4 inch square boxes to be 1/2 inch raised galvanized steel covers.
6. Weatherproof plates and covers for exterior devices or devices in damp locations to be galvanized gray cast malleable with gasketed, lift cover plate.
7. Weatherproof plates and covers suitable for wet locations while in use.
   a. Hinged and gasketed cover/enclosure to maintain weather tight seal while the equipment is plugged into it. TayMac or equal.

G. Explosionproof Devices:

1. Wiring devices for use in hazardous areas shall be explosionproof approved for Class I, Division 1, Group D areas.
2. Receptacles: Appleton Cat. No. EFS B175-2023M, Cooper Crouse-Hinds Cat. No. ENR 21201 or equal NEMA 5-20R.
3. Plugs: Match receptacles. Furnish one plug for each receptacle installed.
4. Switches: Appleton EFS series, Cooper Crouse-Hinds EDS series or equal.

2.07 MOTOR AND CIRCUIT DISCONNECTS

A. Manufacturers:

1. Square D, Schneider Electric.
2. Eaton Electrical.

B. Safety Switches:

1. NEMA heavy duty Type HD.
2. Dual cover interlock.
3. Visible blades.
4. Provisions for control circuit interlock.
5. Pin type hinges.
6. Tin plated current carrying parts.
7. Quick make and break operator mechanism.
8. Handle attached to box, not cover.
9. Handle position indication, On in up position, Off in down position.
10. Padlock provisions for up to three padlocks in On and Off position.
11. UL listed lugs for type and size of wire specified.
12. Spring reinforced fuse clips for Class R fuses.
13. Provisions for insulated or groundable neutral.
14. UL listed short circuit rating 200,000 RMS amp with Class R fuses.

C. Enclosures:

1. NEMA 1 in electrical equipment rooms
2. NEMA 4X stainless steel with watertight hubs for outdoor and wet locations or as indicated on plans.
3. NEMA 7 in hazardous classified locations.
4. As otherwise indicated and as required by NEC.

2.08 FUSES

A. Manufacturers:

1. Cooper Bussmann.
2. Ferraz Shawmut.

3. Littelfuse.

B. 250v Fuses:

1. Class RK 1, 1-end rejection or to fit mountings specified, 1/10 to 600 amps, 200,000 amp interrupting rating.
   a. Bussmann Low-Peak. LPN-R, dual element, time delay with short circuit protection for motor, transformer, welder, feeder, and main service protection.

C. 600v Fuses:

1. Class RK 1, 1-end rejection or to fit mountings specified, 1/10 to 600 amps, 200,000 amp interrupting rating.
   a. Bussmann Low-Peak. LPS-R, dual element, time delay with short circuit protection for motor, transformer, welder, feeder and main service protection.
2. Class L, bolt-in, 601 to 6 000 amps, 200,000 amp interrupting rating.
   a. Bussmann HI-CAP. KRP-C, time delay for overload and short circuit protection for motor, transformer, feeder, and main service protection.
3. Class CC, fast acting, single element, 1/10 to 30 amps, 200,000 amp interrupting rating.
   a. Bussmann Limitron. KTK-R, UL listed for motor control circuits, lighting ballasts, control transformers, and street lighting fixtures.

D. Spare Fuses:

1. 10%, minimum of three, of each type and rating of installed fuses.

2.09 PANELBOARDS

A. Manufacturers:

1. Square D, Schneider Electric.
2. Eaton Electrical.

B. Panelboard Ratings:

1. UL listed short circuit rating (integral equipment rating):
   a. Up to 240 Volts: 22,000 RMS symmetrical amp minimum or as indicated on plans.
   b. Up to 480 Volts: 65,000 RMS symmetrical amp minimum or as indicated on plans.
   c. As shown on plans.

C. Panelboard Construction:

1. Main breaker or main lugs only, per panelboard schedule.
2. Surface mounted as indicated on panelboard schedule.
3. NEMA Type 1 enclosure, unless otherwise indicated on panelboard schedule.
4. Equipment ground bus adequate for feeder and branch-circuit equipment ground conductors, bonded to box.
5. Listed for use as service equipment for panelboards with main service disconnect.
6. Molded case circuit breakers.
7. Terminals:
   a. UL listed for type of wire specified.
   b. Anti-turn solderless compression type.
8. Bussing:
   a. Distributed phase sequence type.
   b. 225 amps, 98% conductivity hard drawn copper or as shown on panelboard schedule or plans.

c. Copper.
d. Bussing and mounting hardware behind all usable space.

9. Gutters adequate for wire size used, 4 inch minimum.
10. Boxes:
    a. Code gauge galvanized steel.
    b. Without knockouts.
11. Fronts:
    a. Rust inhibiting primer, baked enamel finish.
    b. Dead front safety type.
    c. Concealed hinges.
    d. Flush stainless steel cylinder tumbler type locks with spring loaded door pulls.
    e. Circuit Directory:
        1) Suitable for complete descriptions.
        2) Clear plastic cover.
        3) Typewritten card.
12. Special features as shown on plans.
13. Engraved laminated nameplate:
    a. Stock melamine plastic laminate.
    b. Legend in black letters on white face and punched for mechanical fasteners.
    c. Except as otherwise indicated, provide single line of text, with 1/2 inch high lettering on 1 1/2 inch high label (2 inches high where two lines are required). Text shall match terminology and numbering of contract documents and Shop plans.

D. Panelboard Circuit Breakers:

1. Thermal and magnetic protection.
2. Single-handle common trip, 2 and 3 poles (handle ties not acceptable).
3. Bolt-on type unless otherwise noted on plans.
4. Quick make and break toggle action.
5. Handle trip indication.
6 Handle position indication, On, Off, and Tripped centered.
7. UL listed for type of wire specified.
8. UL listed short circuit rating (integrated equipment rating).
    a. Up to 240 Volts: 22,000 RMS symmetrical amp minimum.
    b. Up to 480 Volts: RMS symmetrical amps as indicated on plans.

2.10 TRANSFORMERS

A. Manufacturers:

1. Square D, Schneider Electric.
2. Eaton Electrical.

B. Materials and Equipment:

1. Dry type, air cooled.
2. Insulation:
    a. 30 kVa and below: Class F or better, having 239°F rise, average maximum over 104°F ambient temperature.
3. Copper windings.
4. Cores: High grade, non-aging, sheet silicone steel laminations having core plating insulation on both sides of each lamination.
5. Terminal boards.
6. Taps: Two 2 1/2% taps above and below.
7. Overload Capacity: Not less that 10% for intermittent operation.
8. Size: kVa as indicated on plans and schedules.

9. Transformers shall be quiet type for installation in areas of low ambient noise levels. Maximum sound levels shall not exceed NEMA standards.
10. Cabinets: Sheet steel, phosphatized having one prime coat and two finish coats of baked enamel.
    a. Indoor, ventilated unless otherwise indicated.
    b. Wall mounting brackets through 75 kVa when indicated as wall mounted.
11. Nameplate: Metal nameplate listing manufacturer's name, serial number, type, class, kVa voltage, frequency, and showing internal wiring diagram.
12. Comply with UL 506.

PART 3 EXECUTION

3.01 RACEWAY SYSTEMS

A. Outdoors, Damp or Wet Locations: Use following wiring methods unless otherwise noted on plans:

1. Exposed: PVC-coated steel conduit.
2. Concealed: Galvanized rigid steel.
3. Underground Power: Rigid nonmetallic (PVC) schedule 80 conduit and PVC-coated steel conduit.
4. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.

B. Indoor Dry Locations: Use following wiring methods unless otherwise noted on plans.

1. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit.
2. Exposed: Galvanized rigid steel conduit.

C. Hazardous Classified Locations: Use following wiring methods unless otherwise noted on plans.

1. Exposed and Concealed: Galvanized rigid steel conduit.

D. Use 3/4 inch minimum trade size conduit unless otherwise noted except conduit runs to room light switches may be 1/2 inch.

E. PVC schedule and 80 conduit and PVC coated galvanized rigid steel conduits may be used underground without concrete encasement. PVC conduit may be used without concrete encasement for underfloor conduit or where specifically indicated on plans.

1. Underground conduit shall be minimum of 1 inch, buried at depth of not less than 24 inches below grade.
2. Provide conduits or ducts terminating below grade with means to prevent entry of dirt and moisture.
3. When using PVC conduit provide PVC coated galvanized rigid steel elbows.
4. Slope conduit min 1 inch per 100 feet as indicated on plans.

F. Raceways Embedded in Slabs: Comply with Section 03300 and the following:

1. Use galvanized rigid steel conduit.
2. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
3. Space raceways laterally to prevent voids in concrete.
4. Install in middle third of slab thickness where practical, and leave at least 1 inch concrete cover.

5. Run conduit larger than 1 inch trade size parallel to or at right angles to main reinforcement and spaced on center of at least three times conduit trade diameter with minimum 2 inch concrete covering. Conduits over 1 inch may not be installed in slab without approval of Engineer.
6. When at right angles to reinforcement, place conduit close to slab support.
7. Conduits embedded in concrete frame shall comply with applicable provisions of ACI 318.

G. Raceways Embedded in Slabs: Following restrictions shall be adhered to, unless otherwise noted.

1. Use galvanized rigid steel conduit.
2. No conduit placed vertically shall be larger in cross-sectional area than 4% of column into which it is placed.
3. Conduits, when placed within slab and walls, shall not be larger than 1/3 thickness of slab or wall nor placed closer than three outside diameters clear from each other.
4. Reinforcing steel shall be in-place before embedded items placed and reinforcing cut or removed shall be replaced with additional reinforcing as indicated on plans or approved by Engineer.
5. Do not pass sleeves through columns without Engineer's approval.
6. Do not place conduits in slabs on grade. Place minimum 4 inches under bottom of slab.
7. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
8. Space raceways laterally to prevent voids in concrete.
9. Install in middle third of slab thickness where practical, and leave at least 1 inch concrete cover.
10. Run conduit larger than 1 inch trade size parallel to or at right angles to main reinforcement and spaced on center of at least three times conduit trade diameter with minimum 2 inch concrete covering. Conduits over 1 inch may not be installed in slab without approval of Engineer.
11. When at right angles to reinforcement, place conduit close to slab support.
12. Conduits embedded in concrete frame shall comply with applicable provisions of ACI 318.

H. Examine surfaces to receive raceways, wireways, and fittings for compliance with installation tolerances and other conditions affecting performance of raceway system.

I. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

J. Complete conduit installation prior to installing cables.

K. Raceway systems shall be continuous from outlet to outlet and from outlets to cabinets, junction or pull boxes.

L. Enter and secure to boxes ensuring electrical continuity from point of service to outlets.

M. Conduit shall be run concealed except exposed surface conduit may be installed where noted on plansor where concealment found to be impractical or impossible, and only with approval of Engineer.

N. Provide watertight conduit system where installed in wet places, underground or where buried in masonry or concrete.

1. Use threaded hubs when entering top of enclosures.
2. Use sealing type locknuts when entering sides or bottom of enclosures.

O. Conduit runs extending through areas of different temperature or atmospheric conditions or partly indoors and partly outdoors shall be sealed, drained, and installed in manner preventing drainage of condensed or entrapped moisture into cabinets, motors or equipment enclosures.

P. Route conduit runs above suspended acoustical ceilings not interfering with tile panel removals.

Q. Cap conduits after installation to prevent entry of debris.

R. Connections to motors and equipment subject to vibration shall be maximum of 3 feet long. Locate where least subject to physical abuse.

S. Install conduit expansion fittings complete with bonding jumper in following locations.

1. Conduit runs crossing structural expansion joint.
2. Conduit runs attached to two separate structures.
3. Conduit runs where movement perpendicular to axis of conduit may be encountered.

T. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

U. Install separate ground conductor inside flexible conduit connections.

V. Use approved flexible connections in hazardous locations.

W. Use explosionproof fittings and seals in hazardous areas in accordance with NEC.

X. PVC Coated Galvanized Rigid Steel Conduit: Use only fittings approved for use with that material. Patch nicks and scrapes in PVC coating after installing conduit.

Y. Transition under floor conduit to galvanized rigid steel conduit before rising above floor. Wrap with plastic tape to provide 40 mil thick cover to height of 6 inches above floor or use PVC coated steel conduit.

3.02 BOXES

A. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

B. Support and fasten items in accordance with Section 16070.

C. Do not burn holes, use knockout punches or saw.

D. Provide outlet box accessories as required for each installation such as mounting brackets, fixture studs, cable clamps, and metal straps for supporting outlet boxes compatible with outlet boxes being used and meeting requirements of individual wiring situations.

E. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

F. Locations of outlets and equipment shown on plans are approximate. Verify exact location.

G. Flush outlets shall have edges or plaster flush with finished wall or ceiling surfaces so plates can be drawn tightly to wall or ceiling surfaces.

H. Minor modification in location of outlets and equipment is considered incidental up to distance of 10 feet with no additional compensation, provided notification of modification is given prior to roughing in of outlet.

I. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types for each location in conformance with following requirements unless otherwise noted on plans:

1. Interior Dry Locations: Sheet steel, NEMA type 1 for flush mounting and feraloy Type FS or FD cast boxes with threaded conduit hubs for surface mounting.
2. Locations Exposed to Weather or Dampness: Galvanized, cast metal, NEMA Type 4X, stainless steel.
3. Wet Locations: Stainless Steel, NEMA type 4X enclosures.
4. Corrosive Locations: Stainless Steel, NEMA type 4X enclosures.
5. Hazardous (Classified) Locations: NEMA type listed and labeled for location and class of hazard indicated.

J. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location.

K. Mounting height as follows unless otherwise shown on plans:

1. Switches: 48 inches above floor.
2. AC Receptacles and Telephone Outlets: 15 inches above floor or 6 inches above counters, counter back-splashes, and baseboard radiators in finished areas; 48 inches above floor in unfinished areas.
3. Pushbuttons: 48 inches above floor.
4. Motor Starters and Disconnect Switches: 60 inches above floor.
5. Thermostats: 60 inches above floor.

L. Lighting Fixture Outlet Boxes:

1. Securely mount with approved type bar hangers spanning structural members to support weight of fixture.
2. Do not support from conduit.
3. Equip with 3/8 inch fixture stud and tapped fixture ears.

3.03 WIRE AND CABLE

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA "Standard of Installation".

B. Run wire and cable in conduit unless otherwise indicated on plans.

C. On branch circuits, use standard colors.

D. Run ground wire with power circuits; conduit shall not be grounding path.

E. Provide separate conduit systems for following.

1. Line voltage control.
2. Low voltage control.
3. Shielded instrumentation.
4. Telephone system.
5. Utility telephone cables.
6. Exit lights.
7. As required by NEC.

F. Run instrumentation cable into control cabinets or MCC only if terminated therein.

G. Terminate control, instrumentation, and communication cables on terminal strips in separate terminal cabinets located near conduit entrances of buildings or as shown on plans.

H. Color Coding: Conductors for lighting and power wiring as indicated below.

Phase	208/120 Volt	480/277 Volt
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Travelers	Pink	Purple
Neutral	White	White with non-green stripe or grey*
Ground	Green	Green

*Provide permanently posted at each feeder panelboard or similar feeder distribution equipment the identification method utilized for conductors originating within each feeder panelboard or similar feeder distribution per NEC 255.12(C)(1)(b).

I. Color coding for intrinsically safe systems shall be light blue.

3.04 JOINTS, TAPS, AND SPLICES

A. Where preinsulated spring connectors are used for motor and equipment connections, tape connector to wire to prevent loosening under vibration.

B. Each tap, joint or splice in conductors No. 8 AWG and larger shall be taped with 2 half-lap layers of vinyl plastic electrical tape and finish wrap of color coding tape where required by code.

C. Cable splices shall be made only in handholes**,** wireways, distribution boxes, and junction boxes.

3.05 WIRING DEVICES

A. Do not install devices until wiring is complete.

B. Do not use terminals on wiring devices (hot or neutral) for feed-through connections, looped or otherwise. Make circuit connections by using wire connectors and pigtails.

C. Install gasket plates for devices or system components having light emitting features such as switch with pilot light and dome lights. Where installed on rough textured surfaces, seal with black self-adhesive polyfoam.

D. Ground receptacles with insulated green ground wire from device ground screw to bolted outlet box connection or as shown on plans.

E. Install GFCI receptacles as required by NEC.

3.06 MOTOR AND CIRCUIT DISCONNECTS

A. Locate disconnect switches as shown on plans and required by NEC.

B. Provide control circuit interlock as required by NEC.

C. Overcurrent protective devices.

1. Install fuses just prior to energizing equipment.
2. Locate circuit breakers as shown on plans.

D. Install on equipment rack or anchor firmly to wall or structural surface.

E. Support and fasten in accordance with Section 16070.

3.07 PANELBOARDS

A. Support panel cabinets independently to structure with no weight bearing on conduits.

B. Install panelboards so top breaker is not higher than 6 foot 0 inches above floor.

C. Adjacent panel cabinets shall be same size and mounted in horizontal alignment.

D. Install typewritten directory in each panelboard, accurately indicating rooms or equipment being served after final circuit changes have been made to balance circuit loads.

E. Install filler plates in unused spaces.

3.08 TRANSFORMER

A. Install wall mounted transformers on prefabricated brackets designed for that purpose.

B. Tighten bus connections and mechanical fasteners.

C. Adjust voltage taps for required system voltage and check grounding requirements.

3.09 FIELD QUALITY CONTROL

A. Control Circuits, Branch Circuits, Feeders, Motor Circuits, and Transformers:

1. Megger check of phase-to-phase and phase-to-ground insulation levels.
   a. Do not megger check solid state equipment.
2. Continuity.
3. Short circuit.
4. Operational check.

B. Wiring Devices:

1. Test receptacles with Hubbell 5200, Woodhead 1750 or equal tester for correct polarity, proper ground connection, and wiring faults.

3.10 ADJUSTMENT AND CLEANING

A. Motor Starters and Disconnects:

1. Adjust covers and operating mechanisms for free mechanical movement.
2. Tighten wire and cable connections.
3. Verify overcurrent protection thermal unit size with motor nameplate to provide proper operation and compliance with NEC.
4. Clean interior of enclosures.
5. Touch up scratched or marred surfaces to match original finish.

B. Circuit Breakers:

1. Adjustable settings shall be set to provide selective coordination, proper operation, and compliance with NEC.

* * * END OF SECTION * * *

SECTION 16060
GROUNDING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems.
2. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

1.02 SUBMITTALS

A. Report of Field Tests and Observations: Certified by testing agency.

B. Test Results:

1. Certified field tests and observation reports indicating and interpreting test reports for compliance with performance requirements.

C. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Section 01458 independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be full member company in InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing.

B. Comply with UL 467.

C. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

D. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, more stringent requirements and greater size, rating, and quantity indications govern.

2.02 WIRE AND CABLE GROUNDING CONDUCTORS

A. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

1. Material: Copper.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Grounding-Electrode Conductors: Stranded cable.

D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Assembly of Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.

2.03 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.

C. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.04 CONNECTOR PRODUCTS

A. Pressure Connectors: High-conductivity-plated units.

B. Bolted Clamps: Heavy-duty type.

C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.05 GROUNDING ELECTRODES AND TEST WELLS

A. Grounding Rods: Copper-clad steel.

1. Size: 3/4 inch by 120 inches.

B. Test Wells: Fabricate from 15 inches long, square-cut sections of 8 inch diameter, Schedule 80, PVC pipe or as detailed on plans.

PART 3 EXECUTION

3.01 APPLICATION

A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

1. Install equipment grounding conductor with circuit conductors for items below in addition to those required by Code:
   a. Feeders and branch circuits.
   b. Lighting circuits.
   c. Receptacle circuits.
   d. Single-phase motor or appliance branch circuits.
   e. Three-phase motor or appliance branch circuits.
   f. Flexible raceway runs.
2. Non-Metallic Raceways: Install equipment grounding conductor in non-metallic raceway unless designed for telephone or data cables.

B. Piping Systems and Other Equipment: Comply with NEC Article 250 for bonding requirements.

3.02 INSTALLATION

A. Ground electrical systems and equipment according to NEC requirements, except where plans or Specifications exceed NEC requirements.

B. Grounding Rods: Locate minimum of 1 rod length from each other and at least same distance from any other grounding electrode.

1. Drive until tops are 2 inches below finished floor or final grade, except as otherwise indicated.
2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.

C. Grounding Conductors: Route along shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches below grade.

E. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

G. Test Wells: One for each driven grounding electrode system, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1 inch maximum-size crushed stone or gravel.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC Paragraph 250-81(c), using minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. Where base of concrete foundation is less than 20 feet in length, coil excess conductor within base of concrete foundation. Bond grounding conductor to reinforcing steel to at least four locations, and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.03 CONNECTIONS

A. Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on grounding conductor.

H. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Handholes:

1. Install driven grounding rod close to wall and set rod depth so 4 inches will extend above finished floor.
2. Where necessary, install grounding rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from grounding rod into manhole through waterproof sleeve in manhole wall.

3. Protect grounding rods passing through concrete floor with double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete.
4. Seal floor opening with waterproof, nonshrink grout.

B. Connections to Components:

1. Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor.
2. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire.
3. Train conductors plumb or level around corners and fasten to manhole walls.
4. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Grounding System:

1. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.05 FIELD QUALITY CONTROL

A. Test in accordance with Section 01458.

B. Testing Agency: Provide services of qualified independent testing agency to perform specified acceptance testing.

C. Testing: Upon completion of installation of ground-fault protection system and after electrical circuits have been energized, demonstrate capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.13. Certify compliance with test parameters.

D. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

E. Maximum grounding to resistance values are as follows:

1. Equipment Rated 500 kVA and Less: 10 ohms.
2. Equipment Rated 500 to 1000 kVA: 5 ohms.
3. Equipment Rated More than 1000 kVA: 3 ohms.
4. Hanghole Grounds: 10 ohms.

F. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

G. Report: Prepare certified test reports, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.06 RESTORATION

A. Restore disturbed surfaces in accordance with Section 02900.

* * * END OF SECTION * * *

SECTION 16070
SUPPORTING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Supports from building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 QUALITY ASSURANCE

A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

B. Regulatory requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel or malleable iron.

B. Aluminum where indicated.

C. Stainless steel where indicated.

2.02 COATINGS

A. Protect steel and malleable iron supports, support hardware, and fasteners with zinc coating.

B. Products for use outdoors.

C. Use PVC coating where indicated on plans.

2.03 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.
3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for intended service.
4. Nuts, Washers, and Bolts: Stainless steel in outdoor applications.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers.

E. U-Channel Systems: Channels, with 9/16 inch diameter holes, at minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

2.04 FABRICATED SUPPORTING DEVICES

A. Shop- or field-fabricate supports or manufacture supports assembled from U-channel components.

B. Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports. Comply with Section 05500.

C. Pipe Sleeves: Provide pipe sleeves of one of following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from following gauge metal for sleeve diameter noted:
   a. 3 inches and smaller: 20 gauge.
   b. 4 inches to 6 inches: 16 gauge.
   c. Over 6 inches: 14 gauge.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

2.05 FIRE RESISTANT JOINT SEALERS

A. Manufacturers:

1. "Dow Corning Fire Stop Foam," Dow Corning Corp.
2. "Pensil 851," General Electric Co.
3. Or equal.

B. Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.

C. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with structural system and with other electrical installation.

C. Raceway Supports: Comply with NEC and following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least 4. Where this determination results in safety allowance of less than 200 pounds, provide additional strength until there is minimum of 200 pounds safety allowance in strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. In vertical runs, arrange support so load produced by weight of raceway and enclosed conductors is carried entirely by conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

F. Sleeves: Install in concrete slabs and walls and other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.

G. Conduit Seals: Install seals for conduit penetrations of slabs below grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

H. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut in concrete shall not cut main reinforcing bars. Fill holes that are not used.
3. Load applied to any fastener shall not exceed 25% of proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

* * * END OF SECTION * * *

SECTION 16075
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Identification of electrical materials, equipment, and installations.

1.02 SUBMITTALS

A. Product Data:

1. Submit for each type of product specified.

B. Samples:

1. Submit for each color, lettering style, and or graphic representation required for identification materials; samples of labels and signs.

C. Miscellaneous:

1. Schedule of identification nomenclature to be used for identification signs and labels.

D. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Electrical Code: Components and installation shall comply with NFPA 70.

PART 2 PRODUCTS

2.01 RACEWAY AND CABLE LABELS

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.

B. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.
2. Legend: Indicates voltage.

C. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

D. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:

1. Size: Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct burial service.

3. Embedded continuous metallic strip or core.
4. Printed Legend: Indicates type of underground line.

E. Tape Markers: Vinyl or vinyl cloth, self adhesive, wraparound type with preprinted numbers and letters.

2.02 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.

B. Engraving stock, melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, 1/8 inch thick for larger sizes.

1. Engraved Legend: Black letters on white face.
2. Punched for mechanical fasteners.

C. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 inch grommets in corners for mounting.

D. Exterior, Metal Backed, Butyrate Signs: Wear resistant, nonfading, preprinted, cellulose acetate butyrate signs with 0.0396 inch galvanized steel backing, with colors, legend, and size appropriate to application. 1/4 inch grommets in corners for mounting.

E. Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon cable ties with following features:

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 pound minimum.
3. Temperature Range: -40°F to 185°F.
4. Color: As indicated where used for color coding.

B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in contract documents or required by codes and standards. Use consistent designations throughout Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
3. Apply one intermediate and one finish coat of silicone alkyd enamel.
4. Apply primer and finish materials according to manufacturer's instructions.

G. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Pressure sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card stock tags.
3. Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.

H. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 16 inches, use single line marker.

1. Install line marker for underground wiring, both direct buried and in raceway.

I. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.

1. Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than No. 10 AWG.
   a. Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
   b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from terminal and spaced 3 inches apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.
2. 208/120-Volt System: As follows:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Neutral: White.
   e. Ground: Green.
3. 480/277 Volt System: As follows:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: White with non-green stripe or grey*.
   e. Ground: Green.

   *Provide permanently posted at each feeder panelboard or similar feeder distribution equipment the identification method utilized for conductors originating within each feeder panelboard or similar feeder distribution per 2014 NEC 255.12(C)(1)(b).

J. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4 inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Fasten tags with nylon cable ties; fasten bands using integral ears.

K. Apply identification to conductors as follows:

1. Conductors to Be Extended in Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
3. Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.

L. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.

M. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2 inch high lettering on 1 1/2 inch high label; where two lines of text are required, use lettering 2 inches high. Use black lettering on white field. Apply labels for each unit of following categories of equipment.
   a. Panelboards, electrical cabinets, and enclosures.
   b. Electrical switchboards.
   c. Motor control centers.
   d. Motor starters.
   e. Push button stations.
   f. Power transfer equipment.
   g. Control devices.
   h. Transformers.
2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

* * * END OF SECTION * * *

SECTION 16210
ELECTRIC SERVICE

PART 1 GENERAL

1.01 SUMMARY

A. Electric Utility Charges:

1. Electric Utility charges for extension of distribution system to point of service termination and meters will be paid by Contracting Authority.

1.02 DEFINITIONS

A. Electric Utility: Mid-American Energy.

1. Contact Alycia Rourke at 319.291.4709.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Fire Protection Association (NFPA):
   a. NFPA No. 70-93 - National Electrical Code (NEC).

PART 2 PRODUCTS

2.01 ELECTRIC SERVICE

A. Electric Service Characteristics:

1. As indicated on plans and provided by Electric Utility.

PART 3 EXECUTION

3.01 PREPARATION

A. Confirmation of Electric Service:

1. Consult with Electric Utility to verify service information specified and shown on plans.
2. Include deviations required by Electric Utility from contract documents to comply with Electric Utility standards and requirements.

B. Metering:

1. Consult with Electric Utility regarding service entrance requirements and metering equipment.
2. Install metering equipment and empty conduit for metering conductors to meet standards and requirements of Electric Utility.

C. Application for Electric Service.

1. Obtain required forms from Electric Utility.
2. Assist Contracting Authority in completion of forms and deliver completed forms to Electric Utility.

3. Coordinate schedule for installation of electric service with Electric Utility.

* * * END OF SECTION * * *

SECTION 16420
MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. AC motor-control devices rated 600 volt and less that are supplied as enclosed units.

1.02 SUBMITTALS

A. Product Data:

1. Include dimensions, ratings, and data on features and components.

B. Shop Drawings: For each controller center specified in this Section. Include dimensioned drawings, elevations, and component lists. Show ratings, including short-time and short-circuit ratings.

1. Schedule of features, characteristics, ratings, and factory settings of individual units.
2. Wiring Diagrams: Interconnecting wiring diagrams pertinent to class and type specified for and schematic diagram of each type of controller unit indicated.

C. Test Results:

1. Certified reports of field tests and observations.

D. Operation and Maintenance Data (O&M):

1. Maintenance data for motor controllers.

E. Miscellaneous:

1. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
2. Certificates for Field Testing Agency: Signed by Contractor, certifying that agency complies with requirements specified in "Quality Assurance" Article below.

F. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: In addition to requirements specified in Section 01458 independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be full member company in InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing.

C. Source Limitations: Obtain similar motor-control devices through one source from single manufacturer.

D. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

E. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.04 COORDINATION

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.05 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses and Incandescent Indicating Lamps: Furnish one spare for every five installed units, but not less than one set of three of each kind.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Allen Bradley/Rockwell Automation

B. Cutler-Hammer/Eaton.

C. Square D Co.

2.02 MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across line, unless otherwise indicated.

B. Control Circuit: 120 volt; obtained from integral control power transformer, unless otherwise indicated. Include control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

1. Nonfusible Disconnect: NEMA KS 1, heavy-duty, nonfusible switch.

D. Overload Relay:

1. Electronic solid state type with inverse-time-current characteristic, phase loss and phase unbalance protection for size 2 and larger.
2. Provide NEMA Class 20 heaters or sensors in each phase matched to nameplate full load current of specific motor to which connected with appropriate adjustment for duty cycle.
3. Enhanced Protection Overload Relay: Provide overload relays with NEMA Class 10 or better tripping characteristics for submersible equipment or where indicated. Select to protect motor against voltage unbalance and single phasing.

E. When power factor correction capacitors are indicated provide termination lugs on line side of overload relays.

F. Time Delay Restart Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection.

1. Provide in starter enclosure for Size 2 and larger starters.
2. Delay initial motor start.
3. Delay motor restart due to starter dropout caused by undervoltage or starter coil circuit interruption for maintained control circuits.
4. Adjustable on delay from 0.15 to 30.0 seconds set at 10.0 seconds.
5. Connect control relay in motor starter coil circuit.
6. Coordinate control relay section with motor starter to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

2.03 ENCLOSURE

A. Meet environmental conditions of installed location.

1. Provide NEMA-250 Type 1 enclosure in electrical equipment rooms and NEMA-250 Type 12 enclosure for other indoor locations unless otherwise indicated.

PART 3 EXECUTION

3.01 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Use manual controllers for three phase motors only as indicated.

E. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

F. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment where indicated.

3.02 INSTALLATION

A. Install independently mounted motor-control devices according to manufacturer's written instructions.

B. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

C. 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 conforming to Section 16070.

D. Install freestanding equipment on concrete housekeeping bases conforming to Section 03300.

3.03 IDENTIFICATION

A. Identify motor-control components and control wiring according to Section 16075.

3.04 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Section 16050.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic control devices.

1. Connect selector switches to bypass only manual and automatic control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 CONNECTIONS

A. Tighten connectors, terminals, bus joints, and mountings. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by City for minimum man-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of City’s personnel for plant operation. Include:
   a. 1 man-day for Installation Services.
   b. 1/2 man-day for Instructional Services.
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01600.
3. Manufacturer's Field Services: Provide services of factory-authorized service representative to supervise field assembly and connection of components, including pretesting and adjustment of solid-state controllers.

B. Testing Agency: Provide services of qualified independent testing agency to perform specified testing.

C. Testing: After installing motor controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Sections 7.5, 7.6, and 7.16. Certify compliance with test parameters.
2. Remove and replace malfunctioning units with new units, and retest.

3.07 ADJUSTING

A. Time Delay Restart Relay:

1. Adjust control relay to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

B. Set field-adjustable pick-up and time-sensitivity ranges in accordance with Section 16030.

3.09 CLEANING

A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

* * * END OF SECTION * * *

SECTION 16443
MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Motor-control centers for use on ac circuits rated 600 volt and less.

1.02 SUBMITTALS

A. Product Data:

1. Include dimensions, ratings, and data on features and components.

B. Shop Drawings: For each motor-control center specified in this Section. Include dimensioned plans, elevations, and component lists. Show ratings, including short-time and short-circuit ratings, and horizontal and vertical bus ampacities.

1. Schedule of features, characteristics, ratings, and factory settings of individual motor-control center units.
2. Wiring Diagrams: Interconnecting wiring diagrams pertinent to class and type specified for motor-control center. Schematic diagram of each type of controller unit indicated.

C. Test Results:

1. Certified reports of field tests and observations.

D. Operation and Maintenance Data (O&M):

1. Maintenance data for MCC.

E. Miscellaneous:

1. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

F. Submit in accordance with Section 1105 of the Standard Specifications.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain, within 100 miles of Project site, service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain similar motor-control devices through one source from single manufacturer.

C. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

D. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

E. Product Selection for Restricted Space: Plans indicate maximum dimensions for motor-control centers, including clearances between motor-control centers and adjacent surfaces and items, and are based on types and models indicated. Other manufacturers' motor-control centers with equal performance characteristics and complying with indicated maximum dimensions may be considered.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path.

B. Store so condensation will not occur on or in motor-control centers. Provide temporary heaters as required to prevent condensation.

C. Handle motor-control centers according to NEMA ICS 2.3. Use factory-installed lifting devices.

1.05 COORDINATION

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuse and Incandescent Indicating Lamps: Furnish one spare for every five installed units, but not less than one set of three of each kind.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Allen Bradley/Rockwell Automation.

B. Cutler-Hammer/Eaton.

C. Square D Co.

2.02 MOTOR-CONTROL CENTERS

A. Where coordination study specified in Section 16030 recommends changes in types, classes, features or ratings of equipment or devices from those indicated, make written request for instruction. Obtain instructions from Engineers before ordering equipment or devices recommended to be changed.

B. Wiring: NEMA ICS 3, Class I, Type B.

C. Enclosures: Surface-mounted cabinets as indicated. NEMA 250, Type 1 gasketed, unless otherwise indicated to meet environmental conditions at installed location.

1. Compartments: Modular; individual doors have concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units require disconnect means in off position before door can be opened or closed, except by consciously operating permissive release device.
2. Interchangeability: Compartments are constructed to remove units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in control center. Units requiring same size compartment are interchangeable, and compartments are constructed to permit ready rearrangement of units, such as replacing three single units with unit requiring three spaces, without cutting or welding.
3. Wiring Spaces: Each vertical section of structure with horizontal and vertical wiring has spaces for wiring to each unit compartment in each section, with supports holding wiring in place.

D. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.04 BUSES

A. Material: Tin Plated copper.

B. Ampacity Ratings:

1. As indicated for horizontal buses.
2. 300 amp min for vertical main buses or larger as required for installed units.

C. Neutral Buses: Full size in service entrance section only.

D. Equipment Ground Bus: Noninsulated, horizontal copper bus 2 by 1/4 inch, minimum.

E. Horizontal Bus Arrangement: Main phase and ground buses extended with same capacity entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections.

F. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.

2.05 FUNCTIONAL FEATURES

A. Description: Modular arrangement of motor controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center as indicated.

B. Motor-Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.

1. Units with full-voltage, across-the-line, magnetic controllers up to and including Size 3 are installed on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
2. Units have short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center section.
3. Units in motor-control centers with Type B wiring are equipped with pull-apart terminal strips or drawout terminal boards for external control connections.

C. Overcurrent Protective Devices: Types of devices with features, ratings, and circuit assignments indicated. Individual feeder-tap units through 225 A rating shall be installed on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.

D. Transient Voltage Surge Suppressors: Connected to motor-control center bus.

E. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

F. Spare Units: Type, sizes, and ratings as indicated, and installed in compartments indicated "spare."

2.06 MAGNETIC MOTOR CONTROLLERS

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across-the-line, unless otherwise indicated.

B. Control Circuit: 120 volt; obtained from integral control power transformer, unless otherwise indicated. Include control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity.

C. Combination Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses indicated. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by Nationally Recognized Testing Laboratory.
2. Nonfusible Disconnect: NEMA KS 1, heavy-duty, nonfusible switch.
3. Circuit-Breaker Disconnect: NEMA AB 1, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.

D. Overload Relay:

1. Electronic solid state type with inverse-time-current characteristic, phase loss and phase unbalance protection for size 2 and larger.
2. Provide NEMA Class 20 heaters or sensors in each phase matched to nameplate full load current of specific motor to which connected with appropriate adjustment for duty cycle.
3. Enhanced Protection Overload Relay: Provide overload relays with NEMA Class 10 or better tripping characteristics for submersible equipment or where indicated. Select to protect motor against voltage unbalance and single phasing.

E. When power factor correction capacitors are indicated provide termination lugs on line side of overload relays.

F. Time Delay Restart Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection.

1. Provide in starter enclosure for Size 2 and larger starters.
2. Delay initial motor start.
3. Delay motor restart due to starter dropout caused by undervoltage or starter coil circuit interruption for maintained control circuits.
4. Adjustable on delay from 0.15 to 30.0 sec set at 10.0 sec.
5. Connect control relay in motor starter coil circuit.

6. Coordinate control relay section with motor starter to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

2.07 COMBINATION SOFT STARTER UNITS

A. Provide a control power transformer with a rated secondary voltage of 120 volt AC. The control power transformer shall be provided with primary and secondary fusing.

B. The controller shall be Allen-Bradley SMC Flex and shall include the following features:

1. Integrated bypass contactor that is closed once the motor is up to full speed
2. Electronic overload protection with adjustable trip class
3. Four programmable auxiliary contacts
4. Selectable control capabilities: soft start, kickstart, current limit start, dual ramp, full voltage, linear speed, preset slow speed, soft stop
5. Additional control capabilities: Pump Control
6. LCD display
7. Keypad programming for configuration
8. Built-in, selectable protective functions for: overload, jam, stall, excessive starts per hour, underload, over/under voltage, voltage unbalance
9. Metering capabilities for: current, voltage, kiloWatt, kiloWatt-Hour, power factor, motor thermal capacity utilized, elapsed time
10. Ground fault protection (1 Amp to 5 Amp) required

C. Provide an input isolation contactor.

D. The SMC unit shall be provided with line side protective modules. The modules shall contain capacitors and metal oxide varistors (MOVs) that protect the internal power circuitry from severe electrical transients and/or high electrical noise.

E. Provide door-mounted local off remote selector switch as shown on the contract drawing wiring diagrams.

F. Emergency run bypass contactor is not required.

G. Provide one empty 12 inch space with separate door for future mounting and wiring of all pump protection modules by Contractor.

H. MAS 711 Pump Monitoring Units for all Submersible Storm Water Pumps.

1. Receive, install and wire Flygt MAS 711 pump monitoring unit at factory. Unit consists of base unit and operator panel. Unit furnished by pump vendor, one unit per controller.
2. Install operator panel in controller door.
3. Install MAS 711 Ethernet port in controller door.
4. Provide separate 24 VDC power supply with adequate capacity to operate monitoring unit.
5. Install and wire per pump monitoring unit manufacturer's recommendations.
6. Install base unit minimum of 18 inches above controller SCRs and SCR wiring or provide metallic shielding for base unit.
7. Provide ability to accept minimum of six twisted shielded pair cables for inputs.
8. Provide ability to wire minimum of four No. 14 for output of warning and alarm.

2.08 FEEDER OVERCURRENT PROTECTION

A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.

1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
2. Application Listing: Appropriate for application, including Type HACR for heating, air-conditioning, and refrigeration equipment.
3. Circuit Breakers, 200 Amp and Larger: Trip units interchangeable within frame size.
4. Circuit Breakers, 400 Amp and Larger: Field-adjustable, short-time and continuous-current settings.
5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
8. Shunt Trip: Where indicated or required for ground fault protection trip.

2.09 ACCESSORIES

A. Factory install in controller enclosure, unless otherwise indicated.

B. Furnish following devices when indicated on plans.

1. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
2. Stop and Lockout Push-Button Station: Momentary-break push-button station with factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
3. Control Relays: Auxiliary and adjustable time-delay relays.
4. Elapsed Time Meters: Heavy duty with digital readout in hours.

PART 3 EXECUTION

3.01 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

D. Hand-Off-Automatic Selector Switches: Where Indicated.

E. Pilot Lights: Push to test LED type where indicated.

3.02 INSTALLATION

A. Install motor-control centers according to NEMA ICS 2.3 and manufacturer's written instructions.

B. Anchor each motor-control center assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by tack welding or bolting. Level and grout sills flush with motor-control center mounting surface.

C. Install motor-control centers on concrete housekeeping bases.

D. Fuses: Install fuses in each fusible switch.

3.03 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs according to Section 16075.

3.04 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Section 16120.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic control devices according to indicated wiring diagram or one that is manufacturer approved, where available.

1. Connect selector switches to bypass only manual and automatic control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.05 CONNECTIONS

A. Tighten motor-control center bus joint, electrical connector, and terminal bolts according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by City for minimum man-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of City’s personnel for plant operation. Include:
   a. 1 man-day for Installation Services.
   b. 1/2 man-day for Instructional Services.
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process. See Section 01600.

B. Test and inspect in accordance with Section 01458.

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by City for minimum man-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of City’s personnel for plant operation. Include:
   a. 1 man-day for Installation Services.
   b. 1 man-day for Instructional Services.
2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process.

B. Testing:

1. Reports: Notify Engineer in writing indicating defective materials and quality and unsatisfactory test results. Include record of repairs and adjustments made.
2. Perform following tests:
   a. Test insulation resistance of MCC buses; components; and of connecting supply, feeder, and control circuits. For components with solid-state devices or other sensitive components, perform tests in accordance with manufacturer's instructions.
   b. Make continuity tests of circuits.
   c. Inspect MCC'S for defects and physical damage, testing laboratory labels, circuit connections, and nameplate compliance with up-to-date system drawings.
   d. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   e. Check MCC anchorage, external clearances, and alignment and fit of components including internal elements.
   f. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   g. Perform visual and mechanical inspection and related work for motor control and protective devices as specified in Section 01458 and 16420.
   h. Device Ratings and Settings: Verify ratings and settings of overload relays, motor circuit protectors, and overcurrent protective devices. Make final adjustments of devices in accordance with Section 16420.
3. Quality Control Testing Program: Assure MCC installation meets specified requirements, is operational within specified tolerances, and provides appropriate protection for systems and equipment.
   a. Test and inspect MCC' in accordance with manufacturer's recommendations and these specifications.
   b. Schedule tests and provide notification at least 7 days in advance of test commencement.
   c. Reports: Prepare written reports of test results and observations. Report defective materials and quality. Include complete records of adjustments and corrective action taken.
   d. Labeling: On satisfactory completion of tests and related effort, apply label to tested components indicating results, person responsible, and date.
   e. Test insulation resistance of buses and portions of control wiring that disconnect from solid-state devices through normal disconnecting features. Insulation resistance less than 100 megohms is not acceptable.
   f. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformers and control power wiring.
   g. Check phasing of supply source to bus.
   h. Test motor-control devices as specified in Section 16420.
   I. Test overcurrent protective devices as specified in Section 01458.
4. Retesting: Correct deficiencies and retest. Verify by retests that specified requirements are met.

3.08 ADJUSTMENTS

A. Set field-adjustable pick-up and time-sensitivity ranges as indicated.

3.09 CLEANING

A. Inspect interior and exterior of motor-control centers. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

* * * END OF SECTION * * *

SECTION 16511
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior lighting fixtures
2. Lamps
3. Ballasts
4. Emergency lighting units
5. Accessories.

1.02 DEFINITIONS

A. Emergency Lighting Unit: Fixture with integral emergency battery-powered supply and means for controlling and charging battery. Also known as an emergency light set.

B. Fixture: Complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply. Internal battery-powered exit signs and emergency lighting units also include battery and means for controlling and recharging battery. Emergency lighting units include ones with and without integral lamp heads.

C. Average Life: Time after which 50% fails and 50% survives under normal conditions.

D. Lighting terminology used herein is defined in IES RP-16. See referenced documents for additional definitions.

1. Exception: The term “driver” is used herein to broadly cover both drivers and power supplies, where applicable.
2. Clarification: The term “LED light source(s)” is used herein per IES LM-80 to broadly cover LED package(s), module(s), and array(s).

1.03 SUBMITTALS

A. Product Data

1. Describe fixtures, lamps, ballasts, and emergency lighting units. Arrange Product Data for fixtures in order of fixture designation.
2. Include data on features and accessories and following:
   a. Outline drawings indicating dimensions and principal features of fixtures.
   b. Electrical Ratings and Photometric Data: Certified results of laboratory tests for fixtures and lamps.
   c. Battery and charger data for emergency lighting units.

B. Shop Drawings:

1. Detail nonstandard fixtures and indicate dimensions, weights, method of field assembly, components, features, and accessories.

C. Test Reports:

1. Field test reports indicating and interpreting test results.

D. Maintenance and Operating Data (O&M):

1. Maintenance data for fixtures to include operation and maintenance information.

E. Submit in accordance with Section 1105 of the Standard Specifications.

1.04 QUALITY ASSURANCE

A. Items provided under this section shall be listed or labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.
3. Special Listing and Labeling: Provide fixtures for use in damp or wet locations, underwater, and recessed in combustible construction that are specifically listed and labeled for such use. Provide fixtures for use in hazardous (classified) locations that are listed and labeled for specific hazard.

B. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

C. Fixtures for Hazardous Locations: Conform to UL 844. Provide units that have Factory Mutual Engineering and Research Corporation (FM) certification for indicated class and division of hazard.

D. Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades, required to be mounted on ceiling or in ceiling space.

1.05 WARRANTY

A. Special Warranty for Batteries: Submit written warranty executed by manufacturer agreeing to replace rechargeable system batteries that fail in materials or quality within the specified warranty period.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Lamps: Ten lamps for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.01 FIXTURES AND FIXTURE COMPONENTS

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:

1. White Surfaces: 85%.
2. Specular Surfaces: 83%.
3. Diffusing Specular Surfaces: 75%.
4. Laminated Silver Metallized Film: 90%.

E. Lenses, Diffusers, Covers, and Globes: 100% virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Lens Thickness: 0.125 inch minimum; except where greater thickness is indicated.

F. Fixture Support Components: Comply with Section 16070.

1. Single-Stem Hangers: 1/2 inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
2. Twin-Stem Hangers: Two, 1/2 inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
3. Rod Hangers: 3/16 inch minimum diameter, zinc-plated, threaded steel rod.
4. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

G. LED Luminaires:

1. LED luminaires must be of the type as indicated on the plans and in this Specification SECTION.
2. Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
3. LED light source(s) shall be RoHS (Restriction of Hazardous Substances) compliant.
4. Thermal Management: Liquids or other moving parts shall be clearly indicated in submittals, and shall be consistent with product testing.
5. Color Rendering Index (CRI): >70.
6. Correlated Color Temperature: 4000K.
7. Minimum luminaire efficacies: 85 lumens per watt.
8. Fully enclosed wiring and LED diodes enclosed to prevent penetration of dust, insects, and other debris into the lamp and driver compartment.
9. Rated life based on IESNA LM-80-2008 (or latest) shall be 50,000 hours at 70% lumen maintenance.

H. Fluorescent Fixtures: Conform to UL 1570.

I. Fluorescent Ballasts: Electronic integrated circuit, solid-state, full-light-output, energy-efficient type compatible with lamps and lamp combinations to which connected.

1. Certification by Electrical Testing Laboratory (ETL).
2. Labeling by Certified Ballast Manufacturers Association (CBM).
3. Type: Class P, high power factor, except as otherwise indicated.
4. Sound Rating: "A" rating, except as otherwise indicated.
5. Voltage: Match connected circuits.
6. Lamp Flicker: Less than 5%.
7. Minimum Power Factor: 90%.
8. Total Harmonic Distortion (THD) of Ballast Current: Less than 20%.
9. Conform to FCC Regulations Part 18, for electromagnetic and radio frequency interference.
10. Conform to IEEE C62.41, Category A, for resistance to voltage surges for normal and common modes.
11. Multilamp Ballasts: Use two, three, or four lamp ballasts for multilamp fixtures where possible.
12. Lamp-ballast connection method does not reduce normal rated life of lamps.
13. Low-Temperature Fluorescent Ballasts: Comply with above requirements, except ballast may be Class P electromagnetic type. Starting temperature is -20°C or colder.

J. Exit Signs: Conform to UL 924 and following:

1. Sign Colors: Conform to local code.
2. Minimum Height of Letters: Conform to local code.
3. Arrows: Include as indicated.

K. Self-Powered Exit Signs (Battery Type): Integral automatic high/low trickle charger in self-contained power pack.

1. Battery: Sealed, maintenance-free or NiCad, nickel-cadmium type with special warranty.

L. Emergency Lighting Units: Conform to UL 924. Provide self-contained units with following features:

1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10 year nominal life and special warranty.
2. Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80% of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. Relay disconnects lamps and battery and automatically recharges and floats on trickle charger when normal voltage is restored.
4. Wire Guard: Where indicated, provide heavy-chrome-plated wire guard arranged to protect lamp heads or fixtures.
5. Time-Delay Relay: Provide time-delay relay in emergency lighting unit control circuit arranged to hold unit ON for fixed interval after restoration of power after outage. Provide adequate time delay to permit HID lamps to restrike and develop adequate output.

2.02 LAMPS

A. Comply with ANSI C78 series that is applicable to each type of lamp.

B. Fluorescent Color Temperature and Minimum Color-Rendering Index (CRI): 3500 K and 85 CRI, except as otherwise indicated.

C. Noncompact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid start circuits.

2.03 FINISHES

A. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

PART 3 EXECUTION

3.01 INSTALLATION

A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved Shop Drawings. Support fixtures according to Section 16070.

B. Support for Suspended Fixtures: Brace pendants and rods over 48 inches long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.

C. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.

3.02 CONNECTIONS

A. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

3.03 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replaced damaged fixtures and components.

1. Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source.
2. Give advance notice of dates and times for field tests.
3. Provide instruments to make and record test results.
4. Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include following information in tests of emergency lighting equipment:
    a. Duration of supply.
    b. Low battery voltage shutdown.
    c. Normal transfer to battery source and retransfer to normal.
    d. Low supply voltage transfer.
    e. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
    f. Report results of tests.

B. Replace fixtures that show evidence of corrosion during Project warranty period.

3.04 ADJUSTING AND CLEANING

A. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

* * * END OF SECTION * * *

SECTION 16900
INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. General provisions and requirements for instrumentation and control equipment and systems.

1.02 DEFINITIONS

A. Systems House: Supplier whose principle function is design, manufacture, and service of instrumentation and control (I&C) systems.

B. Process Control System: Portion of I&C system including PCs, PLCs, data highways, and software.

1.03 SYSTEM DESCRIPTION

A. Instrumentation and control package for plant process control. Does not include process equipment package panels.

1.04 QUALITY ASSURANCE

A. Standardization:

1. Instrumentation and Control system shall be provided by single Systems House.
2. Equipment shall be latest model or version available at time bids are opened, unless otherwise noted.
3. When more than one I&C equipment component of like function is required, end products shall be of single manufacturer to achieve standardization for maintenance, spare parts, operation, and service.
4. Maintain consistent front of panel layout for panels.
5. Systems House shall coordinate data highway communication with process package systems.

B. Experience:

1. Systems House shall have at least 5 years experience in design, manufacture, installation, and successful operation of instrumentation systems similar to specified.

1.05 MAINTENANCE

A. Extra Materials:

1. Packaging:
   a. Obtain spare parts from manufacturer of equipment. Do not provide third-party equivalent replacements.
   b. Package spare parts for protection against dirt, moisture, and static discharge. Label each package as to its contents with description and part number.

c. Size packages for convenient storage and handling. Packages shall weigh no more than 30 pounds each and be no larger than 30 inches long by 18 inches deep by 18 inches wide unless individual components exceed these dimensions.
d. Do not place spare part items for different equipment in same package.

2. Parts:
   a. PLC: Provide spare module for each type used on Project for following:
      1) Processor.
      2) Power supply.
      3) I/O.
      4) Communications.
      5) I/O chassis.
   b. Lightning/Surge Protection: Provide spare module for each type used on Project.
3. Extra materials identified in Section 13442 for equipment in this Section.

PART 2 PRODUCTS

2.01 SYSTEMS HOUSE

A. Primex (previous known as ICS Healy-Ruff) (763-559-0568)

B. Automatic Systems Co. (515- 232-4770)

C. Integrated Process Solutions, Inc (608-849-4375)

D. Quality Control and Integration (952-758-9445)

E. Starnet Technologies (262-886-0228)

2.02 EQUIPMENT

A. Equipment provided under this section includes:

1. Field Instrumentation and Control Devices: Section 16912.
2. PC/PLC Control System: Section 16916.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and wire in accordance with manufacturer's written instructions and approved submittals.

B. Wire instrumentation and control package panels specified in Divisions 11, 13, 14, and 15.

C. Wire components specified in Divisions 11, 13, 14, and 15.

3.02 FIELD QUALITY CONTROL

A. System’s House/Manufacturer’s Field Services:

1. Manufacturer’s Engineer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system related areas other than process design and philosophy. See Section 01600.
2. Provide services of qualified service Engineer to supervise and inspect equipment installation to ensure system is installed in accordance with manufacturer’s recommendations.

3. Field calibrate equipment at time of complete system startup on loop-by-loop basis. Document field calibration results for each piece of equipment and provide to Contracting Authority.
4. Make adjustments necessary to place equipment in satisfactory operation.
5. Manufacturer's Engineer for equipment specified shall be present at job site or classroom designated by City for man-days indicated, travel time excluded, for assistance during plant construction, plant startup, equipment adjustment, and training of City's personnel for plant operation. Include minimum of:
   a. Instruments and Control Devices, Section 16912:
      1) 1/2 man-day for Installation Services.
      2) 1/2 man-day for Instructional Services.
      3) 1/2 man-day for Post Startup Services.
   b. PLC/PC Control System, Section 16916:
      1) 1 man-day for Installation Services.
      2) 1 man-day for Instructional Services.
      3) 1/2 man-day for Post Startup Services.

* * * END OF SECTION * * *

SECTION 16912
FIELD INSTRUMENTATION AND CONTROL DEVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Abbreviations:

1. PLC: Programmable Logic Controller.
2. OIU: Operator Interface Unit.
3. LCP: Local Control Panel.

PART 2 PRODUCTS

2.01 INSTRUMENTATION AND CONTROL (I&C) EQUIPMENT

A. Equipment provided in this section shall conform to following:

1. General Provisions for Instrumentation and Control: Section 13440.
2. Panel and Field Devices: Section 13453.
3. 24/26 GHz Radar Level Detection Equipment: Section 13431.
4. Electronic Analyzers/Detectors: Section 13466.

B. Items in tables noted with "*" shall be suitable for Class I, Division 1, Group D hazardous location.

C. Items in tables noted with "**" shall be suitable for Class I, Division 2, Group D hazardous location.

2.02 FLOAT SWITCHES

Designation	Description/Range	Range/Interface
** LSLL-1-3-1	North Pump Station Storm Water Pump Low-Low Level	Elev. 841.25 / Backup Level Stop
** LSHH-1-3-1	North Pump Station Storm Water Pump High-High Level	Elev. 841.75 / Backup Level Start
** LSLL-2-3-1	South Pump Station Storm Water Pump Low-Low Level	Elev. 835.25 / Backup Level Stop
** LSHH-2-3-1	South Pump Station Storm Water Pump High-High Level	Elev. 843.00 / Backup Level Start
** LSLL-2-6-1	South Sump Pump Low-Low Level	Elev. 831.00 Sump Stop
NOTE: **Suitable for Class 1, Division 2 Hazardous Area		

2.03 RADAR TRANSMITTER

Designation	Description	Range/Interface
** LE/LT-1-4-1	North Pump Station Storm Water Wet Well Level	0 – 27 feet/ N63-PLC-1
** LE/LT-2-4-1	South Pump Station Storm Water Wet Well Level	0 – 31 feet/ S63-PLC-1
NOTE: **Suitable for Class 1, Division 2 Hazardous Area		

2.04 ON/OFF SWITCH (In NEMA 4X Enclosure)

Designation	Description	Range/Interface
** HS-2-6-1-1	North Pump Station On/Off maintained selector switch	S63-PLC-1
NOTE: **Suitable for Class 1, Division 2 Hazardous Area		

2.05 REMOTE CONTROL DISABLE SWITCH (In NEMA 4X Enclosure)

Designation	Description/Range	Interface
** HS-1-5-1-1	North Pump Station Storm Water Pump No.1 Remote Control-Disable maintained push-pull switch	N63-PLC-1
** HS-1-5-2-1	North Pump Station Storm Water Pump No.2 Remote Control-Disable maintained push-pull switch	N63-PLC-1
** HS-1-5-3-1	North Pump Station Storm Water Pump No.3 Remote Control-Disable maintained push-pull switch	N63-PLC-1
** HS-2-5-1-1	South Pump Station Storm Water Pump No.1 Remote Control-Disable maintained push-pull switch	S63-PLC-1
** HS-2-5-2-1	South Pump Station Storm Water Pump No.2 Remote Control-Disable maintained push-pull switch	S63-PLC-1
** HS-2-5-3-1	South Pump Station Storm Water Pump No.3 Remote Control-Disable maintained push-pull switch	S63-PLC-1
** HS-2-5-4-1	South Pump Station Storm Water Pump No.4 Remote Control-Disable maintained push-pull switch	S63-PLC-1
NOTE: **Suitable for Class 1, Division 2 Hazardous Area		

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and wire in accordance with plans, manufacturer's written instructions, and approved submittals.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by City for man-days indicated, travel time excluded, for

assistance during plant construction, plant startup, and training of City's personnel for plant operation. Include minimum man-days indicated in Section 16900.

3.03 FIELD TESTING

A. Preparation:

1. Schedule field testing which affects plant operation through Contracting Authority 48 hours before testing.
2. Resolve interface discrepancies.
3. Maintenance:
   a. Perform maintenance on equipment throughout course of Work.
   b. Perform preventative maintenance in accordance with manufacturer's recommendations.
   c. Keep maintenance records with equipment and make records available for examination during Work.
4. Before start of testing:
   a. Have O&M manuals for each item of equipment on-site during testing.
   b. Have spare parts, expendables, and test equipment pertinent to equipment being tested on-site during testing.
   c. Check equipment against submittals.
   d. Verify equipment is installed properly.

B. Testing:

1. Perform tests in accordance with contract documents and manufacturer's recommendations.
2. Power up equipment to verify proper operation.
3. Loop-by-loop testing from field devices to control panel devices.
   a. Calibrate device to correct range for analog signals.
   b. Verify that discrete signals are being transmitted.
4. After installation of equipment test panels and field devices:
   a. Verify signals between system components.
   b. Test panel devices from field device and panel to panel to verify operation.
   c. Use actual signals whenever possible using installed equipment. When not possible, simulated signals are acceptable.
5. Correct deficiencies found during testing.

* * * END OF SECTION * * *

SECTION 16916
PC/PLC CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. PC and PLC hardware, software, data highway, programming, and appurtenances for process control system for Blowers Creek storm water facility.
2. Factory and Field Testing requirements.

1.02 DEFINITIONS

A. Standard System: Standard system is one which is available at time of Bid, with fully tested, field proven, software and hardware, documentation, and training material. Custom software and custom hardware are not acceptable.

B. Systems House: In addition to responsibilities described in Section 16900, Systems House shall include Work of Paragraph 1.01.A.

C. Data Highway: Communications link between separate stations tied with multidrop cable or optical connections. Data highway eliminates need for separate, independently wired data links. Each station on data highway will function independently.

D. Abbreviations:

1. PC: Personal computer.
2. PLC: Programmable logic controller.
3. OIU: Operator interface unit.
4. I/O: Input/Output.
5. LCP: Local control panel.
6. UPS: Uninterruptable power supply.

1.03 SYSTEM DESCRIPTION

A. Description:

1. System shall consist of PLCs connected via Data Highway to OIUs.
   a. Data Highway shall provide peer-to-peer communication between PLCs and other devices connected to system.
   b. Operator interface units connected to data highway shall be capable of accessing data from PLC in system.
   c. PLC shall provide data to RTU and Radio additions to existing Trunk Radio System to be transmitted to Wastewater Utility Control Room (monitor only).
   d. Provide HMI screens on existing Wonderware HMI clients at Wastewater Utility Control Room.
2. Hierarchy of Control:
   a. Local (at equipment).
   b. Local Control Panels.
   c. PLC Panels.

B. System Components:

1. Control System includes PLC located at pump station.
2. Control System shall include OIUs, PLCs, and I/O subsystems.
3. Power OIUs and PLC from UPS.
4. Provide 24 vdc regulated power supplies as required to power analog instrumentation loops.
5. Provide data communication equipment and wiring and associated configuration.
6. Expandable, at future date, to accommodate:
   a. Additional PLCs and OIUs with similar I/O capabilities.
7. Provide Control System software and application programming. Load prior to factory testing.
8. Provide, including but not limited to, PLC ladder logic, OIU tag database, graphic displays, and operator reports.

C. Component Functions:

1. Existing Control Room PC:
   a. Supervisory control.
      1) View system.
      2) Control, operate and adjust system.
   b. Work shall be consistent with existing screen presentations.
2. OIU at PLC Panel with view, control, operate and adjust system.
3. PLC Panels:
   a. Monitor pump station process system.
   b. Control pump station process system.

D. Design Requirements:

1. PLC pump station shall include OIU which provide operator interface for manual and automatic control.
2. PLC and OIU shall display graphic screens for entire pump station.
3. Do not use OIU for automatic control functions except as an operator interface.
4. Local manual control components at process equipment shall be independent from PLC system to provide maintenance and redundancy functions.
5. Passwords when used shall become property of Contracting Authority.
6. Provide manual means to bypass UPS upon UPS failure.
7. Maximum control system reaction time is 2 seconds.
8. Communication protocols Ethernet and RS-232.

1.04 SUBMITTALS

A. Submittals below are in addition to submittals required in Section 13440.

B. Miscellaneous:

1. Submit completed Events and Alarm Tables and copy of color display screens 21 days before System Demonstration.
2. Prior to factory testing submit wiring diagrams with Engineer’s review comments incorporated.
3. Factory Testing:
   a. At least 6 weeks before testing submit inventory of equipment to be tested.
   b. Submit wiring diagram documenting test results.
4. Wiring diagram corrected to factory test results.

C. Shop Drawings:

1. Network diagram showing network components and their locations.

D. PC and OIU Operation and Maintenance (O&M) Data:

1. Passwords and passcodes.
2. Software:
   a. Installation instructions.
   b. Version and registration numbers.
   c. Data required to obtain manufacturers software support.
3. Driver:
   a. List of drivers installed.
   b. Installation instructions.
4. Communication installation and setup parameters.

1.05 QUALITY ASSURANCE

A. Provide system hardware, software, and systems programming to provide complete, functional, and tested system.

B. Process Control System Meeting:

1. Contractor shall schedule meeting with Contracting Authority and Engineer not less than 45 days before system demonstration described in Section 01814.
2. Meeting shall:
   a. Assign alarm priorities for each alarm point.
   b. Select operational event logging.
   c. Select discrete event logging.
   d. Select analog logging.
   e. Develop regulating authority custom report.
3. Prior to meeting prepare table indicating operational events, discrete events and analog values with “yes” and “no” columns, and “notes” column. Prepare alarm table with columns identifying alarm priority and description of alarm. Tables shall include columns identifying PLC, P&ID numbers.
4. After meeting prepare typed, completed, separate Events and Alarm Tables indicating decisions made during meeting.

1.06 SEQUENCING AND SCHEDULING

A. Follow sequences described below for work of this section:

1. Schedule Process Control System Meeting.
2. Perform Source Quality Control Testing.
3. Perform Field Testing.

1.07 MAINTENANCE

A. Spare Parts:

1. Provide 20% spare I/O points for each type of I/O for each PLC Panel. Install spares in I/O chassis grouped with similar I/O types.
2. Wire I/O points to terminal blocks.
3. Provide one useable spare slot in each PLC I/O chassis.

PART 2 PRODUCTS

2.01 CONTROL SYSTEM

A. Equipment provided for Control System shall conform to following:

1. General Provisions for Instrumentation and Controls: Section 13440.
2. Instrumentation and Control Panel Construction: Section 13442.
3. Electronic Panel Instruments: Section 13452.
4. Panel and Field Devices: Section 13453.
5. Programmable Logic Controller (PLC): Section 13464.
6. Uninterruptible Power Supply (UPS): Section 13476.
7. Operator Interface Unit (OIU): Section 13478.

2.02 INPUT/OUTPUT POINTS

A. Provide I/O Points in accordance with Schedule 1 to Section 16916.

2.03 PLC GENERAL REQUIREMENTS

A. Changes to setpoints, alarm values, timer values, control loop tuning parameters, and other numeric values used within PLC programs shall not require modification to any instructions within PLC ladder logic program.

B. Unless specified otherwise, procedures for control power fail restart for equipment shall be as follows:

1. Equipment shall shut down and return to fail/safe condition on loss of PLC control power.
2. Upon restoration of power previously running equipment shall be restarted using same sequence of startup used for automatic control.
3. Equipment running in PLC-manual control shall not restart following power restoration.
4. Restart of multiple like equipment shall be sequenced through use of timers to prevent simultaneous restart.

C. Control equipment from PLC only when PLC control is selected.

D. Monitor and log data in any control mode.

E. Provide adjustable digital filtering of analog inputs to eliminate process upsets due to noise. Use minimum time constant required to remove noise.

F. Provide adjustable timers for alarm display points to prevent nuisance alarm. Timer values shall be 0 to 30 seconds. Initial setting, unless otherwise specified, shall be 5 seconds.

G. Provide data entry areas for PLC adjustment through OIU and PC screens as minimum for:

1. Control loop tuning parameters.
2. Minimum and maximum pump speeds, valve positions, and other control parameters.
3. Level and alarm setpoints generated from analog values.

2.04 OIU AND PC GENERAL REQUIREMENTS

A. Provide upper and lower limits on acceptable values for data entry points. Entry of values outside limits shall not be accepted and shall generate appropriate message on screen.

B. Scan I/O points under program control. Provide 10 second scanning intervals.

C. Display status of I/O points on each PC based OIU.

D. Provide operational and tuning parameters to meet functionality specified.

E. Provide high and low setpoints for analog I/O points for operation and alarming.

F. Password Protection Levels:

1. Minimum levels:
   a. Operator Mode: Password entry required. Parameters that may be changed at this level include:
      1) Switch between manual and automatic control.
      2) Manual control of equipment.
      3) Acknowledge alarm.
   b. Superintendent Mode: Password entry required. In addition to operator functions, parameters that may be changed at this level include:
      1) Alarm setpoints for alarms generated from analog signals.
      2) Process setpoints for control loops.
   c. Engineer Mode: Password entry required. In addition to operator and superintendent functions, parameters that may be changed at this level include:
      1) PID control loop tuning parameters and loop update times.
      2) Pump minimum and maximum speeds.
      3) Adjustment of control output minimum and maximum clamp values.
      4) Exit from run-time operation for Process Control System software editing.
      5) Software editing.
      6) Password authorization.
2. View Mode: No password entry required. Can only view screens. Cannot change operating parameters.
3. Password entry for superintendent and Engineer shall consist of four characters or more.
4. Automatic log-out after 1 hour of inactivity.

2.05 PLANT ALARM SYSTEM

A. Provide alarm summary at OIUs and PCs:

1. Display only active alarms.
2. Allow operator to acknowledge alarms using single action at alarm summary screen.
3. For Plant Alarms remain consistent with present presentation and function.

2.06 OIU AND PC DISPLAY SCREENS

A. General Requirements:

1. Display last pump station alarm messages at bottom of screen.
2. Current time and date.
3. Navigate to overview screen with single action from any screen.
4. Navigate to alarm summary screen with single action from any screen.

B. Facilities Overview:

1. Pump station layout.

C. Graphic:

1. Graphic representation of equipment and process piping.
2. Animated analog value with digital display.
3. Process equipment designation and Engineer’s tag numbers.
4. Designate flow direction.
5. Display equipment run and fail status.
6. Display alarms.

7. Comply with Section 13440 for colors.
8. Use P&ID symbols.
9. Navigate from graphic screen:
    a. To process summary screen.
    b. To previous and next graphic screens.
    c. To Alarm screen.

D. Summary:

1. Configure separate process summary screen for each unit process, include analog and run time values.
    a. Analog:
        1) Instantaneous values.
        2) Yesterday's minimum, maximum and average values.
        3) Today's minimum, maximum and average values.
        4) Yesterday's flow total.
        5) Today's flow total.
    b. Run Time:
        1) Run times from equipment monitored by PLC.
        2) Runtime value shall be six digit in 10th of hour.

E. Alarm:

1. As specified.

2.07 DATA LOGGING REQUIREMENTS - ANALOG

A. Provide logging of selected analog values to PC designated for logging.

1. Data logged shall be in ASCII format and comma delimited.

B. Procedure for data collection and storage shall be:

1. PLC shall sample and calculate values every 5 seconds.
2. PLC shall calculate min., max., and average for each point over period of 24 hours and save values. Save 2 hour values to PC designated for logging.
3. Every 5 minutes write totalized flow values to PC designated for logging.

2.08 REPORTS

A. Facility Operational for pump station only (if required):

1. Daily and monthly:
    a. Analog input values (minimum, maximum, average, and total) except for position and speed.
    b. Run time.
    c. Print and electronically archive.
2. On Demand:
    a. Spread sheet.
    b. Print screen.

2.09 PUMP STATION PLC PANEL (N63-PLC-1)

A. Panel:

1. NEMA 12.

2. Freestanding.
3. Dimensions: Approximately 48 inches wide by 72 inches high by 24 inches deep.
4. Front access.
5. 120 vac power supply powered from UPS.

B. Front of Panel Devices:

Designation	Description	Interface
HS-1-5-1-2	Storm Water Pump No.1 HOA 3 position selector switch.	PLC / MCC
HS-1-5-1-3	Storm Water Pump No.1 Reset push button	PLC / MCC
ETM-1-5-1	Storm Water Pump No.1 Elapsed Time Meter	Run Signal
HS-1-5-2-2	Storm Water Pump No.2 HOA 3 position selector switch.	PLC / Motor Starter
HS-1-5-2-3	Storm Water Pump No.2 Reset push button	PLC/ MCC
ETM-1-5-2	Storm Water Pump No.2 Elapsed Time Meter	Run Signal
HS-1-5-3-2	Storm Water Pump No.3 HOA 3 position selector switch.	PLC / Motor Starter
HS-1-5-3-3	Storm Water Pump No.3 Reset push button	PLC/ MCC
ETM-1-5-3-1	Storm Water Pump No.3 Elapsed Time Meter	Run Signal
LI-1-4-1-1	Storm Water Wet Level digital indicator	LT-1-4-1
LLHH-1-3-1	Backup Start Storm Water Pumps indicator	LSHH-1-3-1 float
LLLL-1-3-1	Backup Stop Storm Water Pumps indicator	LSLL-1-3-1 float
YA-1-3-1	Backup Level Control active	Backup Floats/ Reset
HS-1-3-1	Reset Backup Level Control push button	Backup Control
YL-1-2-1-1	Bypass Gate Remote indicator	HS-1-2-1-1
HS-1-2-1-3	Bypass Gate Open/Close 2 position selector switch	SLD-1-2-1
ZLO-1-2-1	Bypass Gate Open indicator	ZS-1-2-1
ZLC-1-2-1	Bypass Gate Closed indicator	ZS-1-2-1
ZAO-1-2-1	Bypass Gate Fail To Open indicator	Delay timer
ZAC-1-2-1	Bypass Gate Fail To Close indicator	Delay timer
OIU	Operator interface unit	PLC

C. OIU Pump Station Screens Functions:

Designation	Description
HS-1-2-1-4	Bypass Gate Manual/Auto control selector switch
YL-1-5-1-1	Storm Water Pump No.1 Run Indicator
YL-1-5-1-2	Storm Water Pump No.1 Remote Indicator
YA-1-5-1-1	Storm Water Pump No.1 Fail Indicator
YA-1-5-1-2	Storm Water Pump No.1 Pump Seal Fail Indicator
TAH-1-5-1	Storm Water Pump No.1 Pump High Temp Indicator
YL-1-5-2-1	Storm Water Pump No.2 Run Indicator
YL-1-5-2-2	Storm Water Pump No.2 Remote Indicator
YA-1-5-2-1	Storm Water Pump No.2 Fail Indicator
YA-1-5-2-2	Storm Water Pump No.2 Pump Seal Fail Indicator
TAH -1-5-2	Storm Water Pump No.2 Pump High Temp Indicator
YL-1-5-3-1	Storm Water Pump No.3 Run Indicator
YL-1-5-3-2	Storm Water Pump No.3 Remote Indicator
YA-1-5-3-1	Storm Water Pump No.3 Fail Indicator

Designation	Description
YA-1-5-3-2	Storm Water Pump No.3 Pump Seal Fail Indicator
TAH -1-5-3	Storm Water Pump No.3 Pump High Temp Indicator
LSL-1-4-1-1	Storm Water Pump Lead Off Set Point
LSL-1-4-1-2	Storm Water Pump Lag 1 Off Set Point
LSL-1-4-1-3	Storm Water Pump Lag 2 Off Set Point
LSL-1-4-1-4	Storm Water Pump Bypass Gate Closed Set Point
LSH-1-4-1-1	Storm Water Pump Lead On Set Point
LSH-1-4-1-2	Storm Water Pump Lag 1 On Set Point
LSH-1-4-1-3	Storm Water Pump Lag 2 On Set Point
LSH-1-4-1-4	Storm Water Pump Bypass Gate Open Set Point
LSLL-1-4-1	Storm Water Wet Well Low-Low Alarm (Radar) Set Point
LSHH-1-4-1	Storm Water Wet Well High-High Alarm (Radar) Set Point
LAHH-1-4-1	Storm Water Wet Well High-High Alarm (Radar) indicator
LALL-1-4-1	Storm Water Wet Well Low-Low Alarm (Radar) indicator
LI-1-4-1-2	Storm Water Wet Well Level indicator
YA-1-13-1	Normal Control Power Fail indicator

D. Rear of Panel Devices:

Designation	Description	Interface
KC-1-4-1-1	Storm Water Lead Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-1-4-2-1	Storm Water Lag1 Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-1-4-3-1	Storm Water Lag2 Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-1-3-1	Low Level Float On Delay (0 – 60 sec)	Backup Stop circuit
LY-1-4-1	Wet Well Level Signal Isolator	LIT-1-4-1
PLC	Programmable Logic Controller	
UPS	Uninterruptible Power Supply	

E. Additional Requirements:

1. Intrinsically safe relays for wet well floats and intrinsically safe barrier for radar level transmitter.
2. Power intrinsically safe devices from UPS for line power or from power supply to eliminate false trips on momentary power interruptions.
3. Provide hard wired backup circuit for float switch Storm Water Pump control independent of PLC.
4. Provide a stand or shelf for UPS such that the UPS does not sit on the bottom of the enclosure.

F. Functional Description:

1. Storm Water Pumps No.1, 2, & 3 shall be controlled via Hand-Off-Auto selector switches HS-1-5-1-2, -2-2, & -3-2 and field mounted Remote Control Disable switches HS-1-5-1-1, -2-1, & -3-1. When HOA selector switch is in “Hand” mode pumps shall Run continuously. When HOA selector switch is in “Off” mode pumps shall not run. When HOA selector switch is in “Auto” mode pumps shall be controlled via 4 – 20 mAdc Wet Well Level signal. When field mounted Remote Control Disable (RCD) switches are active then PLC shall not start respective Storm Water Pump.
2. Pumps sequence at first start up shall be Storm Water Pump No. 1, Lag 1 shall be Storm Water Pump No. 2, and Lag 2 shall be Storm Water Pump No.3. Pumps shall alternate

when all pumps have stopped operation. Lead pump shall become Lag2, Lag 1 pump shall become Lead, and Lag 2 pump shall become Lag 1.

3. Adjustable level control for Lead, Lag 1, and Lag 2 pumps shall be set at Pump Station OIU using Lead On & Off set points (LSH-1-4-1-1, LSL-1-4-1-1), Lag 1, and Lag 2, On & Off set points (LSH-1-4-1-2, -3, LSL-1-4-1-2, -3,). Initial settings for On and Off set points are as follow:
   a. Lead On: 841.75 Elev.
   b. Lag 1 On: 842.25 Elev.
   c. Lag 2 On: 842.75 Elev.
   d. Lead Off: 841.30 Elev.
   e. Lag 1 Off: 841.800 Elev.
   f. Lag 2 Off: 842.30 Elev.
4. Backup float control shall not require PLC to be operational to function. Should either Low-Low or High-High level floats LSLL-1-3-1 or LSHH-1-3-1 activate pumps shall go into Backup mode of operation and Backup Active indicator YA-1-3-1 shall be illuminated and maintained until Reset Backup HS-1-3-1 push button is pressed which shall also deactivate High-High LLHH-1-3-1 and Low-Low LLLL-13-1 indicators. All Storm Water Pumps in "Auto" mode shall start after a stagger timed start when float High-High signal is active and High-High indicator shall be illuminated and maintained until float Low-Low signal is activated and then Storm Water Pumps shall stop. Low-Low Level Float shall have an adjustable 0 – 60 sec Delay On timer (outside PLC) before Low-Low signal is activated, initially set at 15 seconds. Float Low-Low indicator shall be illuminated and maintained until float High-High signal is active. Float Low-Low signal active shall stop Storm Water Pumps in "Auto" mode. Backup active signal is required as a PLC input for remote monitoring.
5. Storm Water Wet Well Level indicator LI-1-4-1-1 and Pump Station OIU indicator LI-1-4-1-2 shall display level 4 – 20 mAdc from level transmitter LIT-1-4-1. Level Alarm indicator LA-1-4-1 shall be illuminated and maintain when 4 – 20 mAdc signal is at or below 3.75 mAdc or at or above 21.75 mAdc levels depending on how LIT-1-4-1 is configured. Adjustable Low-Low and High-High Storm Water Wet Well Alarm levels shall be set at Pump Station OIU using LSLL-1-4-1-1 and LSHH-1-4-1-1. When levels are reached (and beyond) the respective indicators shall be illuminated. Initial settings for High-High and Low-Low set points are as follow:
   a. High-High (radar level): 841.70 Elev.
   b. Low-Low (radar level): 841.30 Elev.
6. Start Delay Timers KC-1-4-1-1, -2-1, and -3-1shall delay the start of pump for every pump start in all modes of operation. Pump fail logic shall account for delays before reporting Fail status.
7. Monitor Seal Fail and High Temp signals from pump vendor supplied pump protection modules (in MCC/ Motor Starters) and display on OIU at Pump Station for Storm Water Pumps. Seal Fail and High Temp signals will stop pump from running at MCC/Motor Starter.
8. Bypass Gate control shall be controlled via front of enclosure Open-Close selector switch HS-1-2-1-3 and HMI Manual-Auto selector switch HS-1-2-1-4. Front of enclosure Open-Close selector switch shall control Bypass Gate when HMI Manual-Auto selector switch is in Manual mode. When HMI Manual-Auto selector switch is in Auto mode Bypass Gate shall open when LSHH-1-4-1-4, initially set at Elevation 842.00, is reached. When LSLL-1-4-1-4, initially set at Elevation 840.00, is reached Bypass Gate shall close. Respective Gate Fail to Open and Fail to Close indicators shall be illuminated when gate do not open or close in an adjustable time period in any mode of operation.
9. Monitor and alarm normal Control Power Failure and indicate on OIU at Pump Station. Monitor and alarm UPS Battery Failure signal from UPS on OIU at Pump Station.
10. Send the following data via RTU and Radio additions to existing Trunk Radio system to Main WWTP:
    a. Pump Fail (3)
    b. Pump High Temp (3)

c. Pump Seal Fail (3)
d. Bypass Gate Open
e. Bypass Gate Closed
f. Wet Well Level
g. Pump Station in Backup Level Control
h. Normal Power Fail
i. Provide for five spare future signals

2.10 PUMP STATION PLC PANEL (S63-PLC-1)

A. Panel:

1. NEMA 12.
2. Freestanding.
3. Dimensions: Approximately 48 inches wide by 72 inches high by 24 inches deep.
4. Front access.
5. 120 vac power supply powered from UPS.

B. Front of Panel Devices: to be finalized later.

Front of Panel Devices:

Designation	Description	Interface
HS-2-5-1-2	Storm Water Pump No.1 HOA 3 position selector switch.	PLC / MCC
HS-2-5-1-3	Storm Water Pump No.1 Reset push button	PLC / MCC
HS-2-5-1-4	Storm Water Pump No.1 Lead/Lag1/Lag2/Lag3 4 position selector switch	Motor Starting Circuit
ETM-2-5-1	Storm Water Pump No.1 Elapsed Time Meter	Run Signal
HS-2-5-2-2	Storm Water Pump No.2 HOA 3 position selector switch.	PLC / Motor Starter
HS-2-5-2-3	Storm Water Pump No.2 Reset push button	PLC/ MCC
HS-2-5-2-4	Storm Water Pump No.2 Lead/Lag1/Lag2/Lag3 4 position selector switch	Motor Starting Circuit
ETM-2-5-2	Storm Water Pump No.2 Elapsed Time Meter	Run Signal
HS-2-5-3-2	Storm Water Pump No.3 HOA 3 position selector switch.	PLC / Motor Starter
HS-2-5-3-3	Storm Water Pump No.3 Reset push button	PLC/ MCC
HS-2-5-3-4	Storm Water Pump No.3 Lead/Lag1/Lag2/Lag3 4 position selector switch	Motor Starting Circuit
ETM-2-5-3-1	Storm Water Pump No.3 Elapsed Time Meter	Run Signal
HS-2-5-4-2	Storm Water Pump No.4 HOA 3 position selector switch.	PLC / Motor Starter
HS-2-5-4-3	Storm Water Pump No.4 Reset push button	PLC/ MCC
HS-2-5-4-4	Storm Water Pump No.4 Lead/Lag1/Lag2/Lag3 4 position selector switch	Motor Starting Circuit
ETM-2-5-4-1	Storm Water Pump No.4 Elapsed Time Meter	Run Signal
HS-2-7-1-2	Sump Pump HOR 3 position selector switch.	PLC / Motor Starter
ETM-2-7-1	Sump Pump Elapsed Time Meter	Run Signal
LI-2-4-1-1	Storm Water Wet Level digital indicator	LT-2-4-1
LLHH-2-3-1	Backup Start Storm Water Pumps indicator	LSHH-2-3-1 float
LLLL-2-3-1	Backup Stop Storm Water Pumps indicator	LSLL-2-3-1 float

Designation	Description	Interface
YA-2-3-1	Backup Level Control active	Backup Floats/ Reset
HS-2-3-1	Reset Backup Level Control push button	Backup Control
YL-2-1-1-1	Inlet Gate Remote indicator	HS-2-1-1-1
HS-2-1-1-3	Inlet Gate Open/Close 2 position selector switch	SLD-2-1-1
ZLO-2-1-1	Inlet Gate Open indicator	ZS-2-1-1
ZLC-2-1-1	Inlet Gate Closed indicator	ZS-2-1-1
ZAO-2-1-1	Inlet Gate Fail To Open indicator	Delay timer
ZAC-2-1-1	Inlet Gate Fail To Close indicator	Delay timer
HS-2-2-1-3	Bypass Gate Open/Close 2 position selector switch	SLD-2-2-1
ZLO-2-2-1	Bypass Gate Open indicator	ZS-2-2-1
ZLC-2-2-1	Bypass Gate Closed indicator	ZS-2-2-1
ZAO-2-2-1	Bypass Gate Fail To Open indicator	Delay timer
ZAC-2-2-1	Bypass Gate Fail To Close indicator	Delay timer
OIU	Operator interface unit	PLC

C. OIU Pump Station Screens Functions:

Designation	Description
HS-2-2-1-4	Bypass Gate Manual/Auto control selector switch
HS-2-1-1-4	Inlet Gate Manual/Auto control selector switch
YL-2-5-1-1	Storm Water Pump No.1 Run Indicator
YL-2-5-1-2	Storm Water Pump No.1 Remote Indicator
YA-2-5-1-1	Storm Water Pump No.1 Fail Indicator
YA-2-5-1-2	Storm Water Pump No.1 Pump Seal Fail Indicator
TAH-2-5-1	Storm Water Pump No.1 Pump High Temp Indicator
YL-2-5-2-1	Storm Water Pump No.2 Run Indicator
YL-2-5-2-2	Storm Water Pump No.2 Remote Indicator
YA-2-5-2-1	Storm Water Pump No.2 Fail Indicator
YA-2-5-2-2	Storm Water Pump No.2 Pump Seal Fail Indicator
TAH -2-5-2	Storm Water Pump No.2 Pump High Temp Indicator
YL-2-5-3-1	Storm Water Pump No.3 Run Indicator
YL-2-5-3-2	Storm Water Pump No.3 Remote Indicator
YA-2-5-3-1	Storm Water Pump No.3 Fail Indicator
YA-2-5-3-2	Storm Water Pump No.3 Pump Seal Fail Indicator
TAH -2-5-3	Storm Water Pump No.3 Pump High Temp Indicator
YL-2-5-4-1	Storm Water Pump No.4 Run Indicator
YL-2-5-4-2	Storm Water Pump No.4 Remote Indicator
YA-2-5-4-1	Storm Water Pump No.4 Fail Indicator
YA-2-5-4-2	Storm Water Pump No.4 Pump Seal Fail Indicator
TAH -2-5-4	Storm Water Pump No.4 Pump High Temp Indicator
YL-2-7-1-1	Sump Pump Run Indicator
YL-2-7-1-2	Sump Pump Remote Indicator
YA-2-7-1-1	Sump Pump Fail Indicator
YA-2-7-1-2	Sump Pump Pump Seal Fail Indicator
TAH -2-7-1	Sump Pump Pump High Temp Indicator
LSL-2-4-1-1	Storm Water Pump Lead Off Set Point
LSL-2-4-1-2	Storm Water Pump Lag 1 Off Set Point
LSL-2-4-1-3	Storm Water Pump Lag 2 Off Set Point
LSL-2-4-1-4	Storm Water Pump Lag 3 Off Set Point

Designation	Description
LSL-2-4-1-5	Storm Water Pump Bypass Gate Open Set Point
LSH-2-4-1-1	Storm Water Pump Lead On Set Point
LSH-2-4-1-2	Storm Water Pump Lag 1 On Set Point
LSH-2-4-1-3	Storm Water Pump Lag 2 On Set Point
LSH-2-4-1-4	Storm Water Pump Lag 3 On Set Point
LSH-2-4-1-5	Storm Water Pump Bypass Gate Close Set Point
LSLL-2-4-1	Storm Water Wet Well Low-Low Alarm (Radar) Set Point
LSHH-2-4-1	Storm Water Wet Well High-High Alarm (Radar) Set Point
LAHH-2-4-1	Storm Water Wet Well High-High Alarm (Radar) indicator
LALL-2-4-1	Storm Water Wet Well Low-Low Alarm (Radar) indicator
LI-2-4-1-2	Storm Water Wet Well Level indicator
YA-2-13-1	Normal Control Power Fail indicator
YA-2-5-5	Invalid Storm Water Sequence Selected

D. Rear of Panel Devices:

Designation	Description	Interface
KC-2-4-1-1	Storm Water Lead Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-2-4-2-1	Storm Water Lag1 Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-2-4-3-1	Storm Water Lag2 Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-2-4-4-1	Storm Water Lag3 Pump Start Delay Timer (0 – 60 seconds)	Start circuit
KC-2-3-1	Low Level Float On Delay (0 – 60 seconds)	Backup Stop circuit
LY-2-4-1	Wet Well Level Signal Isolator	LIT-2-4-1
PLC	Programmable Logic Controller	
UPS	Uninterruptible Power Supply	

E. Additional Requirements:

1. Intrinsically safe relays for wet well floats and intrinsically safe barrier for radar level transmitter.
2. Power intrinsically safe devices from UPS for line power or from power supply to eliminate false trips on momentary power interruptions.
3. Provide hard wired backup circuit for float switch Storm Water Pump control independent of PLC.
4. Provide a stand or shelf for UPS such that the UPS does not sit on the bottom of the enclosure.

F. Functional Description:

1. Storm Water Pumps No.1, 2, 3, & 4 shall be controlled via Hand-Off-Auto selector switches HS-2-5-1-2, -2-2, & -4-2, Lead/Lag/Lag1/Lag2 selector switches HS-2-4-1-4, -2-4, -3-4, -4-4, and field mounted Remote Control Disable switches HS-2-5-1-1, -2-1, & -3-1. When HOA selector switch is in “Hand” mode pumps shall Run continuously. When HOA selector switch is in “Off” mode pumps shall not run. When HOA selector switch is in “Auto” mode pumps shall be controlled via 4 – 20 mAdc Wet Well Level signal. When field mounted Remote Control Disable (RCD) switches are active then PLC shall not start respective Storm Water Pump.
2. Adjustable level control for Lead, Lag 1, Lag2, and Lag 3 pumps shall be set at Pump Station OIU using Lead On & Off set points (LSH-1-4-1-1, LSL-1-4-1-1), Lag 1, Lag 2, and

Lag3 On & Off set points (LSH-1-4-1-2, -3, -4 LSL-1-4-1-2, -3, -4). Initial settings for On and Off set points are as follow:

a. Lead On: 837.00 Elev.
b. Lag 1 On: 838.00 Elev.
c. Lag 2 On: 838.50 Elev.
d. Lag 3 On: 839.00 Elev.
e. Lead Off: 835.50 Elev.
f. Lag 1 Off: 836.50 Elev.
g. Lag 2 Off: 837.00 Elev.
h. Lag 3 Off: 837.50 Elev.

3. Backup float control shall not require PLC to be operational to function. Should either Low-Low or High-High level floats LSLL-2-3-1 or LSHH-2-3-1 activate pumps shall go into Backup mode of operation and Backup Active indicator YA-2-3-1 shall be illuminated and maintained until Reset Backup HS-2-3-1 push button is pressed which shall also deactivate High-High LLHH-2-3-1 and Low-Low LLLL-13-1 indicators. All Storm Water Pumps in "Auto" mode shall start after a stagger timed start when float High-High signal is active and High-High indicator shall be illuminated and maintained until float Low-Low signal is activated and then Storm Water Pumps shall stop. Low-Low Level Float shall have an adjustable 0 – 60 sec Delay On timer (outside PLC) before Low-Low signal is activated, initially set at 15 seconds. Float Low-Low indicator shall be illuminated and maintained until float High-High signal is active. Float Low-Low signal active shall stop Storm Water Pumps in "Auto" mode. Backup active signal is required as a PLC input for remote monitoring.
4. Lead, Lag 1, Lag 2, and Lag 3 shall be selected using Pump Station enclosure mounted selector switches HS-2-4-1-4, 2-4, -3-4 & -4-4. Invalid Sequence Selector Alarm indicator shall be illuminated if a pump is not in Lead, Lag, Lag 1, or Lag 2 position for more than 30 seconds.
5. Storm Water Wet Well Level indicator LI-2-4-1-1 and Pump Station OIU indicator LI-2-4-1-2 shall display level 4 – 20 mAdc from level transmitter LIT-2-4-1. Level Alarm indicator LA-2-4-1 shall be illuminated and maintain when 4 – 20 mAdc signal is at or below 3.75 mAdc or at or above 21.75 mAdc levels depending on how LIT-2-4-1 is configured. Adjustable Low-Low and High-High Storm Water Wet Well Alarm levels shall be set at Pump Station OIU using LSLL-2-4-1-1 and LSHH-2-4-1-1. When levels are reached (and beyond) the respective indicators shall be illuminated. Initial settings for High-High and Low-Low set points are as follow:

a. High-High (radar level): 840.50 Elev.
b. Warning (radar level): 840.25 Elev.
c. Low-low (radar level): 836.50 Elev.

6. Sump Pump shall be controlled via Hand-Off-Remote selector switch HS-2-7-1-2 and field mounted On/Off selector switch HS-2-7-1-1. When HOA selector switch is in "Off" mode pump shall not run. When in "Hand or Auto" mode pump shall be controlled via Loadout Station BC-LCP-2 Start / Stop push buttons HS-1-7-1-1 and 1-7-1-2 respectively. When in "Auto" mode pump shall be Stopped when Low-Low level float LSLL-1-8-1is active. Provide power to illuminate YL-1-7-1-1 Pump Run and YL-1-7-1-2 Pump Ready indicators in Loadout Station BC-LCP-2. Ready means that motor controller is powered, pump is not in fail from previous run, and HS-1-7-1-3 HOA selector switch is in "Auto" mode. Control of Sump pump shall be via PLC output wired to motor controller.
7. Start Delay Timers KC-1-4-1-1, -2-1, -3-1, and -4-1shall delay the start of pump for every pump start in all modes of operation. Pump fail logic shall account for delays before reporting Fail status.
8. Monitor Seal Fail and High Temp signals from pump vendor supplied pump protection modules (in MCC/ Motor Starters) and display on OIU at Pump Station for Storm Water Pumps and Sump Pump. Seal Fail and High Temp signals will stop pump from running at MCC/Motor Starter.
9. Bypass Gate and Inlet Gate control shall be controlled via respective front of enclosure Open-Close selector switch HS-2-2-1-3, -2-1-1-3 and respective HMI Manual-Auto selector

switch HS-2-2-1-4, -2-1-1-4. When either HMI Manual-Auto selector switches are put into Auto mode both must be set to Auto mode. Front of enclosure Open-Close selector switch HS-2-2-1-3 shall control Bypass Gate when HMI Manual-Auto selector switch HS-2-2-1-4 is in Manual mode. Front of enclosure Open-Close selector switch HS-2-1-1-3 shall control Inlet Gate when HMI Manual-Auto selector switch HS-2-1-1-4 is in Manual mode. When HMI Manual-Auto selector switches are in Auto mode Inlet Gate shall open when LSHH-2-4-1-4, initially set at Elevation 840.50, is reached, when Inlet Gate is confirmed open then Bypass Gate shall be closed. When LSLL-2-4-1-5, initially set at Elevation 836.25, is reached Bypass Gate shall open, when Bypass Gate is confirmed open then Inlet gate shall close. Respective Bypass and Inlet Gate Fail to Open and Fail to Close indicators shall be illuminated when gates do not open or close in an adjustable time period in any mode of operation.

10. Monitor and alarm normal Control Power Failure and indicate on OIU at Pump Station. Monitor and alarm UPS Battery Failure signal from UPS on OIU at Pump Station.
11. Send the following data via RTU and Radio additions to existing Trunk Radio system to Main WWTP:
    a. Pump Fail (5)
    b. Pump High Temp (5)
    c. Pump Seal Fail (5)
    d. Inlet Gate Open
    e. Inlet Gate Close
    f. Bypass Gate Open
    g. Bypass Gate Closed
    h. Wet Well Level
    i. Pump Station in Backup Level Control
    j. Normal Power Fail
    k. Provide for five spare future signals

2.11 SOFTWARE

A. Provide development software license and installation media for PLC configuration and programming.

B. Provide development software license and installation media for OIU screen configuration and programming.

2.12 TELEMETRY PANEL

A. Telemetry panel shall be provided as a complete package from a single supplier. City of Waterloo has incorporated a Trunk Radio telemetry network. Telemetry panels provided in this contract shall interface with existing telemetry system.

B. Current Trunk Radio provider: Radio Communications Systems, 1657 Falls Avenue, Waterloo, Iowa 50701. Contact: Dave Burger, phone 319-234-3511.

C. Components:

1. Control panel: Full windowed 36 inch by 36 inch by 12 inch enclosure as defined above.
2. RTU:
    a. Application and Tag Number: Provide unique tag number consistent with Waterloo Water Pollution Control Trunk Radio Network for North and South US 63 Pump Stations.
    b. RTU system shall be comprised of RTU enclosure and I/O madule.
    c. I/O module shall support 16 discrete inputs, 16 open collector outputs, four analog inputs, and four analog output.

d. Manufacturer and Model: Zetron, Model 18+ (901-9287), no substitutions.

3. Radio:
   a. Application Tag Number: Provide unique tag number consistent with Waterloo Water Pollution Control Trunk Radio Network for North and South US 63 Pump Stations.
   b. Telemetry system interfaces with existing 800 MegaHertz Trunk Radio network, providing communication between selected lift stations and Wastewater Treatment Facility.
   c. Kenwood mobile 800 MegaHertz Trunking Control Station, model TK980K, no substitutions.
   d. Cabinet for Radio and Power Supply. BaseKen5, no substitutions.
   e. No ground plan 800 MegaHertz antenna.
   f. Manufacturer: Kenwood, no substitutions.

2.13 SOURCE QUALITY CONTROL

A. Test equipment furnished under this section:

1. Test each PLC with I/O cards installed. Simulate I/O devices to test PLC I/Os.
2. Demonstrate control strategies.
3. During testing have manufacturer's operation manuals for each item of equipment available.

B. Examine equipment for compliance with contract documents prior to In-Factory Tests:

1. Panel dimensions, layout, wiring, and components.
2. Components are installed and wired.
3. Wire and termination identification.
4. Direct access to field wire termination points.
5. Direct access to components for maintenance.
6. Wiring and wire harness construction.
7. Software packages are installed.
8. Correct deficiencies.

C. In-Factory Tests:

1. Test hardware, software, and configuration.
2. Demonstrate operation and functionality of system under simulated conditions:
   a. Run hardware diagnostics.
   b. Demonstrate software loading process for PLCs, OIUs, and PCs.
   c. Perform system backup and restart.
   d. Reaction to PLC equipment failure.
   e. I/O point output signal generation and input signal processing.
   f. Communication of network components.
   g. Demonstrate change of state for discrete input and output functions on display.
   h. Demonstrate analog input and output functions on display, test at 0, 50, and 100%.
   i. Demonstrate each report.
   j. Demonstrate control strategies and displays.
   k. Demonstrate calculations.
   l. Demonstrate system response to failure of each type of equipment on network.
   m. Demonstrate outputs to alarm system.
3. Confirm response times between network components.

D. Correct deficiencies.

E. Prepare wiring diagram incorporating factory test corrections.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and wire in accordance with manufacturer's written instructions and approved submittals.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Supplier's or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by City for man-days indicated, travel time excluded, for assistance during plant construction, plant startup, and training of City's personnel for plant operation. Include minimum man-days indicated in Section 16900.

3.03 FIELD TESTING

A. Preparation:

1. Schedule field testing which affects plant operation through Contracting Authority 48 hours before testing.
2. Resolve interface discrepancies between I/O subsystem, panels, equipment, and instrumentation.
3. Maintenance:
    a. Perform maintenance on equipment throughout course of Work.
    b. Perform preventative maintenance in accordance with manufacturer's recommendations.
    c. Keep maintenance records with equipment and make records available for examination during Work.
4. Before Start of Testing:
    a. Have O&M manuals for each item of equipment on-site during testing.
    b. Have spare parts, expendables, and test equipment pertinent to equipment being tested on-site during testing.
    c. Check equipment against submittals.
    d. Verify equipment is installed properly.

B. Testing:

1. Test in accordance with contract documents and manufacturer's recommendations.
2. Power up equipment and run diagnostics to verify proper operation.
3. After installation of equipment test OIUs, PCs, PLCs, and I/Os:

    a. Verify communications between system components.
    b. Test panel I/O from field device, through I&C panel terminations, and through to OIU/PC screens utilizing configured software.
    c. Use actual signals whenever possible using installed equipment. When not possible, simulated signals are acceptable.

4. Test operation of process control system. Coordinate testing with Contracting Authority all equipment, all logic functions, and input/outputs.
5. Correct deficiencies found during testing.
6. Use Schedules 2 and 3 to Section 16916 to document field testing, store documentation on Site.

C. System Demonstration:

1. Test all components of pump station control system.

3.04 I/O LIST - SCHEDULE 1 TO SECTION 16916

A. Schedule Column Definitions:

1. TAG: Field instrument, local panel, equipment, or panel device tag number.
2. P&ID: Process and instrumentation Drawing number where point terminates at PLC.
3. DESCRIPTION: Alphanumeric character string.
4. SIGNAL TYPE: One of following:
   a. AI designates analog input.
   b. DI designates digital input.
   c. DO designates digital output.
   d. AO designates analog output.
5. DATA FIELD 1 and DATA FIELD 2: Signal Type describes function or signal characteristics.
   a. Analog Input (AI):
      1) DATA FIELD 1: Signal type and units.
      2) DATA FIELD 2: Range and engineering unit.
   b. Digital Input (DI):
      1) ATA FIELD 1: Contact closed.
      2) ATA FIELD 2: Contact open.
   c. Digital Output (DO):
      1) ATA FIELD 1: Contact closed.
      2) ATA FIELD 2: Contact open.
   d. Analog Output (AO):
      1) DATA FIELD 1: Signal type and units.
      2) DATA FIELD 2: Range and engineering units.
6. PLC NUMBER is number of PLC where signal terminates.

B. Schedule 1:

SCHEDULE 1 TO SECTION 16916						
Tag	**P&ID**	**Description**	**Signal Type**	**Data Field 1**	**Data Field 2**	**PLC Number**
HS-1-3-1	M-150	Backup Level Reset	DI	Reset Level	Not Reset Level	N63-PLC-1
YA-1-3-1	M-150	Backup Level Active	DI	Backup Active	Not Backup Active	N63-PLC-1
LI-1-4-1	M-150	Wet Well Level	AI	4 – 20 mAdc	0 - ??Feet	LI-1-4-1
ZLC-1-2-1	M-150	Bypass Gate Closed	DI	Closed	Not Closed	N63-PLC-1
ZLO-1-2-1	M-150	Bypass Gate Opened	DI	Open	Not Open	N63-PLC-1
HS-1-2-1-1a	M-150	Bypass Gate Open Manual Request	DI	Open Request	Not Open Request	N63-PLC-1
HS-1-2-1-1b	M-150	Bypass Gate Close Manual Request	DI	Close Request	Not Close Request	N63-PLC-1
SLD-1-2-1a	M-150	Bypass Gate Open Command	DO	Open Command	Not Open Command	N63-PLC-1
SLD-1-2-1b	M-150	Bypass Gate Close Command	DO	Close Command	Not Close Command	N63-PLC-1
YA-1-13-1	M-150	Normal Power Fail	DI	Power Fail	Not Power Fail	N63-PLC-1
YA-1-3-1	M-150	Backup Level Active	DO	Backup Active	Not Backup Active	N63-PLC-1
ZLC-1-2-1	M-150	Bypass Gate Closed	DO	Gate Closed	Not Gate Closed	N63-PLC-1
ZLO-1-2-1	M-150	Bypass Gate Open	DO	Gate Open	Not Gate Open	N63-PLC-1
YA-1-13-1	M-150	Normal Power Fail	DO	Power Fail	Not Power Fail	N63-PLC-1
LSH-1-4-1-1	M-150	Storm Water Lead Pump Required	DO	Required	Not Required	N63-PLC-1
LSH-1-4-1-2	M-150	Storm Water Lag1 Pump Required	DO	Required	Not Required	N63-PLC-1
LSH-1-4-1-3	M-150	Storm Water Lag 2 Pump Required	DO	Required	Not Required	N63-PLC-1
YA-1-5-1-1	M-150	Storm Water Pump No.1 Fail	DO	Fail	Not Fail	N63-PLC-1
XY-1-5-1	M-150	Storm Water Pump No.1 Reset	DO	Reset	Not Reset	N63-PLC-1
TAH-1-5-1	M-150	Storm Water Pump No.1 High Temp	DO	High Temp	Not High Temp	N63-PLC-1
YA-1-5-1-2	M-150	Storm Water Pump No.1 Seal Fail	DO	Seal Fail	Not Seal Fail	N63-PLC-1
HS-1-5-1-1	M-150	Storm Water Pump No.1 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	N63-PLC-1
YL-1-5-1-1	M-150	Storm Water Pump No.1 Run	DI	Run	Not Run	N63-PLC-1
TAH-1-5-1	M-150	Storm Water Pump No.1 High Temp	DI	High Temp	Not High Temp	N63-PLC-1
YA-1-5-1-2	M-150	Storm Water Pump No.1 Seal Fail	DI	Seal Fail	Not Seal Fail	N63-PLC-1
YL-1-5-1-2	M-150	Storm Water Pump No.1 Remote	DI	Remote	Not Remote	N63-PLC-1
HS-1-5-1-2a	M-150	Storm Water Pump No.1 Hand	DI	Hand	Not Hand	N63-PLC-1
HS-1-5-1-2b	M-150	Storm Water Pump No.1 Auto	DI	Auto	Not Auto	N63-PLC-1
HS-1-5-1-3	M-150	Storm Water Pump No.1 Reset	DI	Reset	Not Reset	N63-PLC-1
YA-1-5-2-1	M-150	Storm Water Pump No.2 Fail	DO	Fail	Not Fail	N63-PLC-1
XY-1-5-2	M-150	Storm Water Pump No.2 Reset	DO	Reset	Not Reset	N63-PLC-1

SCHEDULE 1 TO SECTION 16916						
Tag	**P&ID**	**Description**	**Signal Type**	**Data Field 1**	**Data Field 2**	**PLC Number**
TAH-1-5-2	M-150	Storm Water Pump No.2 High Temp	DO	High Temp	Not High Temp	N63-PLC-1
YA-1-5-2-2	M-150	Storm Water Pump No.2 Seal Fail	DO	Seal Fail	Not Seal Fail	N63-PLC-1
HS-1-5-2-1	M-150	Storm Water Pump No.2 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	N63-PLC-1
YL-1-5-2-1	M-150	Storm Water Pump No.2 Run	DI	Run	Not Run	N63-PLC-1
TAH-1-5-2	M-150	Storm Water Pump No.2 High Temp	DI	High Temp	Not High Temp	N63-PLC-1
YA-1-5-2-2	M-150	Storm Water Pump No.2 Seal Fail	DI	Seal Fail	Not Seal Fail	N63-PLC-1
YL-1-5-2-2	M-150	Storm Water Pump No.2 Remote	DI	Remote	Not Remote	N63-PLC-1
HS-1-5-2-2a	M-150	Storm Water Pump No.2 Hand	DI	Hand	Not Hand	N63-PLC-1
HS-1-5-2-2b	M-150	Storm Water Pump No.2 Auto	DI	Auto	Not Auto	N63-PLC-1
HS-1-5-2-3	M-150	Storm Water Pump No.2 Reset	DI	Reset	Not Reset	N63-PLC-1
YA-1-5-3-1	M-150	Storm Water Pump No.3 Fail	DO	Fail	Not Fail	N63-PLC-1
XY-1-5-3	M-150	Storm Water Pump No.3 Reset	DO	Reset	Not Reset	N63-PLC-1
TAH-1-5-3	M-150	Storm Water Pump No.3 High Temp	DO	High Temp	Not High Temp	N63-PLC-1
YA-1-5-3-2	M-150	Storm Water Pump No.3 Seal Fail	DO	Seal Fail	Not Seal Fail	N63-PLC-1
HS-1-5-3-1	M-150	Storm Water Pump No.3 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	N63-PLC-1
YL-1-5-3-1	M-150	Storm Water Pump No.3 Run	DI	Run	Not Run	N63-PLC-1
YA-1-5-3-3	M-150	Storm Water Pump No.3 High Temp	DI	High Temp	Not High Temp	N63-PLC-1
YA-1-5-3-2	M-150	Storm Water Pump No.3 Seal Fail	DI	Seal Fail	Not Seal Fail	N63-PLC-1
YL-1-5-3-2	M-150	Storm Water Pump No.3 Remote	DI	Remote	Not Remote	N63-PLC-1
HS-1-5-3-2a	M-150	Storm Water Pump No.3 Hand	DI	Hand	Not Hand	N63-PLC-1
HS-1-5-3-2b	M-150	Storm Water Pump No.3 Auto	DI	Auto	Not Auto	N63-PLC-1
HS-1-5-3-3	M-150	Storm Water Pump No.3 Reset	DI	Reset	Not Reset	N63-PLC-1
HS-2-3-1	M-250	Backup Level Reset	DI	Reset Level	Not Reset Level	S63-PLC-1
YA-2-3-1	M-250	Backup Level Active	DI	Backup Active	Not Backup Active	S63-PLC-1
LI-2-4-1	M-250	Wet Well Level	AI	4 – 20 mAdc	0 - ??Feet	LI-2-4-1
ZLC-2-1-1	M-250	Inlet Gate Closed	DI	Closed	Not Closed	S63-PLC-1
ZLO-2-1-1	M-250	Inlet Gate Opened	DI	Open	Not Open	S63-PLC-1
HS-2-1-1-1a	M-250	Inlet Gate Open Manual Request	DI	Open Request	Not Open Request	S63-PLC-1
HS-2-1-1-1b	M-150	Inlet Gate Close Manual Request	DI	Close Request	Not Close Request	S63-PLC-1
SLD-2-1-1a	M-150	Inlet Gate Open Command	DO	Open Command	Not Open Command	S63-PLC-1
SLD-2-1-1b	M-150	Inlet Gate Close Command	DO	Close Command	Not Close Command	S63-PLC-1
ZLC-2-2-1	M-250	Bypass Gate Closed	DI	Closed	Not Closed	S63-PLC-1

SCHEDULE 1 TO SECTION 16916						
Tag	**P&ID**	**Description**	**Signal Type**	**Data Field 1**	**Data Field 2**	**PLC Number**
ZLO-2-2-1	M-250	Bypass Gate Opened	DI	Open	Not Open	S63-PLC-1
HS-2-2-1-1a	M-150	Bypass Gate Open Manual Request	DI	Open Request	Not Open Request	S63-PLC-1
HS-2-2-1-1b	M-150	Bypass Gate Close Manual Request	DI	Close Request	Not Close Request	S63-PLC-1
SLD-2-2-1a	M-150	Bypass Gate Open Command	DO	Open Command	Not Open Command	S63-PLC-1
SLD-2-2-1b	M-150	Bypass Gate Close Command	DO	Close Command	Not Close Command	S63-PLC-1
YA-2-13-1	M-250	Normal Power Fail	DI	Power Fail	Not Power Fail	S63-PLC-1
YA-2-3-1	M-250	Backup Level Active	DO	Backup Active	Not Backup Active	S63-PLC-1
ZLC-2-1-1	M-250	Inlet Gate Closed	DO	Gate Closed	Not Gate Closed	S63-PLC-1
ZLO-2-1-1	M-250	Inlet Gate Open	DO	Gate Open	Not Gate Open	S63-PLC-1
ZLC-2-2-1	M-250	Bypass Gate Closed	DO	Gate Closed	Not Gate Closed	S63-PLC-1
ZLO-2-2-1	M-250	Bypass Gate Open	DO	Gate Open	Not Gate Open	S63-PLC-1
YA-2-13-1	M-250	Normal Power Fail	DO	Power Fail	Not Power Fail	S63-PLC-1
LSH-2-4-1-1	M-250	Storm Water Lead Pump Required	DO	Required	Not Required	S63-PLC-1
LSH-2-4-1-2	M-250	Storm Water Lag1 Pump Required	DO	Required	Not Required	S63-PLC-1
LSH-2-4-1-3	M-250	Storm Water Lag 2 Pump Required	DO	Required	Not Required	S63-PLC-1
LSH-2-4-1-4	M-250	Storm Water Lag 3 Pump Required	DO	Required	Not Required	S63-PLC-1
P-2-7-1	M-250	Sump Pump Required	DO	Required	Not Required	S63-PLC-1
YA-2-5-1-1	M-250	Storm Water Pump No.1 Fail	DO	Fail	Not Fail	S63-PLC-1
XY-2-5-1	M-250	Storm Water Pump No.1 Reset	DO	Reset	Not Reset	S63-PLC-1
TAH-2-5-1	M-250	Storm Water Pump No.1 High Temp	DO	High Temp	Not High Temp	S63-PLC-1
YA-2-5-1-2	M-250	Storm Water Pump No.1 Seal Fail	DO	Seal Fail	Not Seal Fail	S63-PLC-1
HS-2-5-1-1	M-250	Storm Water Pump No.1 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	S63-PLC-1
YL-2-5-1-1	M-250	Storm Water Pump No.1 Run	DI	Run	Not Run	S63-PLC-1
TAH-2-5-1	M-250	Storm Water Pump No.1 High Temp	DI	High Temp	Not High Temp	S63-PLC-1
YA-2-5-1-2	M-250	Storm Water Pump No.1 Seal Fail	DI	Seal Fail	Not Seal Fail	S63-PLC-1
YL-2-5-1-2	M-250	Storm Water Pump No.1 Remote	DI	Remote	Not Remote	S63-PLC-1
HS-2-5-1-2a	M-250	Storm Water Pump No.1 Hand	DI	Hand	Not Hand	S63-PLC-1
HS-2-5-1-2b	M-250	Storm Water Pump No.1 Auto	DI	Auto	Not Auto	S63-PLC-1
HS-2-5-1-3	M-250	Storm Water Pump No.1 Reset	DI	Reset	Not Reset	S63-PLC-1
HS-2-5-1-4	M-250	Storm Water Pump No.1 Lead/Lag Position select	DI	Position Select	NA	S63-PLC-1
YA-2-5-2-1	M-250	Storm Water Pump No.2 Fail	DO	Fail	Not Fail	S63-PLC-1
XY-2-5-2	M-250	Storm Water Pump No.2 Reset	DO	Reset	Not Reset	S63-PLC-1
TAH-2-5-2	M-250	Storm Water Pump No.2 High Temp	DO	High Temp	Not High Temp	S63-PLC-1

SCHEDULE 1 TO SECTION 16916						
Tag	**P&ID**	**Description**	**Signal Type**	**Data Field 1**	**Data Field 2**	**PLC Number**
YA-2-5-2-2	M-250	Storm Water Pump No.2 Seal Fail	DO	Seal Fail	Not Seal Fail	S63-PLC-1
HS-2-5-2-1	M-250	Storm Water Pump No.2 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	S63-PLC-1
YL-2-5-2-1	M-250	Storm Water Pump No.2 Run	DI	Run	Not Run	S63-PLC-1
TAH-2-5-2	M-250	Storm Water Pump No.2 High Temp	DI	High Temp	Not High Temp	S63-PLC-1
YA-2-5-2-2	M-250	Storm Water Pump No.2 Seal Fail	DI	Seal Fail	Not Seal Fail	S63-PLC-1
YL-2-5-2-2	M-250	Storm Water Pump No.2 Remote	DI	Remote	Not Remote	S63-PLC-1
HS-2-5-2-2a	M-250	Storm Water Pump No.2 Hand	DI	Hand	Not Hand	S63-PLC-1
HS-2-5-2-2b	M-250	Storm Water Pump No.2 Auto	DI	Auto	Not Auto	S63-PLC-1
HS-2-5-2-3	M-250	Storm Water Pump No.2 Reset	DI	Reset	Not Reset	S63-PLC-1
HS-2-5-2-4	M-250	Storm Water Pump No.2 Lead/Lag Position select	DI	Position Select	NA	S63-PLC-1
YA-2-5-3-1	M-250	Storm Water Pump No.3 Fail	DO	Fail	Not Fail	S63-PLC-1
XY-2-5-3	M-250	Storm Water Pump No.3 Reset	DO	Reset	Not Reset	S63-PLC-1
TAH-2-5-3	M-250	Storm Water Pump No.3 High Temp	DO	High Temp	Not High Temp	S63-PLC-1
YA-2-5-3-2	M-250	Storm Water Pump No.3 Seal Fail	DO	Seal Fail	Not Seal Fail	S63-PLC-1
HS-2-5-3-1	M-250	Storm Water Pump No.3 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	S63-PLC-1
YL-2-5-3-1	M-250	Storm Water Pump No.3 Run	DI	Run	Not Run	S63-PLC-1
YA-2-5-3-3	M-250	Storm Water Pump No.3 High Temp	DI	High Temp	Not High Temp	S63-PLC-1
YA-2-5-3-2	M-250	Storm Water Pump No.3 Seal Fail	DI	Seal Fail	Not Seal Fail	S63-PLC-1
YL-2-5-3-2	M-250	Storm Water Pump No.3 Remote	DI	Remote	Not Remote	S63-PLC-1
HS-2-5-3-2a	M-250	Storm Water Pump No.3 Hand	DI	Hand	Not Hand	S63-PLC-1
HS-2-5-3-2b	M-250	Storm Water Pump No.3 Auto	DI	Auto	Not Auto	S63-PLC-1
HS-2-5-3-3	M-250	Storm Water Pump No.3 Reset	DI	Reset	Not Reset	S63-PLC-1
HS-2-5-3-4	M-250	Storm Water Pump No.3 Lead/Lag Position select	DI	Position Select	NA	S63-PLC-1
YA-2-5-4-1	M-250	Storm Water Pump No.4 Fail	DO	Fail	Not Fail	S63-PLC-1
XY-2-5-4	M-250	Storm Water Pump No.4 Reset	DO	Reset	Not Reset	S63-PLC-1
TAH-2-5-4	M-250	Storm Water Pump No.4 High Temp	DO	High Temp	Not High Temp	S63-PLC-1
YA-2-5-4-2	M-250	Storm Water Pump No.4 Seal Fail	DO	Seal Fail	Not Seal Fail	S63-PLC-1
HS-2-5-4-1	M-250	Storm Water Pump No.4 Disable Control	DI	Disable Ctrl	Not Disable Ctrl	S63-PLC-1
YL-2-5-4-1	M-250	Storm Water Pump No.4 Run	DI	Run	Not Run	S63-PLC-1
YA-2-5-4-3	M-250	Storm Water Pump No.4 High Temp	DI	High Temp	Not High Temp	S63-PLC-1
YA-2-5-4-2	M-250	Storm Water Pump No.4 Seal Fail	DI	Seal Fail	Not Seal Fail	S63-PLC-1
YL-2-5-4-2	M-250	Storm Water Pump No.4 Remote	DI	Remote	Not Remote	S63-PLC-1
HS-2-5-4-2a	M-250	Storm Water Pump No.4 Hand	DI	Hand	Not Hand	S63-PLC-1

SCHEDULE 1 TO SECTION 16916						
Tag	**P&ID**	**Description**	**Signal Type**	**Data Field 1**	**Data Field 2**	**PLC Number**
HS-2-5-4-2b	M-250	Storm Water Pump No.4 Auto	DI	Auto	Not Auto	S63-PLC-1
HS-2-5-4-3	M-250	Storm Water Pump No.4 Reset	DI	Reset	Not Reset	S63-PLC-1
HS-2-5-4-4	M-250	Storm Water Pump No.4 Lead/Lag Position select	DI	Position Select	NA	S63-PLC-1
YA-2-7-1-1	M-250	Sump Pump Fail	DO	Fail	Not Fail	S63-PLC-1
XY-2-7-1	M-250	Sump Pump Reset	DO	Reset	Not Reset	S63-PLC-1
TAH-2-7-1	M-250	Sump Pump High Temp	DO	High Temp	Not High Temp	S63-PLC-1
YA-2-7-1-2	M-250	Sump Pump Seal Fail	DO	Seal Fail	Not Seal Fail	S63-PLC-1
HS-2-7-1-1	M-250	Sump Pump On Request	DI	On	Not On	S63-PLC-1
YL-2-7-1-1	M-250	Sump Pump Run	DI	Run Request	Not Run Request	S63-PLC-1
YA-2-7-1-3	M-250	Sump Pump High Temp	DI	High Temp	Not High Temp	S63-PLC-1
YA-2-7-1-2	M-250	Sump Pump Seal Fail	DI	Seal Fail	Not Seal Fail	S63-PLC-1
YL-2-7-1-2	M-250	Sump Pump Remote	DI	Remote	Not Remote	S63-PLC-1
HS-2-7-1-2a	M-250	Sump Pump Hand	DI	Hand	Not Hand	S63-PLC-1
HS-2-7-1-2b	M-250	Sump Pump Auto	DI	Auto	Not Auto	S63-PLC-1
HS-2-7-1-3	M-250	Sump Pump Reset	DI	Reset	Not Reset	S63-PLC-1

Digital Testing Report Form, Schedule 2 to Section 16916.

Tag No.	Description	I/O Address	Data Type	PLC	OIU	Field	Comments	Date	Time	Initials

SYSTEM HOUSE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

I hereby certify the SYSTEMS HOUSE has inspected this equipment and conducted the required tests and that it has been properly installed, adjusted, and calibrated. I further certify this equipment may now be operated for test purposes and/or normal use.

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

This form shall be completed and submitted to Engineer prior to start of Configuration and Hardware testing.

Analog Test Report Form, Schedule 3 to Section 16916:

Tag No.	Description	I/O Address	Data Type	Read Values 10%/50%/90%	PLC	OIU	Comments	Date	Time	Initials
				/ /						

SYSTEM HOUSE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

I hereby certify the SYSTEMS HOUSE has inspected this equipment and conducted the required tests and that it has been properly installed, adjusted, and calibrated. I further certify this equipment may now be operated for test purposes and/or normal use.

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

This form shall be completed and submitted to Engineer prior to start of Configuration and Hardware testing.

* * * END OF SECTION * * *

SECTION 40 05 62
FRP SLUICE GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Gates of fiberglass reinforced polyester (FRP) sluice gate with pedestal-mounted manual actuator and extension stems and wall-mounted stem guide accessories.

1.02 SYSTEM DESCRIPTION

A. Design Requirements:

1. Conform to AWWA C563 except as modified.
2. Proportion for stresses occurring during continuous operation, and for additional stresses occurring during fabrication or installation to parts of various control structures.
3. Sluice gate assemblies maximum fiber stress (ultimate or yield whichever applies) shall not exceed 2.5 times working stress.
4. Reinforce gates to withstand maximum seating head with deflection of less than L/360 of gate width or 1/4 inch, whichever is less.
5. Design gates with unseating heads for maximum deflection of L/360 of gate width or 1/16 inch, whichever is less at maximum operating head.
6. Gates shall be flat and level.
7. Warpage throughout entire gate shall not produce crown of more than 1/16 inch in any direction.
8. Gates shall be as shown on plans and as specified in Schedule 1.

B. Performance Requirements:

1. Field Leakage Criteria:
   a. Seating Head: Leakage shall not exceed 0.1 gallon per minute per foot of periphery under design head conditions.
   b. Unseating Head: Leakage shall not exceed 0.2 gallon per minute per foot of periphery under design head less than 20 feet. For heads greater than 20 feet, leakage shall not exceed 0.2 gallon per minute per foot plus 0.005 gallon per minute per foot for each foot of head greater than 20 feet.
2. Composition of gate laminate shall be in accordance with the Quality Assurance Report for Reinforced Thermostat Plastic (RTP) Corrosion Resistant Equipment, Society of the Plastics Industry, Inc. (SPI), and Material Technology Institute of the Chemical Process Industries, Inc. (MTI), for “Hand Lay-Up Laminates.”
   a. Composition of gate laminate shall meet specifications for Type 1, Grade 10 laminates shown in Appendix M-1.

1.03 SUBMITTALS

A. General:

1. Submit Product Data and Shop Drawings in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals are unacceptable.

B. Shop Drawings:

1. Installation and assembly drawings and specifically prepared technical data for each gate assembly.

C. Product Data:

1. Catalog cuts and product specifications for gate components and operators.
2. Proposed coating system. Submittal information for coating system.

D. Submit above in accordance with Section 1105 of the Standard Specifications.

E. Operation and Maintenance (O&M) Data.

1. Submit in accordance with Section 1105 of the Standard Specifications and Civil General Notes in plans.

1.04 QUALITY ASSURANCE

A. Items of equipment shall be end products of 1 manufacturer in order to achieve standardization for maintenance, spare parts, operation, and manufacturer's service.

B. Defects:

1. No cracks, crazing, blisters, chips, pits, dry spots, fish eyes, burned areas or entrapped air.
2. No wrinkles and solid blisters with maximum deviation of 10% of thickness, not to exceed 1/8 inch.
3. No surface porosity (pinholes or pores in laminate surface).
4. No exposed glass, exposure of cut edges.
5. No scratches more than 0.002 inch deep.
6. No foreign matter.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Plasti-Fab, Inc., Series Heavy Duty Titeseal, Tualatin, OR.

2.02 MATERIALS

A. Head Frames, Guides and Operator Support Yoke: Type 304 Stainless Steel (SS).

B. Gates:

1. Fiberglass reinforced polyester (FRP) totally encapsulating an internal reinforcing structure.
2. Structural characteristics for 1/8-inch glass mat laminate shall meet minimum physical properties:

a.	Tensile Strength	17,900 psi
b.	Flexural Modulus	800,000 - 900,000 psi
c.	Flexural Strength	27,600 psi
d.	Compressive Strength	22,000 psi
e.	Impact Strength	9.0 foot-pounds/inch
f.	Water Absorption	0.13% (in 24 Hours)

C. Stems and Gate Hardware: 304 Stainless Steel.
D. Closure Seals:

1. Hollow Bulb J-Seals and Bottom Wedge Seal - Molded of extruded virgin EPDM with vulcanized corners per ASTM D-2000.
   a. Specific Gravity 1.25
   b. Hardness 55 - 65 Shore A Durometer
   c. Tensile Strength 15,000 psi min.
   d. Elongation 300%
   e. Low Temperature Brittleness -40°F
2. J-Seal Clamping Bars and Fasteners: FRP
3. Wear Strips - UHMW Polyethylene.
   a. Tensile Strength 5600 psi
   b. Water Absorption 0.01% (in 24 Hours)
   c. Flexural Modulus (@731 F) 130,000 - 140,000 psi
   d. Coefficient of Friction 0.15

2.03 MANUAL OPERATORS

A. Lift Nuts and Thrust Nuts - Manganese Bronze. ASTM B-584, Alloy 865.

B. Thrust Collar - Cast Iron. ASTM A-126 Class B.

C. Anchor Bolts - T-316 Stainless Steel.

2.04 ELECTRIC MOTOR ACTUATORS

A. Gates shall be equipped with permanently installed electric motor actuators with Open/Close control.

B. Electric motor actuator shall be designed to move gate slide at rate of 10 to 14 inches per minute under specified head conditions.

C. Electric motor actuators shall include, but not be limited to, electric motor, reduction gearing, drive coupling between final drive gear and valve stem, torque switches, position limit switches, limit switch gearing, bored and key-wayed drive sleeve, declutch lever, gear case, and auxiliary handwheel as self-contained unit.

D. Unless otherwise indicated on Gate Schedule, OPEN/CLOSE service is assumed. Where modulating service is specified, actuators shall be equipped with 4-20 mA input and output positioning signals.

E. Actuator shall be suitable for area in which it is installed. Enclosure shall be rated minimum NEMA 4.

F. Manufacturers:

1. Auma.
2. Gate manufactures or equal.

G. Motor:

1. 460 volt, 3 phase, 60 Hertz
2. Rated for duty at 122°Fahrenheit ambient.
3. For Open/Close Applications: Motors, Class F with 15-minute duty rating.

H. Gears:
1. Reduction shall be accomplished by means of spur, helical, bevel, and/or worm gears.
2. Gears shall be carburized and hardened alloy steel with threads ground after heat treating.

3. Worm gears shall be alloy bronze accurately cut with hobbing machine.

I. Bearings:

1. All gears and shafting shall be supported on ball or roller bearings.
2. Where thrust is consideration, roller or axial-thrust needle bearings (to accept thrust) shall be provided.

J. Lubrication:

1. All gearing and bearings shall be grease-lubricated.
2. Lubricants shall be suitable for year-round service based on prevailing ambient temperatures from 0°F to 150°F.

K. Drive Coupling:

1. Mating of electric motor actuator to driven equipment shall be accomplished by separate, removable drive coupling.
2. Drive coupling shall be bronze stem nut for rising stem applications.
3. Drive coupling shall be steel bushing for shaft and key applications.

L. Limit Switches:

1. Provide field-adjustable open and close limit switches capable of being set either fully-open, fully-closed, or at any intermediate position. Set switches to trip at fully-open and fully-closed gate positions.
2. Open and close limit switches shall be geared to drive mechanism and in step at all times whether or not unit is operated electrically or manually.
3. Limit switch gearing shall be appropriately lubricated and totally enclosed to exclude foreign material and prevent loss of lubricant.
4. Factory wire electrical interconnections between limit switches, torque switches, and limit switch gearing, ready for operation.

M. Torque Switches:

1. Each gate shall include field-adjustable double torque switch, responsive to load encountered in either direction of travel.
2. Open torque switch bypass circuit shall be provided for torque-seated gates to eliminate nuisance trip during unseating.

N. Electrical Controls:

1. For OPEN/CLOSE service, electrical controls shall include, but not be limited to, reversing starter, control power transformer, OPEN/STOP/CLOSE push buttons and indicating light(s).
2. Terminal strips, limit switches and torque switches shall be housed in NEMA 4 enclosure integral to actuator.

O. Manual Operation:

1. Auxiliary crank arm, removable, with 2 inch operating nut shall be provided for manual operation. Shall be in accordance with 2.14.G.
2. Transfer from power actuator operation to manual operation accomplished by positive declutching lever, which shall disengage motor gearing mechanically but not electrically.
3. Unit shall not be capable of being placed in manual operation when motor is running.

4. During manual operation, maximum force required to operate gate shall be 40 pounds pull on handwheel, or 50-foot-pounds torque on lift nut or input shaft.

2.05 GENERAL CONSTRUCTION

A. In conformance with AWWA C563-12.

B. Sluice Gate Cover: Fiberglass reinforced polyester totally encapsulating an internal reinforcing structure.

1. Copolymer Composite: Ultraviolet stabilized and seamless to protect inner structural members from corrosion caused by exposure to water or corrosive chemicals.

C. Furnish with complete frames, slides, J-seals, UHMW wear strip, operating stems, operators and necessary appurtenances.

2.06 GATES

A. Mold gate individually to dimensions specified:

1. Manufacture of reinforced thermoset plastic containing ultraviolet absorbers.
2. Surface shall be resin rich to depth of 0.010 inch to 0.020 inch and reinforced with C-glass or polymeric fiber surfacing material.
3. Surface shall be free of exposed reinforcing fibers.
4. Composition of layers shall be approximately 95% (by weight) resin.
5. Remaining laminate shall be made up of copolymer composite and reinforcing fibers in form, orientation and position to meet strength requirements.
6. Use structural reinforcing to attain necessary stiffness to meet deflection requirements, and encapsulate with laminate not less than 1/4-inch thick on each side to ensure against permeation by water to core areas.

B. Bolt Type T-316 stainless steel stem mounting bracket to gate.

1. Bolts shall not pass through or contact internal steel reinforcing.

C. Core Material: 100% resistant to decay and attack by fungus and bacteria and resistant to hydrocarbons.

2.07 SEALS

A. Elastomeric J-seals made of molded or extruded EPDM having hardness range of 55 to 65 shore A durometer and conforming to ASTM. D-2000. Maximum compression set of 25% and low temperature brittleness to meet suffix F-17 (-40°F).

B. Mount seals on gate covers with T-316 stainless steel capscrews and 316 stainless steel or FRP clamping bars. Provide means of repair, and replacement without dewatering channel.

C. Fasten 1/4-inch thick UHMW wear strip to opposite side of gate from J-seals along both sides, with coefficient of friction less than 0.15.

2.08 FRAMES AND GUIDES

A. Design guides for embedment, wall mounting to meet Project requirements.
B. Fabricate guides from 304 stainless steel and have slot for mating with gate cover.

C. Equip guides bolted to head wall with heavy duty slotted clips for ease of mounting to wall by using T-316 stainless steel anchors.

D. Guides extending above operating floor level to form bench stand upon which lift mechanism is fastened, shall be strong and rigid without use of additional stiffening members.

E. Head rail shall also be of 304 stainless steel and shall be affixed so as to allow gate to be removed from guide without disassembly.

F. Head rail shall have maximum deflection of 1/4 inch when subjected to horizontal force of four times 40 pound maximum handwheel pull.

G. Where wall-mounted guide frame extends above concrete wall, top anchor bolt shall be not more than 6 inches below top of wall.

H. Gate inverts shall be flush with channel bottom.

I. Do not use wall thimbles for installation.

2.09 OPERATING STEMS

A. Equip each slide gate with rising operating stem.

B. Stem shall be Type 304 stainless steel with Acme threads and provided with adjustable stop collars to limit upward and downward travel.

C. Stems shall have maximum L/R of 200.

D. Stem guides with FRP bushings shall be used to maintain an L/R of 200.

2.10 STEM COVERS

A. Galvanized steel stem covers shall be provided with vent holes to minimize condensation.

B. Stem covers shall be attached by a padklocked, threaded connection and be marked with "Open" and "Closed" position indicators.

2.11 ADJUSTABLE WEDGING DEVICE

A. Provide adjustable assembly to achieve specified leakage rate.

B. Adjustable wedging assembly shall be comprised of T-316 stainless steel wedging bar and silicon bronze adjusting bolts with locking nuts.

C. Adjusting bolts shall be non-galling for long-term easy adjustment.

D. Adjust gate seals at factory and in field to less than specified leakage rate.

2.12 ANCHOR BOLTS

A. Adhesive Anchors: Ramset/Red Head Epcon System or Hilti HIT System.

B. Not less than 1/2 inch diameter.

C. Provide anchor bolts with size to withstand force created by operation of gate.

2.13 COATING

A. Manufacturer shall be responsible for factory surface preparation, shop priming of any exposed ferrous metal surfaces. Do not paint or coat fiberglass components or stainless steel. Contractor is responsible for field painting. System shall comply with:

1. Surface Preparation: Ferrous Metal - SP6.
2. First Coat: 3.0 DFT/“Series 90-97 Zinc Rich Primer” by Tnemec.
3. Second Coat: 3.0 to 4.0 DFT/“73-Color Endura-Shield III” by Tnemec.

B. Coat machined or bearing surfaces and holes with protective grease until installation.

2.14 MANUALLY OPERATED FLOOR STANDS

A. Maximum effort of 40 pounds shall be required to unseat gate and maximum of 25 pounds to operate gate after it is unseated.

B. Enclosed gear type with crank capable of manual operation or by means of portable electric, gasoline or hydraulic-powered operator. Equipment to match existing City of Waterloo operators. Provide bracket (permanent or removable) for mounting of City of Waterloo’s hydraulic operator to floor stand.

C. Provide single or double gear reduction, depending upon lifting capacity required.

D. Type 316 stainless steel gears with machine cut teeth designed for smooth operation.

E. Mount gearing and lift nut in Type 304 stainless steel housing and support with Type 304 stainless steel pedestal to place input shaft or crank arm approximately 36 inches above floor.

F. Provide lubrication fittings in gear housing to permit lubrication of gears and bearings.

G. Removable Type 316 stainless steel crank arm with revolving Type 316 stainless steel grip. Equipment to match existing City of Waterloo operators.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install sluice gates in accordance with manufacturer's written recommendations and approved submittals.

B. Install on wall as indicated on drawings.

C. Adjust wedges to ensure gates seat properly.

D. Test gate as specified.

3.02 FIELD QUALITY CONTROL

A. After installation has been completed, test sluice gates under normal operating conditions in presence of Engineer.

B. Repair leaks or other imperfections found upon testing.

Schedule 1							
Equipment No.	**Qty.**	**Size (foot)**	**Frame Type**	**Flush Bottom**	**Design Head (foot)**	**Head Condition**	***Operator***
SLD-1-2-1	1	48”x48”	Surface-	Yes	22’	Seating	Electric
SLD-2-1-1	1	6’-0”Wx4’-	Mounted	Yes	25’	Seating	Actuator
SLD-2-2-1	1	0”H	Cast-In-Place	Yes	25’	Seating	Electric
		6’-0”Wx4’-	Cast-In-Place				Actuator
		0”H					Electric
							Actuator

3.03 FIELD TESTING

A. Preparation:

1. Schedule field testing which affects operation through Contracting Authority 48 hours before testing.
2. Maintenance:
   a. Perform maintenance on equipment throughout course of Work.
   b. Perform preventative maintenance in accordance with manufacturer’s recommendations.
   c. Keep maintenance records with equipment and make records available for examination during Work.
3. Before start of testing:
   a. Have O&M manuals on-site during testing.
   b. Have spare parts, expendables and test equipment pertinent to equipment being tested on-site during testing.
   c. Check equipment against submittals.
   d. Verify equipment is installed properly.

B. Testing:

1. Testing in accordance with contract documents and manufacturer’s recommendations.
2. Correct deficiencies found during testing.
3. Testing shall be to requirements of Section 1.02.B.1. If adequate head cannot be maintained for testing, or at Conractor’s sole discretion, testing may be performed with video monitoring equipment at no additional cost to Contracting Authority.

* * * END OF SECTION * * *

SECTION 40 05 90.07
STOP LOGS AND APPURTENANCES

PART 1- GENERAL

1.01 DESCRIPTION

A. Provide aluminum stop logs and appurtenances as indicated and in compliance with contract documents.

1.02 REFERENCES

A. Aluminum Association (AA):

1. ASM35: Aluminum Construction Manual.
2. H35.1: Aluminum Alloy and Temper Designation.

B. ASTM International (ASTM):

1. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. A276: Standard Specifications for Stainless Steel Bars and Shapes.
3. D2000: Standard Classification System for Rubber Products in Automotive Applications.
4. D4020: Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

C. American Welding Society Code (AWS):

1. D1.2: Structural Welding Code - Aluminum.
2. D1.6: Structural Welding Code – Stainless Steel.

1.03 SUBMITTALS

A. Submit the following Shop Drawings in accordance with Section 1105 of the Standard Specifications:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.
2. Data for stop log characteristics and performance.
3. Complete description of all materials, material thicknesses of all components.
4. Maximum bending stress and deflection of the stop logs under design head specified and indicated.
5. Installation drawings showing the details required for installation, dimensions, clearances and anchor bolt locations.
6. Recommended storage racks with dimensions and layout.
7. Shop drawing data for accessory items.
8. Certified setting plans, with tolerances, for anchor bolts.
9. Manufacturer's literature as needed to supplement certified data.
10. Operating and maintenance instructions and parts lists.
11. Shop and field inspection reports.
12. Qualifications of field service engineer.
13. Recommendations for short and long-term storage.
14. Field testing procedures and set up…
15. Special tools.

16. The latest ISO 9001 series certification or quality system plan.

B. A copy of the contract mechanical process and structural plans, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all plans with “No changes required” or provide a statement that no changes are required.

1. Failure to include all plans or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS

A. One set of all special tools is required.

1.05 QUALITY ASSURANCE

A. Stop logs shall be the product of one manufacturer.

B. Stop logs shall be manufacturer’s standard cataloged product and modified to provide compliance with the plans, specifications and the service conditions specified and indicated.

C. Welding: In accordance with latest applicable American Welding Society Code, ASME Welding Code,or equivalent.

D. The Contractor shall obtain the stop logs, guide frames (groves) and appurtenances from the stop log manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

E. Services of Manufacturer's Representative as specified herein.

F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment and field erection:
   a. 1 person-days.
3. Functional Testing: Check alignment and perform a functional test. Tests to include all items specified.
   a. 1 person-days.
4. Testing: Field performance test equipment specified.
   a. 1 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
   a. 1 person-days.
6. Credit to the Contracting Authority, all unused service person-days specified above, at the manufacturer's published field service rate.
7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Contracting Authority.

G. Manufacturer of stop logs shall have a minimum of ten operating installations with stop logs of the size specified or larger and in the same service and head as specified operating for not less than 5 years or manufacturer of stop logs shall utilize a Project Manager that is experienced in stop log design and construction. The Project Manager shall be an employee of the gate manufacturer and shall have designed a minimum of ten operating installations with stop logs of the size specified or larger and in the same service and head as specified operating for not less than 5 years.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Stop log sizes and operating data are indicated in the Stop Log Schedule.

2.02 MANUFACTURERS

A. Stop Logs:

1. Whipps
2. RW Gate Co.

2.03 STOP LOG CONSTRUCTION

A. Provide all stop logs produced by a single manufacturer and designed for installation in the channels and structures as specified and indicated.

B. Stop log Configuration, Dimensions and Characteristics: As indicated in the Stop Log Schedule.

C. Leakage Rate: Not to exceed 0.05 gallons per minute per foot of wetted seal perimeter.

D. Provide the stop logs with a continuous resilient seal along the bottom and both sides. Seals on or within the guide frames are not acceptable.

E. Stop Log Height: As indicated and designed to function as specified and indicated when stacked in any order.

F. Provide all structural components of the stop logs fabricated of aluminum or stainless steel and with strength to prevent distortion during normal handling, during installation and while in service as specified and indicated.

G. Provide all structural components of the guide frames fabricated of stainless steel with strength to prevent distortion during normal handling, during installation and while in service as specified and indicated.

H. Provide all welds performed by welders with AWS D1.2 certification for aluminum and AWS D1.6 or ASME Section IX certification for stainless steel.

I. Finish: Mill finish on aluminum and stainless steel.

1. Provide welds on aluminum cleaned to provide a uniform finish.
2. Provide weld on stainless steel passivated in accordance with ASTM A380 to remove weld burn and scale.

J. Materials:

1. Stop Logs: 6061-T6 Aluminum.
2. Frame Guides and Invert: ASTM A240 Type 316L stainless steel.
3. Lip Seal: Urethane ASTM D4020, Neoprene ASTM D2000 or EPDM.
4. Fasteners, Nuts and Bolts: ASTM A276 Type 316 stainless steel.
   a. Anchor Bolts: Minimum 1/2 inch diameter.

2.04 STOP LOGS

A. Provide stop logs constructed of extruded aluminum shapes with a minimum thickness as specified below or as required for the head as indicated in the Stop Log Schedule.

1. Aluminum: 1/4 inch.

B. Provide each stop log 12 inches tall or as indicated in the Stop Log Schedule.

C. Maximum Bending Stress: Not to exceed 7600 psi for aluminum at the maximum operating head.

D. Provide stop logs designed to prevent buoyance and to allow drainage.

E. Provide two slots in the top of each stop log for removal and installation by means of the specified stop log lifter.

F. Provide each stop log with a welded identification tag indicating the following:

1. Manufacturer and model number
2. Width of the opening
3. Design head
4. Seal Material

2.05 SEALS

A. Provide stop logs with a continuous resilient seal along the bottom and both sides to restrict the leakage to the rate specified.

B. Provide all seals of urethane or rubber, replaceable and mechanically retained to the stop logs.

C. Stop logs using rubber “J” or “P” seals are not acceptable.

2.06 FRAMES

A. Provide frame guides or grooves and invert members constructed of stainless steel plate with a minimum thickness of 1/4-inch.

B. Provide frame design to allow for embedded mounting or mounting directly to a wall with stainless steel anchor bolts and grout.

C. Provide mounting style as indicated in the Stop Log Schedule

D. Provide a flush bottom invert member across the bottom of the guides.

E. Frame mounted seals are not acceptable.

2.07 STOP LOG LIFTER

A. Provide one stop log lifter for each different stop log (guide frame) width.

B. Provide the lifter constructed of aluminum or Type 304L stainless steel and fitted with UHMW guide bars and stainless steel fasteners.

C. Provide the lifter with lifting hooks designed to engage the slots in the top of the stop logs.

D. Provide a lanyard release.

E. Provide the lifter capable of installing and removing all stop logs of the same width whether they are installed or at the operating floor level.

2.08 STORAGE RACKS

A. Provide storage racks as indicated to house stop logs while they are not in use.

B. Provide storage racks constructed of aluminum and configured and mounted as indicated.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install items in accordance with shop drawings, manufacturer's printed instructions and as indicated.

B. Clean debris, dirt, and gravel, from inside of stop logs, guide frames and channels before placing stop logs.

C. Install guide frames in a true vertical position and grout all voids between guide frames and walls.

D. Inspect material for defects in quality and material.

3.02 FIELD TESTING

A. Conduct as specified herein.

B. Field testing will not be conducted without a procedure accepted by the Engineer, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 1 for checklist.

C. After installation of guide frames, and after inspection, operation, testing and adjustment have been completed by the manufacturer’s field service technician, conduct operating and leakage test for each stop log in presence of the Engineer to determine its ability to operate as specified, and to operate smoothly without jamming under specified conditions.

D. Test installation and removal of each stop log location with the number of stop logs as indicated.

E. Leakage Test: Leakage not to exceed 0.05 gallons per minute per foot of seal perimeter.

1. Conduct tests at design heads shown in the Stop Log Schedule.

F. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Contracting Authority.

G. Repeat tests until specified results are obtained.

H. Contractor to provide all water labor, piping, testing equipment for conducting tests.

I. Make all adjustments necessary to place equipment in specified working order at time of above tests.

J. Remove all replace equipment at no additional cost to the Contracting Authority with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted.

* * * END OF SECTION * * *

Geotechnical Engineering Report

US Highway 63 Pump Station and Control Building

Waterloo, Iowa

October 19, 2015

Terracon Project No. 13155071-01

Prepared for:

AECOM Technical Services, Inc.

Waterloo, Iowa

Prepared by:

Terracon Consultants, Inc.

Cedar Falls, Iowa

October 19, 2015

Terracon

AECOM Technical Services, Inc.
501 Sycamore Street, Suite 222
Waterloo, Iowa 50703

Attn: Mr. Daniel Kimball, P.E.
P: (319) 232-6531
E: Daniel.Kimball@aecom.com

Re: Geotechnical Engineering Report
US Highway 63 Pump Station and Control Building
Waterloo, Iowa
Terracon Project Number: 13155071-01

Dear Mr. Kimball:

Terracon Consultants, Inc. (Terracon) has performed geotechnical services for the referenced project. Our services were performed in general accordance with our revised proposal dated September 11, 2014 (Terracon Proposal No. P13140227REV1). This report presents the findings of the subsurface exploration and provides geotechnical recommendations and considerations concerning lateral earth pressures, groundwater control and earth retention systems, and the design and construction of the proposed pump station and pump control building.

We appreciate the opportunity to be of service to you on this phase of the project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Lisa Gallery IFOR

Ted D. Bechtum
Staff Geotechnical Engineer

Jason P. Heinz

Jason P. Heinz, P.E.
Geotechnical Department Manager

Report Distribution: Addressee (1 + PDF)

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EXECUTIVE SUMMARY

Terracon Consultants, Inc. (Terracon) has performed subsurface exploration and geotechnical engineering services for a proposed storm water pump station and pump control building planned to be located near Highway 63 in Waterloo, Iowa. A total of four (4) borings were performed to depths of approximately 28½ to 45 feet below the existing ground surface at two sites, north and south of the Cedar River. A summary of the findings and recommendations presented in this report follow.

- Existing, variable fill with some rubble and organics was encountered to depths of about 25 to 27 feet below existing grades. Below the existing fill, residual granular and fine-grained soils and/or karst limestone bedrock was encountered to the boring termination depths.

- Groundwater control and earth retention systems will be required for pump station construction. Special design and construction considerations will be required for these system designs due to the presence of the existing flood protection system and karst bedrock and the potential for overexcavation. Designs for these system are typically provided by the contractor(s) involved in the construction, and specific recommendations for design of these systems is beyond the scope of this report.

- The depth of the pump station had not been determined at the time of this report. Based on conversations with ATS, we expect that the pump station excavation will be extended to suitable bedrock and backfilled with CLSM or lean concrete, if required.

- The pump control room building should be supported on a deep foundation system if the owner is not willing to accept the risk associated with support of the structure on the existing, levee fill. We have provided a compensated mat foundation alternative for the pump control building if the owner is willing to accept some risk of building movement in order to provide construction savings.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. Terracon be should be retained to monitor this portion of the work.

This executive summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this summary, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
US HIGHWAY 63 PUMP STATION AND CONTROL BUILDING
WATERLOO, IOWA

Terracon Project No. 13155071-01
October 19, 2015

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) has performed subsurface exploration and geotechnical engineering services for a pump station and pump control building planned to be located near Highway 63 in Waterloo, Iowa. A total of four (4) borings were performed to depths of approximately 28½ to 45 feet below existing grades at two sites, north and south of the Cedar River. A Site Location Map (Exhibit A-1), Boring Location Diagrams (Exhibits A-2 and A-3) and logs of the borings (Exhibits A-5 through A-8) are included in Appendix A. This report presents the results of the subsurface exploration and provides geotechnical information and recommendations relative to:

- subsurface soil and rock conditions
- groundwater conditions
- earthwork
- subsurface drainage
- foundation design and construction
- seismic considerations
- lateral earth pressures
- dewatering and earth retention systems

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
South site Pump station	■ General construction: CIP reinforced concrete ■ Base elevation: not determined ■ Top of wall elevation: 862 feet
North site Pump control building	■ General construction (assumed) o Walls: Concrete masonry units o Roof: Pre-cast concrete or steel o Floor: Structural or over a mat o Floor elevation: 861 feet
Assumed maximum pressures/loads	■ South pump station base/mat: 4,000 psf ■ Pump control building walls: 2.1 klf ■ Pump control building floor slab: 150 psf

Item	Description
Assumed maximum site grading	■ North and South sites o Fill: None o Cut: None
Below-grade walls	■ South pump station: depth unknown

2.2 Site Location and Description

Item	Description
Location	■ North site: north of Cedar River, west of E. 1st St. ■ South site: south of Cedar River, west of W. Mullan Ave.
Existing improvements	■ North site: existing pump station ■ South site: levee
Current ground cover	■ North site: grass on levee ■ South site: grass and rip rap on levee
Existing topography	■ North pump control building site o Crest of levee: 860.5 feet o North levee toe: 849 feet ■ South pump station site o Crest of levee: 860.5 feet o South levee toe: 851 feet o North levee toe: 843 feet or lower

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Conditions encountered at each boring location are indicated on the individual boring logs in Appendix A. Stratification boundaries on the boring logs represent the approximate location of changes in material types; in situ, the transition between material types may be gradual or abrupt horizontally and vertically. Please note that the following depths are approximate, and are in reference to the grades existing at the time the borings were performed. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

North Pump Control Building Site – Borings 1 and 2			
Stratum	**Approximate Depth to Bottom of Stratum (feet)**	**Material Description**	**Consistency / Relative Density**
Surface	24.5 to 25	Fill - Silty Sand to Sandy Lean Clay and Clayey Sand, with varying amounts of organics	n/a
1	30.5 (Bottom of Boring 1)	Lean to Fat Clay to Sand with clay layers (residual soil)	Stiff / Medium Dense
Sedimentary Bedrock	28.5 [1] (Bottom of Boring 2)	Limestone, highly weathered and broken	n/a

1. Boring 2 was terminated in limestone bedrock at a depth of 28.5 feet after an auger penetration of 4 feet was achieved.

South Pump Station Site – Borings 3 and 4			
Stratum	**Approximate Depth to Bottom of Stratum (feet)**	**Material Description**	**Consistency / Relative Density**
Surface	26.5 to 27	Fill - Sandy Lean Clay and Clayey Sand, with varying amounts of rubble, organics, and gravel	---
1	29 to 30	Sandy Fat Clay and Silt with limestone gravel (residual soil)	Medium Stiff to Stiff
Sedimentary Bedrock	45 [1] (Bottom of Borings)	Limestone, highly weathered and broken with zones of sand and clay	n/a

1. Borings 3 and 4 were terminated in limestone bedrock at depths of 45 feet after penetrations of 15 to 16 feet were achieved with a tri-cone bit.

3.2 Groundwater

The boreholes were observed during and after drilling and sampling for the presence and level of groundwater. Groundwater levels observed at this time are indicated on the boring logs and are summarized in the following table.

Boring	**Depth to Observed Groundwater (feet)**		
	During Drilling / Sampling	**Before Casing Removal**	**After Drilling**
1	24	26.5	25
2	24	25.5	None

Boring	Depth to Observed Groundwater (feet)		
	During Drilling / Sampling	Before Casing Removal	After Drilling
3	26	---	27
4	22	28.5	27.5

These water level observations provide an approximate indication of the groundwater conditions existing on the site at the time the observations were made. Long term observations in piezometers or observation wells sealed from the influence of surface water would be required to provide a better evaluation of groundwater levels.

Groundwater level fluctuations will occur due to seasonal variations in the amount of rainfall, runoff, the level of the Cedar River, and other factors not evident at the time the borings were performed. In addition, perched groundwater can develop within variable existing fill and more 'permeable' material overlying and/or within less 'permeable' soil and bedrock. Therefore, groundwater levels during construction or at other times during the lives of the pump station and control building may be different than the levels indicated on the boring logs, and the possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the project information and results of the subsurface exploration, laboratory testing, and our evaluations, geotechnical considerations for this project include the presence of:

- Variable, existing fill
- Existing improvements
- Relatively shallow groundwater
- Relatively shallow, karst bedrock

4.1.1 Pump Control Building

Existing fill was encountered in Borings 1 and 2 to depths of about 24.5 to 25 feet below existing grades. These materials were variable in composition and density based on the results of the subsurface exploration and laboratory testing. In our opinion, there would be a risk of greater than normal settlement if the pump control building was supported on a shallow foundation placed over the existing fill. Structures supported on or above variable, existing fill material may not perform predictably due to the possible presence of unsuitable, low density or compressible materials, such as rubble and organic materials that will not be discovered. In addition to the

risks associated with supporting the pump control building on a shallow foundation system over the existing fill, slope stability analyses may be required to evaluate whether the factors of safety required for the existing levee are met. Levee/slope stability evaluation is beyond our scope of services for this project.

Support of the pump control building foundation and floor slab on or above existing fill is discussed in this report. However, even with the soil boring information and the recommended construction testing services, there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill.

4.1.2 Pump Station

Special design and construction considerations will be required for the pump station due to the presence of the flood protection system, relatively shallow groundwater, and karst bedrock. We anticipate that the base of the pump station will be at a depth of about 26 to 35 feet below the crest of the existing levee, corresponding to approximate elevations of 834.5 to 825.5 feet. Groundwater was observed in Borings 3 and 4 at depths of about 22 to 27.5 feet below existing grades, corresponding to elevations of about 838.5 to 833 feet. Limestone bedrock was encountered in Borings 3 and 4 at depths of about 29 to 30 feet below existing grades, corresponding to elevations of about 831.5 to 830.5 feet. We therefore anticipate that a temporary dewatering system and earth retention system will be required to facilitate pump station construction. If the base of the pump station is near or below an approximate elevation of 831.5 feet, rock excavation should be expected. Although sheet pile design parameters are provided in this report, specific recommendations for design and construction of earth retention systems, as well as groundwater control systems, and are beyond the scope of this report. These system designs are typically provided by the contractor(s) involved in the construction. We recommend that earth retention/shoring and dewatering contractors experienced with similar subsurface conditions and projects be engaged for this project.

4.2 Groundwater Control and Excavation

4.2.1 Geotechnical Discussion

If the groundwater level at the time of construction is not significantly lower than the levels observed in the borings, excavation for the south pump station will extend below the groundwater level. Groundwater levels will increase and decrease with the level of the Cedar River, and consideration should therefore be given to the potential for groundwater level fluctuations throughout construction and the lives of new improvements. Localized areas of higher groundwater can also occur as a result of accumulation within existing fill, and can also accumulate at the interface of fill and underlying less ‘permeable’ soils, and at the interface of overburden and bedrock.

Based on the results of the subsurface exploration and laboratory testing, rapid groundwater inflows should be expected in the sand soils. Refer to Appendix B for grain size distributions of granular samples obtained from Boring 3. Rapid groundwater inflows may also be encountered in the karst bedrock. Dewatering with a series of wells extended into bedrock is anticipated to be necessary to facilitate construction 'in the dry'. It will be important on this project to install a properly designed groundwater control system in conjunction with a temporary earth retention system prior to excavation for the pump station and other utilities. Excavations made prior to controlling groundwater can reduce the support capability of soil/material and can cause unnecessary additional costs and construction delays. Groundwater should be maintained at least 2 feet below the lowest working construction level until structure and utility construction and any backfilling operations have been completed. Consideration should also be given to the possibility that overexcavation may be required to reach suitable bearing material.

Uniform installation of a temporary earth retention system may be difficult because the composition of the residual soils and the composition and degree of weathering of the bedrock is usually variable in karst. It is our experience that a layer or zone of 'harder rock' or 'cap rock' can be present in some areas. These remaining 'harder' bedrock remnants can be present in residual soil and in karst bedrock, and can vary from gravel to boulder sizes. Because of the nature of the residual soil and weathered sedimentary bedrock present at the site, it may not be feasible to provide a complete cutoff, even with a grout curtain. If a complete cutoff is desired, then a comprehensive grouting program consisting of secondary, tertiary, and possible additional grouting to significant depths could be required. This would involve additional cost.

Settlement of material within the 'water table draw down zone' or 'cone of depression' is possible. The strength of materials supporting existing improvements may vary and this should be considered as part of the designs and construction. Movement or deflection of a temporary earth retention system and removal of a temporary earth retention system can also contribute to settlement of adjacent and soil/material and improvements. As excavation for the pump station will be within and near the existing flood protection system that will remain in place, we recommend that the provisions of a preconstruction survey and a settlement monitoring program throughout construction be included in the project's work scope. Criteria for allowable settlement of adjacent improvements should be developed for the groundwater control and earth retention system designs, and plans should be prepared for mitigation of settlement of an adjacent improvement in the event that the settlement criteria is exceeded.

Care should be taken during excavation and construction adjacent to existing improvements to avoid damaging or undermining improvements that are in service and/or are to remain in service. Materials removed from excavations should not be stockpiled immediately adjacent to an excavation. Excavations should be performed in accordance with governing safety regulations. The structure foundation type and/or bearing elevation(s) of improvements should be determined prior to the start of construction so excavation plans can be adjusted or supplemented, if necessary. If as-built plans of the existing improvements are not available,

consideration should be given to staged excavation or excavating test pits adjacent to the improvement to provide more information on the bearing elevation, foundation type, and condition of the foundation bearing soil. Modification of the excavation/backfill procedure and/or the use of a different support system may be required. In no instance should excavation be performed below an existing improvement unless the owner and designer are is provided with a written plan in advance of the work that outlines the means and methods proposed for performance of the excavation.

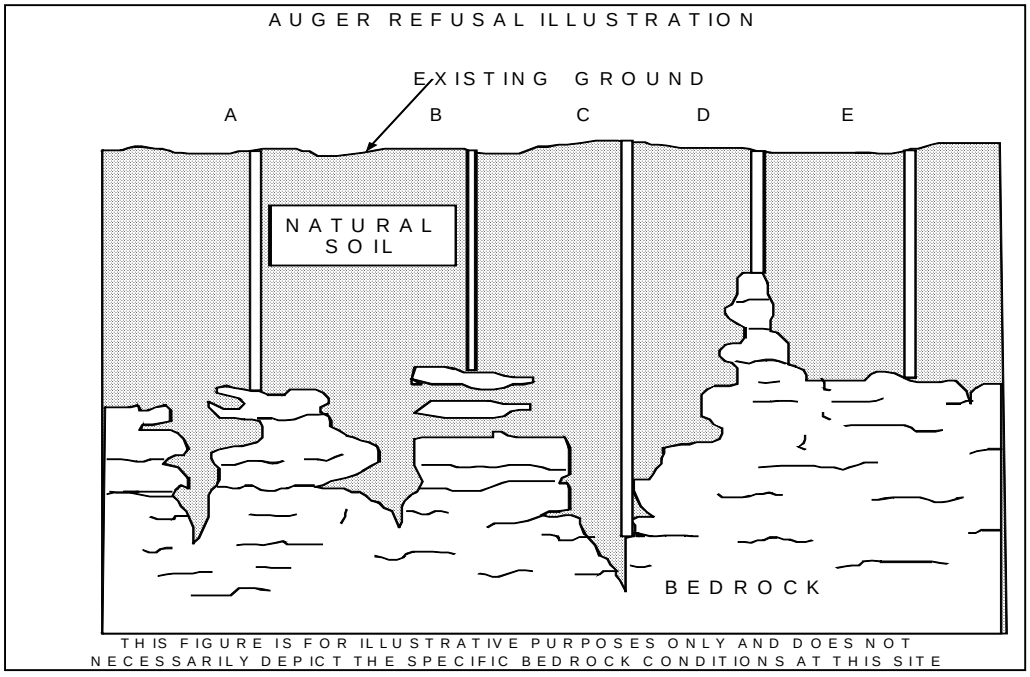
4.2.2 Rock Excavation

Auger refusal was experienced in Borings 3 and 4 at depths of about 33.5 to 34 feet, after penetrations of about 3.5 to 4.5 feet. About 1 to 1.5 feet of harder bedrock was encountered in these borings to depths of about 35.5 feet. Below these depths, zones of sand and clay and more highly weathered bedrock were encountered.

Auger refusal generally indicates the presence of ‘harder’ and/or ‘higher quality rock’ in the boring. However, the subsurface conditions encountered are generally consistent with our experience that very poor to poor quality rock, which is broken and contains voids, clay, and/or sand, are present below the auger refusal depth within the Cedar Valley Group limestone. Harder and subsequently slower rock excavation can result on the upper surface of discontinuous bedrock (A), slabs of less weathered rock suspended in the residual soil matrix or "floaters" (B), in widened joints that may extend well below the surrounding bedrock surface (C), on rock "pinnacles" (D) rising above the surrounding bedrock surface, or on the upper surface of continuous bedrock (E). These possible bedrock conditions are illustrated in the figure on the following page.

Due to these features of karst bedrock, estimating the exact quantity of rock excavation is difficult. Linear interpolation of apparent bedrock elevations based upon the boring data is often used but can misrepresent actual rock removal quantities where such anomalies exist. To minimize the potential for rock excavation “extras”, we suggest the contract be bid as “unclassified” excavation. The contractor should be provided with the data in this report and allowed to perform any additional exploration or studies necessary to develop his/her bid. If final plans, along with our boring data, suggests that significant rock excavation may be encountered, additional exploration consisting of rock probes can be performed to further delineate the rock surface.

We anticipate that it may be possible to rip the limited upper weathered and broken zones of bedrock that were penetrated with our augers. Beneath the practical auger refusal depths or in less weathered zones of bedrock, hammering may be more efficient. It should be noted that the rippability of sedimentary bedrock is more dependent on the type and size of the equipment used, the fracturing or quality of the bedrock, and the amount of effort expended, than it is on the type of rock.



4.3 Site Preparation and Fill Placement and Compaction

4.3.1 Site Preparation

Site preparation should commence with stripping of all vegetation, organic soils, root systems, and any unsuitable materials (e.g., debris, desiccated soil, frozen soil, etc.) from the site surface. Prior to the placement of fill in areas below design grade, subgrades should be evaluated by Terracon. Subgrade evaluations should include probes and strength and density testing, where appropriate. If low density fill, low strength soil, or disturbed soil or rock is present, it should be overexcavated prior to the placement of fill, pipe, or foundations. If a limited thickness of granular material or bedrock is present, compaction of the subgrade may be considered instead of overexcavating the material. Terracon should evaluate the depths of removal of unsuitable materials and should observe foundation subgrades prior to fill placement and foundation construction, and could assist in developing appropriate subgrade preparation procedures based on the conditions encountered during construction.

4.3.2 Fill Material Requirements

Fill placed below foundations and floor slabs and foundation wall backfill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
On-site, low plasticity [1], [2]	CL, CL/SC (LL ≤ 45 and PI ≤ 23)	■ Pump control building o Below the foundation o Exterior foundation and wall backfill ■ Pump station o Wall backfill
Imported, low-plasticity, fine-grained [1, 2, 3]	CL, CL/SC (LL ≤ 45 and PI ≤ 23)	■ Pump control building o Below the foundation o Exterior foundation and wall backfill ■ Pump station o Wall backfill

1. Fill should consist of materials that are free of deleterious materials and debris and have an organic content of 5 percent or less. Frozen material should not be used, and fill should not be placed on a frozen subgrade. By our definition, low plasticity soil/material would have a liquid limit (LL) of 45 or less, and a plasticity index (PI) of 23 or less. A sample of each fill material should be subjected to appropriate laboratory testing and the results submitted to the design engineer for approval prior to delivery and/or use.
2. Due to the presence of existing fill with rubble and organics, and some zones of sand with fines (SM and SC), sorting of suitable and unsuitable on-site fill materials should be expected.
3. Use of controlled low-strength material (CLSM) or lean concrete is recommended below the pump station foundation and may also be used for foundation/wall backfill, if approved by the designer.

4.3.3 Fill Placement and Compaction Requirements

Fill placed below foundations and foundation backfill should be placed and compacted in accordance with the following requirements:

Item	Description
Fill lift thickness	■ 9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used. ■ 4 inches in loose thickness when hand equipment (e.g., jumping jack, vibratory plate compactor, etc.) is used

Item	Description
Minimum compaction requirements [1, 2, 3]	■ 95 percent below and adjacent to the pump control building foundation and walls ■ 98 percent adjacent to the pump station walls 15 feet or more below final grade ■ 95 percent adjacent to the pump station walls less than 15 feet below final grade
Moisture content range from optimum moisture content [1]	■ Low plasticity material: -2 to +3 percent

1. Percent compaction values and moisture content ranges are relative to 'standard Proctor' maximum dry density and optimum moisture content (ASTM D698).
2. We recommend that each lift of fill below foundations and any foundation/wall backfill be tested for moisture content and compaction. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved, or removed and replaced with other suitable material.
3. Placement of fine-grained material in relatively small areas can be difficult. Moisture conditioning should be expected if on-site materials are re-used for fill.

4.3.4 Site Preparation Considerations

Unstable subgrade conditions could develop during construction, particularly if the soils are wetted and/or subjected to construction traffic. The use of remotely operated equipment, such as a backhoe, should be considered to perform cuts and reduce the amount of subgrade disturbance where possible. Construction traffic over the completed subgrade should be avoided to the extent practical. Should unstable subgrade conditions develop, subgrade improvement measures will be required. Terracon should be contacted to discuss alternatives to improve subgrades.

Sites should be graded to prevent water from collecting on prepared subgrades. Excessive moisture can significantly reduce the support capability of soil/material and contribute to soft subgrades and settlement. Water that accumulates on bearing subgrades should be removed as soon as possible. If a subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed, or scarified, moisture conditioned, and compacted prior to further construction. It is important to note that the material types encountered in the borings can be eroded by surface water, so appropriate erosion control measures should be provided.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of foundations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and re-compacted prior to placement of foundations.

By conducting this exploration and site characterization, Terracon is in a beneficial position to observe and evaluate conditions exposed during construction and compare the conditions to the findings of the exploration, which would assist in resolutions if variations are present.

4.4 Foundation Recommendations

4.4.1 Mat Foundation Design Recommendations for the Pump Station

Based on the project information and the results of the subsurface exploration and laboratory testing, it is our opinion that the proposed pump station could be supported on a mat foundation. We recommended the mat foundation bear on a relatively uniform thickness of suitable fill over bedrock evaluated by Terracon. The foundation subgrade should be prepared as recommended in this section, section **4.3 Site Preparation and Fill Placement and Compaction**, and section **4.4.3 Construction Considerations for Mat Foundations**.

Item	Descriptions and Values
Subgrade Preparation	Maintain groundwater level below the bottom of the excavation, remove unsuitable existing fill and residual soils, and have an evaluation performed by the geotechnical engineer.
Subgrade support system	Suitable fill over bedrock evaluated by the geotechnical engineer or bedrock evaluated by the geotechnical engineer
Net allowable bearing pressure [1]	6,000 psf
Approximate total settlement [2]	< 1 inch
Approximate differential settlement [2]	~1/2 of total

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable soil and bedrock will be removed and replaced with suitable fill.
2. The foundation settlement will depend on the variations within the subsurface profile, the structural loading conditions, and the quality of construction operations.

Subsurface structures placed below groundwater levels are subjected to uplift forces. For uplift and buoyancy design purposes, a unit weight for backfill of 115 pcf above the maximum groundwater level and 53 pcf below the groundwater level may be used. Uplift forces may be resisted by the effective dead weight of the structure and by the effective weight of the material placed above the extensions of the base slab, and above the structure, if any.

4.4.2 Mat Foundation Recommendations for the Pump Control Building

As mentioned previously, variable existing fill was encountered in Borings 1 and 2 to depths of about 25 feet, and support of improvements over variable, existing fill involves risk of excessive settlement for the owner. An alternative to removing substantial amounts of existing fill or

providing a deep foundation system, would be to support the pump control building on a compensated, mat foundation. If the owner's risk tolerance is low relative to potential settlement of the foundation and building, then a deep foundation should be used for support of the floor and building. Design recommendations for a compensated, mat foundation are provided in the following table.

Description	Value
Uniform mat contact pressure for a compensated foundation [1]	Foundation embedment depth (feet) * 125 pcf
Minimum embedment depth below finished grade for frost protection [2]	5 feet
Estimated total settlement for a compensated foundation [3]	½ - inch or less
Estimated differential settlement for a compensated foundation [4]	½ of the total settlement
Subgrade response modulus for a compensated mat foundation at 5 feet	10 pci

1. A compensated foundation has a contact pressure approximately equal to the in-situ stress at the bearing level of the foundation.
2. Finished grade is defined as the lowest adjacent grade within 5 feet of the foundation.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the foundation, the thickness of existing fill, and the quality of the earthwork operations. Even with the testing and observation discussed in this report, total and differential settlement of a foundation supported over the existing fill cannot be accurately predicted, and could be greater than normal.
4. Differential settlement between new and existing improvements could equal the total settlement. Frequent control joints in the structure and sufficiently flexible connections are recommended help to accommodate differential settlement.

4.4.3 Construction Considerations for Mat Foundations

Based on the conditions encountered in the borings, we anticipate the material at the bearing depth of the pump control building will consist of existing fill. The exposed bearing subgrade should be evaluated by the geotechnical engineer prior to fill placement, and prior to reinforcing steel and concrete placement. Any rubble or organics should be removed from immediately below the mat, and the resulting subgrade tamped prior to fill or foundation installations.

The material present at the design bearing level of the pump station will depend on the base elevation selected. The pump station foundation should not be supported on existing fill, residual clay soil, very loose to loose granular soils/materials, or otherwise unsuitable bearing materials. Overexcavation to limestone or dense residual soil should be performed, and the foundation could bear on lean concrete or CLSM extending down to suitable, residual soil or bedrock. Proper groundwater control should be maintained throughout construction.

Overexcavation for fill placement below a pump control building mat should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below the footing base elevation. The overexcavation should then be backfilled up to the footing base elevation with suitable material as recommended in section **4.3 Site Preparation and Fill Placement and Compaction**. Lean concrete or CLSM can be used to backfill the overexcavation below the pump control building and is recommended below the lift station.

Rapid groundwater seepage into the excavations should be anticipated for this project. "Quick" conditions will result if excavation is made within soils/materials that have not been properly dewatered prior to excavation. It should be noted that, if proper dewatering procedures are not performed during construction, the density and support capability of previously compacted fill and approved soil could be affected and subsequently contribute to higher than anticipated settlement. Groundwater levels should be maintained at least 2 feet beneath the lowest anticipated excavation level.

The base of foundation excavations should be free of water, loose soil, or disturbed bedrock prior to placing fill or concrete. Fill should be placed soon after excavation to reduce bearing the potential for soil disturbance, and concrete should be placed soon after completion of fill placement or excavation to suitable material. Should the material at bearing level become excessively dry, disturbed or saturated, or frozen, the affected material should be removed prior to placing concrete. It is recommended that the geotechnical engineer be retained to observe and test the soil foundation bearing materials.

4.4.4 Pump Control Building Drilled Shaft Recommendations

Due to the presence of variable, existing fill, and the existing lift station and flood protection system, it is our opinion that the use of straight-sided drilled shafts would be a suitable support system for the new pump control building. Residual, granular soil was encountered in Boring 1 at a depth of about 27.5 feet, corresponding to an elevation of 831 feet, and highly weathered and broken limestone bedrock was encountered in Boring 2 at a depth of about 24.5 feet, corresponding to an elevation of about 834 feet. Due to the variability of the highly weathered and broken limestone, various depths of penetration should be anticipated in order to reach competent bearing bedrock. Debris or rubble fill and boulders within the fill and residual soil could be encountered during shaft excavations that could impede drilling operations. Due to these conditions, we recommend that a deep foundation contractor experienced with the local site conditions be engaged. Drilled shaft construction should be monitored by Terracon personnel continuously and the actual shaft bearing elevations determined at the time of shaft excavation.

We recommend that straight-sided, drilled shafts be extended into the bedrock to achieve sufficient capacity for compressive loading conditions. Drilled shafts should be extended into highly weathered bedrock a minimum of 5 feet and be designed using an allowable end bearing pressure of 6,000 psf. This end bearing pressure includes a factor of safety of at least 3. Side

friction for compressive loading should be ignored. Settlement of drilled shaft foundations designed and constructed in accordance with the recommendations in this report is expected to be on the order of ½-inch. In designing to resist uplift loading, we recommend using the allowable frictional uplift values provided in the following table. The values presented for uplift side friction include a factor of safety of at least 2.

The soil parameters provided in the following table can be used in lateral load analyses for drilled shafts using the software program LPile Version 6. Lateral deflections of drilled shafts should be evaluated using an appropriate design procedure, and would be dependent on the physical characteristics of the shaft, and the restraint conditions at the bottom and top of the shaft. Further analysis and recommendations can be provided upon request.

Material / LPile Soil Model	Depth Interval Below Existing Grade (feet)	Effective Unit Weight (pcf)	Friction Angle (degrees)	Allowable Frictional Uplift Resistance [1] (psf)	Static Modulus [1] (pci)
Existing Fill	0 to 3	115	-	-	-
Existing Fill	3 to 5	60	-	-	-
Existing Fill / Sand (Reese)	5 to 14	60	24	185 to 325	20
Existing Fill / Sand (Reese)	14 to 25	55	20	325 to 425	15
Residual Soil / Sand (Reese)	25 to 30	70	26	425 to 500	60
Highly Weathered and Broken Limestone / Sand (Reese)	30 to 35	75	36	500 to 550	125

The drilled shafts should have diameters of at least 2½ feet and be spaced at least three shaft diameters apart (center-to-center). Perimeter grade beams beneath unheated areas should be embedded at least 5 feet below the lowest adjacent exterior finished grade, within 5 feet of the foundation, for frost protection and to prevent the potential for resulting uplift forces.

Group action for lateral resistance of shafts should be taken into account when spacing is less than 8 diameters (center to center), and design parameters for allowable passive resistance in the direction of the load should be reduced in accordance with the values provided in the following table.

Shaft Spacing (Diameters)	Group Action Reduction Factor
8D	1.0
6D	0.7
4D	0.4
3D	0.25

4.4.5 Drilled Shaft Construction Considerations

We recommend a minimum shaft diameter of 2½ feet be used in order to permit cleaning and testing of the shaft bottoms. During drilling shaft installation, conventional drilling equipment (e.g., soil augers) may not be able to penetrate larger cobbles, boulders, and bedrock. Heavier duty rock augers and core barrels are anticipated to be required to penetrate larger boulders and bedrock where encountered. Rock probes or rock coring should be given consideration at each drilled shaft location to help evaluate the depth to suitable bedrock and check for voids or weak clay layers. The probe holes should be at least 2 inches in diameter and should extend below the base of the shaft excavation a distance at least equal to the shaft diameter or 5 feet, whichever is greater.

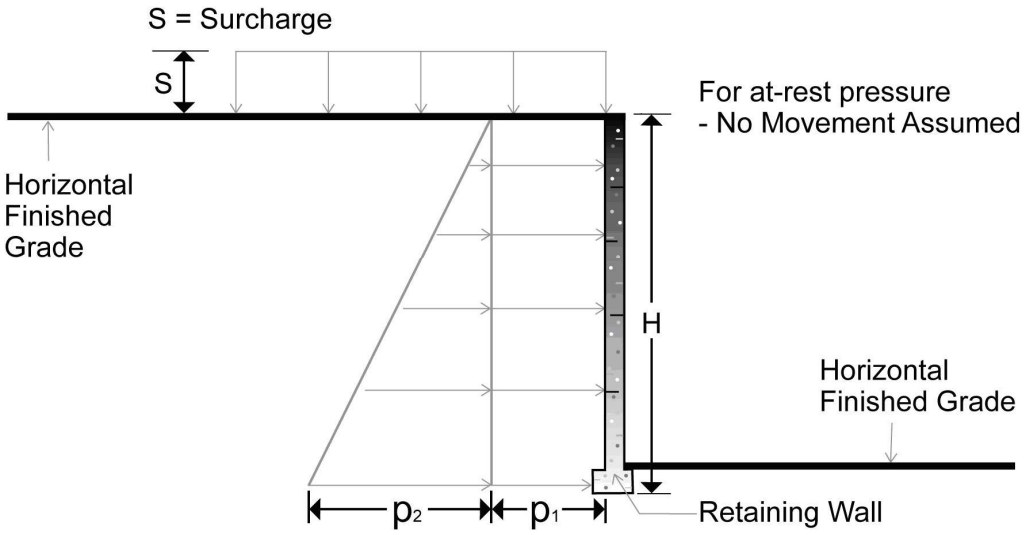
Care should be taken so that the side and bottom of drilled shaft excavations are not disturbed during construction. Variable, existing fill and lower strength and granular soil were encountered in the borings. The use of temporary casing through these materials will be required for this project to reduce groundwater seepage into shaft excavations, prevent collapse of side walls, and maintain sidewall integrity and shaft excavation dimension. The bottoms of shaft excavations should be free of loose/disturbed material before concrete placement. In order to reduce the potential for disturbance of the bearing surface, concrete should be placed as soon as possible after each excavation is completed. Placement of loose backfill should not be permitted around the casing.

Slurry drilling techniques are anticipated to be required to maintain excavation stability for this project unless dewatering is performed prior to excavations. With the slurry drilling procedure, concrete should be placed using a tremie or concrete pump hose extended to within 6 inches of the shaft base. A concrete slump of at least 6 inches is recommended. While withdrawing casing, care should be exercised to maintain a sufficient concrete level inside the casing to resist earth and hydrostatic pressures. Arching of the concrete, loss of seal, and other problems can occur during casing removal, which may cause contamination of the drilled shaft. These conditions should be considered during the design and construction phases.

We recommend that a representative of Terracon be present during shaft excavations and drilled shaft construction to observe the excavations, to evaluate the suitability of the bearing material, to verify that conditions in the shaft excavations are consistent with those encountered in the borings, and to monitor reinforcing steel installations and concrete placements. Due to the variability of the weathered bedrock, sounding of the bedrock using a kelley bar, or a heavy steel bar, should be performed prior to concrete placement. If unsuitable materials are encountered in a shaft excavation, it would be necessary to deepen the shaft and/or increase the shaft diameter.

4.5 Lateral Earth Pressures for Reinforced Concrete Retaining Walls

Reinforced concrete, below-grade walls of the pump station subjected to unbalanced earth pressures should be designed for at-rest earth pressures at least equal to those indicated in the following table. The at-rest condition should be used where no wall movement is permitted. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, final grades or sloping of ground adjacent to the walls, surcharges, methods of construction and/or compaction and the strength of the materials being restrained.



Earth Pressure Condition	Coefficient for Backfill Type	Equivalent Fluid Density, (pcf)		Surcharge Pressure, p_1, (psf)	Earth Pressure, p_2, (psf)	
		Drained	Undrained		Drained	Undrained
At-Rest (K_o)	Cohesive: 0.63	75	100	(0.63)S	(75)H	(100)H
Passive (K_p)	Cohesive: 2.2	265	190	---	---	---

- For passive earth pressure to develop, wall must move horizontally to mobilize resistance.
- Uniform surcharge, where **S** is surcharge pressure.
- In-situ soil backfill weight a maximum of 120 pcf.
- Horizontal backfill compacted following the recommendations in section **4.3 Site Preparation and Fill Placement and Compaction Requirements**.
- Loading from heavy compaction equipment not included.
- No dynamic loading.
- No safety factor included in soil parameters.
- Ignore passive pressure in frost zone.

Backfill placed against below-grade structures should consist of low plasticity cohesive soils, CLSM or lean concrete for this project.

4.6 Seismic Considerations

Parameter	Value
Site Class - 2012 International Building Code [1]	D [2]
0.2 Second Period Spectral Response Acceleration, S_s	0.061 g [3]
1.0 Second Period Spectral Response Acceleration, S_1	0.043 g [3]

1. In accordance with the *2012 International Building Code,* which refers to *ASCE 7*.
2. The 2012 International Building Code (IBC) requires a site soil profile determination extending to a depth of 100 feet. The current scope requested does not include the required 100 foot soil profile determination. Borings extended to a maximum depth of approximately 45 feet and this seismic site class definition considers that similar bedrock continues below the maximum depth of the subsurface exploration.
3. Value obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/designmaps) on September 24, 2015.

4.7 Sheet Pile Parameters

As requested, estimated soil parameters for use in a sheet pile design by others are provided in the following table. The soil parameters were estimated based on Borings 3 and 4.

Sheet Pile Parameters for the Pump Station					
Depth Interval (feet)	**0 - 5**	**5 - 14**	**14 - 25**	**25 - 30**	**>30**
Elevation of Bottom of Layer (feet)	853.5	844.5	833.5	828.5	< 828.5
Layer Thickness (feet)	5	9	11	5	-
Total 'Saturated' Density (pcf) [1]	115	120	115	130	140
Submerged Density (pcf)	-	60	55	70	75
Effective friction angle (degrees)	28	28	26	30	38
Cohesion (psf)	0	0	0	0	0
Steel-soil interface friction angle	11	11	14	17	17
Active Pressure coefficient (K_a)	0.36	0.36	0.39	0.33	0.26
Passive Pressure coefficient (K_p)	2.77	2.77	2.56	3.0	3.85

5.0 GENERAL COMMENTS

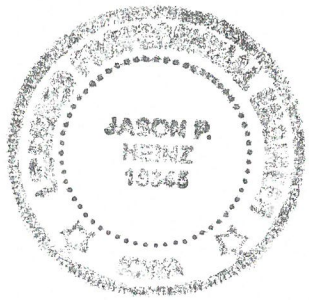
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction, subgrade preparation, and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

Support of structures on or above existing fill soils is discussed in this report. However, even with construction testing services, there is an inherent risk for the client that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by performing additional testing and evaluation.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.



I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Jason Patrick Heinz, P.E. — Date: 10/19/15

My license renewal date is December 31, 2016.

APPENDIX A
FIELD EXPLORATION

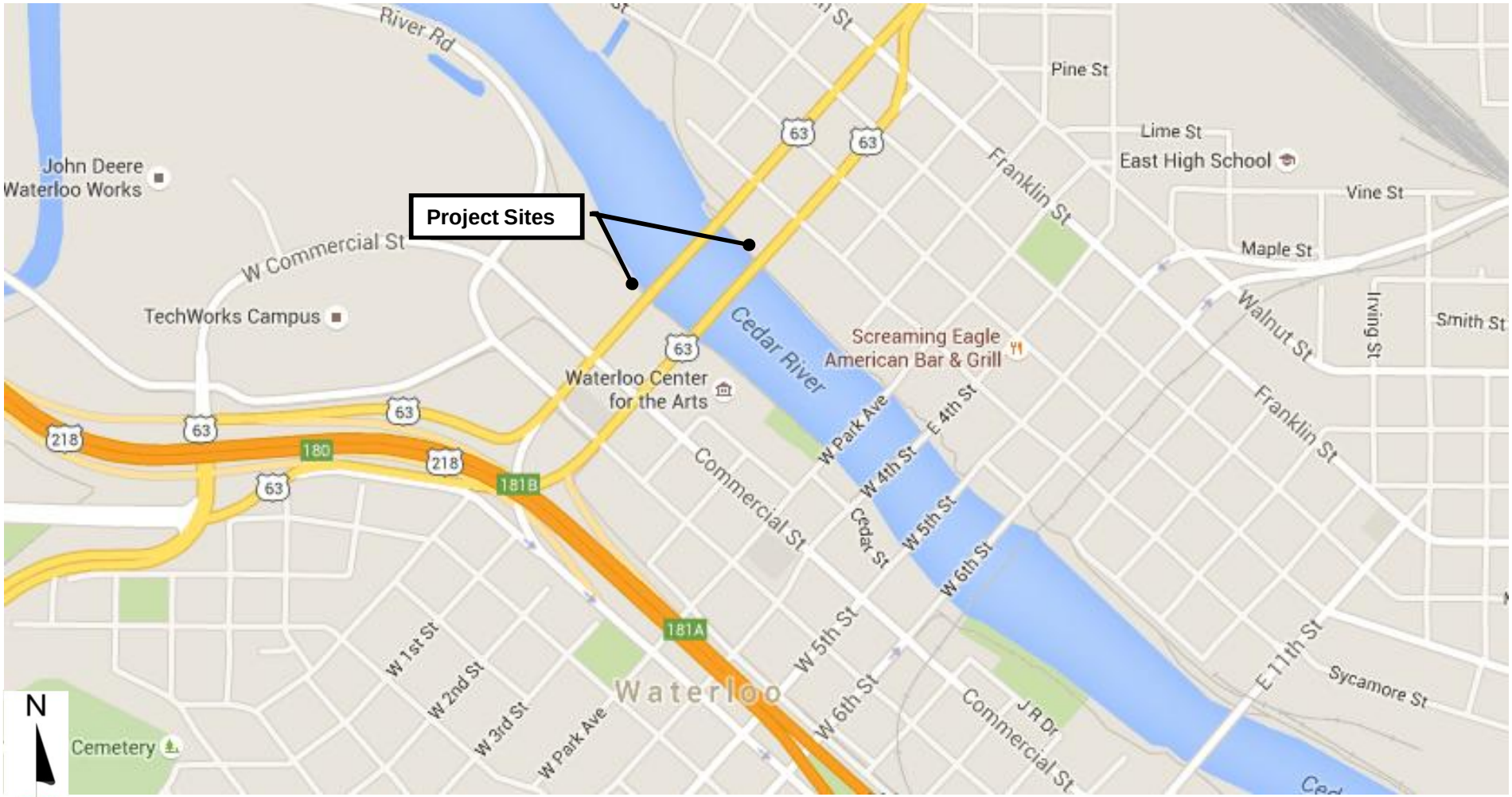


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	REL
Drawn by:	KAD
Checked by:	JPH
Approved by:	JPH

Project No.	13155071
Scale:	N.T.S.
File Name:	13155071_A1.ppt
Date:	9/28/2015

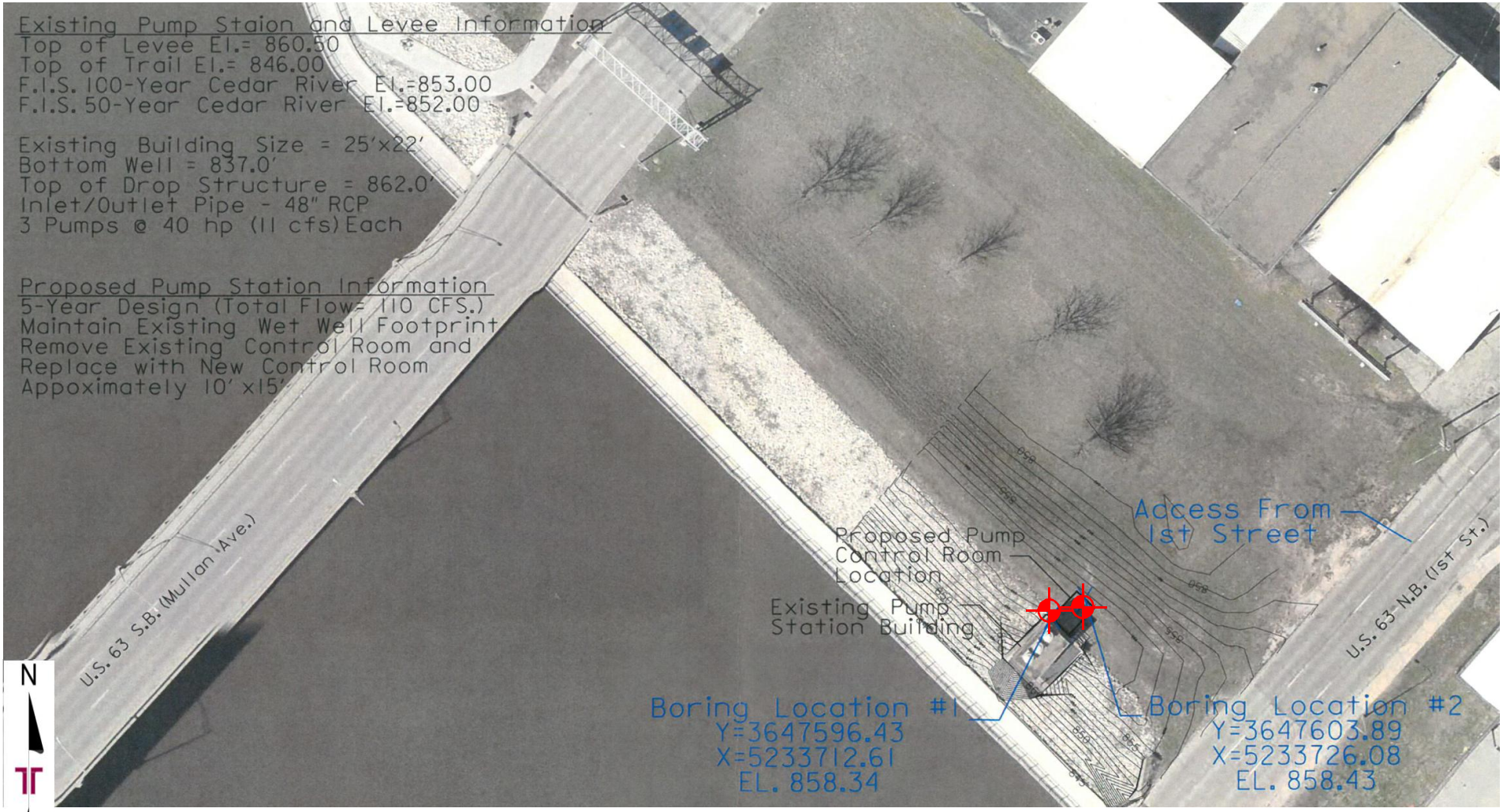
Terracon
Consulting Engineers & Scientists
6612 Chancellor Drive, Suite 102 Cedar Falls, Iowa 50613
PH. (319) 277-4016 FAX. (319) 277-4320

SITE LOCATION MAP

US HIGHWAY 63 PUMP STATION AND PUMP CONTROL BUILDING
WATERLOO, IOWA

Exhibit

A-1



BASE DRAWING PROVIDED BY AECOM TECHNICAL SERVICES.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: REL	Project No. 13155071
Drawn by: KAD	Scale: N. T. S.
Checked by: JPH	File Name: 13155071_A2.ppt
Approved by: JPH	Date: 9/28/2015

Terracon
Consulting Engineers & Scientists
6612 Chancellor Drive, Suite 102 Cedar Falls, Iowa 50613
PH. (319) 277-4016 FAX. (319) 277-4320

BORING LOCATION DIAGRAM

US HIGHWAY 63 PUMP STATION AND PUMP CONTROL BUILDING

WATERLOO, IOWA

Exhibit

A-2

BASE DRAWING PROVIDED BY AECOM TECHNICAL SERVICES.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: REL	Project No. 13155071
Drawn by: KAD	Scale: N. T. S.
Checked by: JPH	File Name: 13155071_A3.ppt
Approved by: JPH	Date: 9/28/2015

Terracon
Consulting Engineers & Scientists
6612 Chancellor Drive, Suite 102 Cedar Falls, Iowa 50613
PH. (319) 277-4016 FAX. (319) 277-4320

BORING LOCATION DIAGRAM

US HIGHWAY 63 PUMP STATION AND PUMP CONTROL BUILDING
WATERLOO, IOWA

Exhibit

A-3

Field Exploration Description

Boring locations and elevations were provided by the client. Surface elevations indicated on the boring logs were rounded to the nearest ½-foot. The Boring Location Diagrams indicating the approximate boring locations is included as Exhibits A-2 and A-3. The locations and elevations of the borings are accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with an atv-mounted rotary drill rig using continuous flight hollow-stem augers and mud-rotary drilling methods to advance the boreholes. Samples were obtained in the borings using the split-barrel sampling procedure. In the split-barrel sampling procedure, a standard 2-inch (outside diameter) split-barrel sampling spoon is driven into the ground with an automatic 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the standard penetration resistance value (N). These "N" values are indicated on the boring logs at the depths of occurrence. The samples were sealed and transported to the laboratory for testing and classification.

The drill crew prepared a field log of each boring to record data including visual classifications of the materials encountered during drilling as well as the drill crew's interpretation of the subsurface conditions between samples. The boring logs include our interpretation of the subsurface conditions at the boring locations based on field and laboratory data and observation of the samples.

BORING LOG NO. 1

PROJECT: US Highway 63 Pump Station and Control Building

CLIENT: AECOM Technical Services, Inc. Waterloo, Iowa

SITE: Highway 63 Waterloo, Iowa

LOCATION See Exhibit A-2, offset about 6' north and 6' west

Latitude: 42.5005474° Longitude: -92.3412585°

Surface Elev.: 858.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ORGANIC CONTENT (%)
1.0	857.5	**FILL - SILTY SAND**, fine to coarse, trace gravel, dark brown								
		FILL - SANDY LEAN CLAY, trace gravel, brown and dark brown								
3.5	855				X	15	5-4-4 N=8		17	
		FILL - SANDY LEAN CLAY, trace gravel, brown gray			X	18	3-3-5 N=8		12	
			5		X	16	2-4-6 N=10		11	
					X	18	5-6-6 N=12		11	
11.0	847.5		10							
		FILL - CLAYEY SAND, fine to medium, trace gravel, with zones of clay, dark brown			X	16	4-5-5 N=10		13	
					X	13	2-3-3 N=6		13	3.5
			15		X	15	1-2-2 N=4		16	
					X	12	1-1-3 N=4		12	
21.0	837.5		20							
		FILL - SANDY LEAN CLAY, with sand layers, brown			X	18	1-1-1 N=2		21	
24.0	834.5			▽						
25.0	833.5	**FILL - SAND**, fine to coarse, trace gravel and clay, brown	25	▼	X	8	2-5-6 N=11		22 23	
		LEAN TO FAT CLAY (CL/CH), trace sand and gravel (residual soil), brown, stiff		▽						
27.5	831			▨	X	17	1-6-10 N=16 2000 (HP)		17	
		SAND (SP-SC), fine to coarse, with clay layers (residual soil), brown, loose to medium dense								
30.5	828		30		X	10	2-3-8 N=11		15	
		Boring Terminated at 30.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-4 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *24' while drilling*
- ▽ *26.5' before casing removal*
- ▼ *25' after boring*
- ▨ *Wet cave-in at 28'*

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

Boring Started: 8/4/2015 Boring Completed: 8/4/2015

Drill Rig: # 94e Driller: RF

Project No.: 13155071.01 Exhibit: A-5

BORING LOG NO. 2

PROJECT: US Highway 63 Pump Station and Control Building

CLIENT: AECOM Technical Services, Inc. Waterloo, Iowa

SITE: Highway 63 Waterloo, Iowa

LOCATION See Exhibit A-2

Latitude: 42.5005674° Longitude: -92.3412082°

Surface Elev.: 858.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ORGANIC CONTENT (%)
		FILL - SILTY SAND, fine to coarse, trace gravel, dark brown								
1.5	857									
		FILL - SANDY LEAN CLAY, trace gravel and zones of sand, gray brown			X	11	3-3-4 N=7		10	
					X	18	3-6-7 N=13		12	
			5		X	18	3-5-6 N=11		11 12	
9.5	849									
		FILL - SANDY LEAN CLAY, trace gravel and organics, brown and dark brown			X	17	4-4-6 N=10		10 11	
			10		X	18	2-4-6 N=10		17	
					X	18	1-1-2 N=3		13	
			15		X	16	1-1-2 N=3		15	
17.5	841									
		FILL - CLAYEY SAND, fine to medium, trace gravel, dark brown to brown							14	
			20		X	18	2-2-2 N=4		14 18	
		brown at about 22 feet			X	18	2-3-1 N=4		16 16	
24.5	834			▽						
		LIMESTONE*, highly weathered and broken, brown	25	▽	X	8	2-13-28 N=41		14 11	
					X	9	10-50/5"		12	
28.5	830									
		Boring Terminated at 28.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

*Classification of bedrock based on observation of distrubed samples. Rock coring and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *24' while sampling*
- ▽ *25.5' before casing removal*
- *None after boring*
- *Dry cave-in at 25'*

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

Boring Started: 8/4/2015 Boring Completed: 8/4/2015

Drill Rig: # 94e Driller: RF

Project No.: 13155071.01 Exhibit: A-6

BORING LOG NO. 3

PROJECT: US Highway 63 Pump Station and Control Building

CLIENT: AECOM Technical Services, Inc. Waterloo, Iowa

SITE: Highway 63 Waterloo, Iowa

LOCATION See Exhibit A-3

Latitude: 42.4997921° Longitude: -92.3441243°

Surface Elev.: 860.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ORGANIC CONTENT (%)
0.7	860	**FILL - SILTY SAND**, fine to coarse, trace gravel, dark brown								
		FILL - SANDY LEAN CLAY, with rubble, trace gravel, dark brown and brown			X	15	9-9-10 N=19		8	
			5		X	18	3-4-5 N=9		13	
6.5	854									
		FILL - SANDY LEAN CLAY, trace gravel, with zones of sand, gray brown			X	18	2-2-5 N=7		15	
			10		X	18	3-5-5 N=10		12	
					X	18	3-5-7 N=12		11	
14.0	846.5									
		FILL - CLAYEY SAND, fine to coarse, with rubble, brick, and cinders, trace gravel, dark brown	15		X	14	8-6-7 N=13		11	
					X	9	0-1-1 N=2		23	
20.0	840.5		20		X	5	2-3-6 N=9		21	
		FILL - CLAYEY SAND, fine to coarse, with rubble, brick, cinders, and organics, trace gravel, dark brown			X	9	2-3-3 N=6		45	
24.0	836.5									
		FILL - SANDY LEAN CLAY, with rubble and cinders, trace gravel, dark brown and brown	25	▽	X	5	1-1-4 N=5		14	
27.0	833.5			▽						
		SANDY FAT CLAY (CH), with silt layers (residual soil), gray and brown, medium stiff			X	15	3-3-4 N=7		16 33	
29.0	831.5									
		LIMESTONE*, highly weathered and broken, light brown and brown	30		X	6	2-7-5 N=12		18	
		practical hollow-stem auger refusal at about 33.5 feet. 'harder' limestone from about 33.5 to 35 feet	35				50/0.5"			

Stratification lines are approximate. In-situ, the transition may be gradual.

*Classification of bedrock based on observation of distrubed samples. Rock coring and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 33.5 feet, then tri-cone bit with drilling mud to boring termination.

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

Boring initially extended to 30.5 feet on 8/5/15. Boring extended to 45 feet in same borehole and completed on 8/24/15.

WATER LEVEL OBSERVATIONS

▽ *26' while sampling*

▽ *27' after boring*

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

Boring Started: 8/5/2015 | Boring Completed: 8/24/2015

Drill Rig: # 94e | Driller: RF

Project No.: 13155071.01 | Exhibit: A-7

BORING LOG NO. 3

PROJECT: US Highway 63 Pump Station and Control Building

CLIENT: AECOM Technical Services, Inc. Waterloo, Iowa

SITE: Highway 63 Waterloo, Iowa

LOCATION See Exhibit A-3

Latitude: 42.4997921° Longitude: -92.3441243°

Surface Elev.: 860.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ORGANIC CONTENT (%)
100% water loss from 33.5 to 45 feet 'harder' limestone from about 35.5 to 36 feet **LIMESTONE***, highly weathered and broken, light brown and brown *(continued)* soft clay from about 36 to 39.5 feet									
				X	2	0-1-50/3"			
'harder' limestone from about 39.5 to 42.5 feet		40							
'harder' limestone from about 42.5 to 43 feet									
						50/0.5"			
45.0	815.5	45							
Boring Terminated at 45 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

*Classification of bedrock based on observation of distrubed samples. Rock coring and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 33.5 feet, then tri-cone bit with drilling mud to boring termination.

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-4 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *26' while sampling*

▽ *27' after boring*

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

Boring Started: 8/5/2015 Boring Completed: 8/24/2015

Drill Rig: # 94e Driller: RF

Project No.: 13155071.01 Exhibit: A-7

BORING LOG NO. 4

PROJECT: US Highway 63 Pump Station and Control Building

CLIENT: AECOM Technical Services, Inc. Waterloo, Iowa

SITE: Highway 63 Waterloo, Iowa

LOCATION See Exhibit A-3

Latitude: 42.4997073° Longitude: -92.3440556°

Surface Elev.: 860.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description
0.7	860	**FILL - SILTY SAND**, fine to coarse, trace gravel, dark brown
		FILL - SANDY LEAN CLAY, trace gravel, gray and brown
4.0	856.5	
		FILL - SANDY LEAN CLAY, with rubble, trace gravel, brown to dark brown
		dark brown at about 6 feet
13.5	847	
		FILL - SANDY LEAN CLAY, with rubble, brick, cinders and glass, trace gravel, brown and dark brown
21.0	839.5	
		FILL - CLAYEY SAND, fine to coarse, trace gravel, rubble, brick, cinders, and glass, brown and dark brown
26.5	834	
		SILT (ML), trace limestone gravel (residual soil), gray and light brown, stiff
30.0	830.5	
		LIMESTONE*, highly weathered and broken, light brown
		Practical hollow-stem auger refusal at about 34 feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)
		12	7-6-6 N=12	6
5		3	5-12-7 N=19	10
		18	7-6-6 N=12	12
10		18	4-6-5 N=11	14
		18	2-4-7 N=11	15
15		15	7-7-8 N=15	14
		9	3-7-27 N=34	21
20		14	2-3-3 N=6	21
		10	3-3-4 N=7	30
25		3	1-3-1 N=4	28
		12	3-4-8 N=12	31
30		18	20-18-9 N=27	11
35			40/0"	

Stratification lines are approximate. In-situ, the transition may be gradual.

*Classification of bedrock based on observation of distrubed samples. Rock coring and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 34 feet, then tri-cone bit with drilling mud to boring termination.

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

Boring initially extended to 30.5 feet on 8/5/15. Boring extended to 45 feet in same borehole and completed on 8/24/15.

WATER LEVEL OBSERVATIONS

- *22' while sampling*
- *28.5' before casing removal*
- *27.5' after boring*

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

Boring Started: 8/5/2015 Boring Completed: 8/24/2015

Drill Rig: # 94e Driller: RF

Project No.: 13155071.01 Exhibit: A-8

BORING LOG NO. 4

PROJECT: US Highway 63 Pump Station and Control Building

CLIENT: AECOM Technical Services, Inc. Waterloo, Iowa

SITE: Highway 63 Waterloo, Iowa

LOCATION See Exhibit A-3

Latitude: 42.4997073° Longitude: -92.3440556°

Surface Elev.: 860.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	WATER CONTENT (%)	ORGANIC CONTENT (%)
'harder' limestone from about 34 to 35.5 feet 100% water loss from 34 to 45 feet **LIMESTONE***, highly weathered and broken, light brown *(continued)*									
'harder' limestone from about 38 to 39.5 feet						50/0.5"			
		40							
45.0	815.5				8	13-8-10 N=18			
		45							
Boring Terminated at 45 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

*Classification of bedrock based on observation of distrubed samples. Rock coring and petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Hollow stem auger to 34 feet, then tri-cone bit with drilling mud to boring termination.

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exhibit A-4 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- *22' while sampling*
- *28.5' before casing removal*
- *27.5' after boring*

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

Boring Started: 8/5/2015 Boring Completed: 8/24/2015

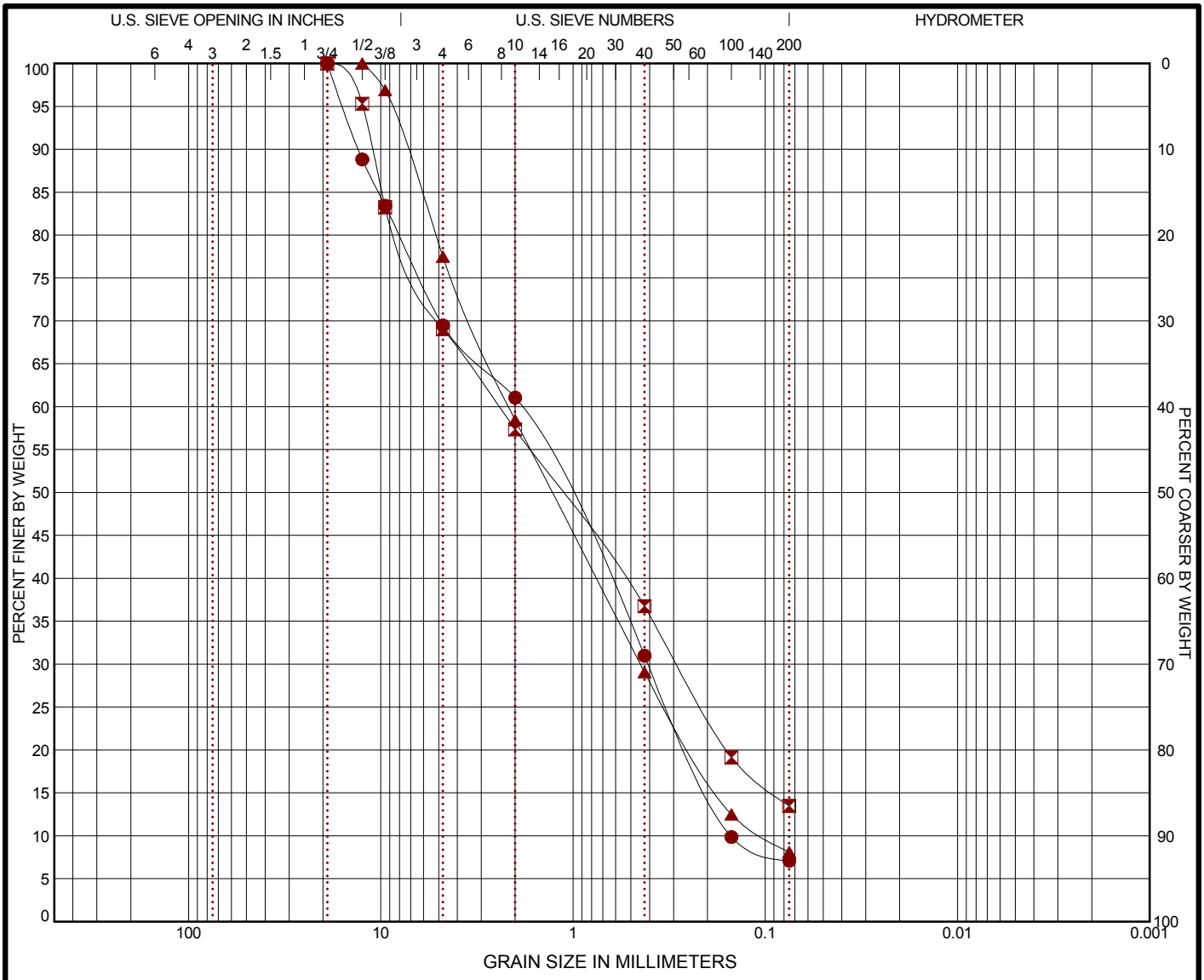
Drill Rig: # 94e Driller: RF

Project No.: 13155071.01 Exhibit: A-8

APPENDIX B
SUPPORTING INFORMATION

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	1	24 - 25.5	0.0	30.5	62.4		7.1		
⊠	3	14 - 15.5	0.0	31.0	55.5		13.5		
▲	3	21.5 - 23	0.0	22.5	69.4		8.1		

	GRAIN SIZE		
	●	⊠	▲
D_{60}	1.894	2.434	2.147
D_{30}	0.405	0.285	0.447
D_{10}	0.151		0.101
	COEFFICIENTS		
C_C	0.57		0.92
C_U	12.55		21.27

SIEVE (size)	PERCENT FINER		
	●	⊠	▲

SOIL DESCRIPTION
●
⊠
▲

REMARKS
●
⊠
▲

PROJECT: US Highway 63 Pump Station and Control Building

SITE: Highway 63
Waterloo, Iowa

Terracon
3105 Capital Way, Suite 5
Cedar Falls, Iowa

PROJECT NUMBER: 13155071.01

CLIENT: AECOM Technical Services, Inc.
Waterloo, Iowa

EXHIBIT: B-1

Laboratory Test Summary

In the laboratory, moisture content (ASTM D4959) tests were performed on portions of the recovered samples. Hand penetrometer tests were performed to estimate the consistency of select samples of native, fine-grained soils. Sieve analyses (ASTM D422) were performed on selected samples for Boring 3. The organic content (ASTM D2974) of one sample was also determined. The results of the laboratory tests follow this page and are shown on the boring logs in Appendix A at their corresponding sample depths.

The samples were classified in the laboratory based on visual observation, texture and plasticity (ASTM D2487 and ASTM D2488), and the laboratory testing described above. The descriptions of the soils indicated on the boring log are in general accordance with the General Notes and the Unified Soil Classification System (USCS), and are summarized in Exhibits C-1 and C-2 in Appendix C. Classification of rock materials provided on the borings logs is in general accordance with the Description of Rock Properties included as Exhibit C-3.

Procedural standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING


Auger


Split Spoon


Shelby Tube


Macro Core


Ring Sampler


Rock Core


Grab Sample


No Recovery

WATER LEVEL


Water Initially Encountered


Water Level After a Specified Period of Time


Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

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

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

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

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

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

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

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

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

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

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

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

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

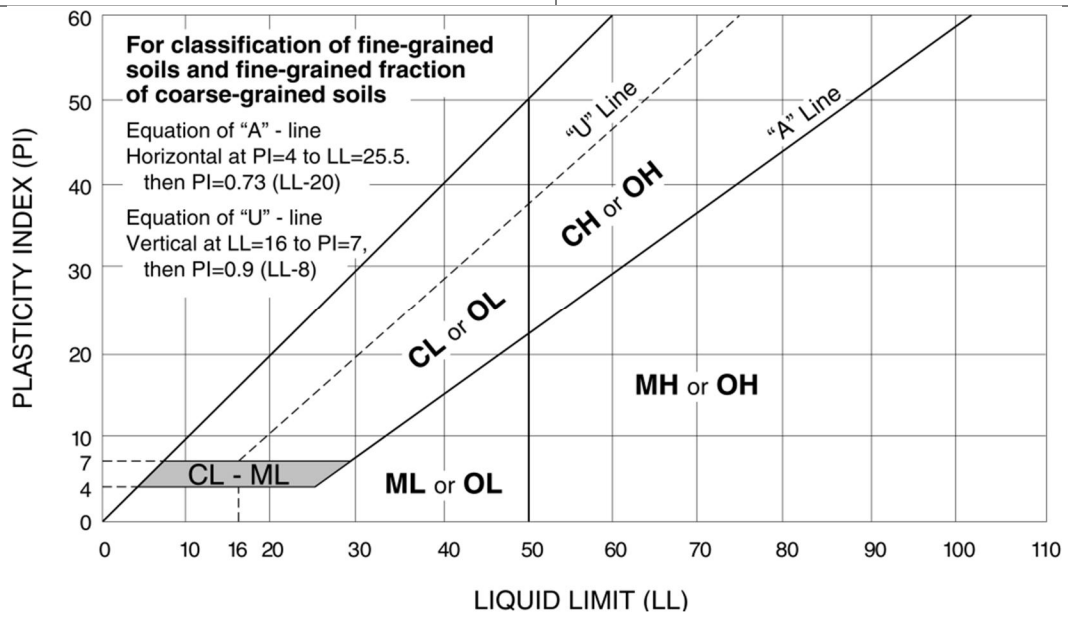
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

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

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



GENERAL NOTES

Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

LIMESTONE	Light to dark colored, crystalline to fine-grained texture, composed of $CaCo_{3,}$ reacts readily with HCI.
DOLOMITE	Light to dark colored, crystalline to fine-grained texture, composed of $CaMg(CO_3)_2$, harder than limestone, reacts with HCI when powdered.
CHERT	Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz (SiO_2), brittle, breaks into angular fragments, will scratch glass.
SHALE	Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The unlaminated equivalent is frequently referred to as siltstone, claystone or mudstone.
SANDSTONE	Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.
CONGLOMERATE	Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (1/2 inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

DEGREE OF WEATHERING:

SLIGHT	Slight decomposition of parent material on joints. May be color change.
MODERATE	Some decomposition and color change throughout.
HIGH	Rock highly decomposed, may be extremely broken.

Classification of rock materials has been estimated from disturbed samples.
Core samples and petrographic analysis may reveal other rock types.

September 29, 2016

Terracon

AECOM Technical Services, Inc.
501 Sycamore Street, Suite 222
Waterloo, Iowa 50703

Attn: Mr. Todd Allyn, P.E.
P: (319) 232-6531
E: todd.allyn@aecom.com

Re: Geotechnical Engineering Report Addendum 1
US Highway 63 Pump Station and Control Building
Waterloo, Iowa
Terracon Project Number: 13155071-02

Dear Mr. Allyn:

As requested by Mr. William Cline, P.E. of ATS on September 28, 2016, we have prepared this geotechnical engineering report addendum for the subject project. As you are aware, we prepared a Geotechnical Engineering Report (GER) for this project with a project report number of 13155071.01, dated October 19, 2015. This addendum has been prepared after conversations with Mr. Cline regarding drilled shaft loadings for the control buildings, which we understand are planned at the north and south sites. This addendum should be considered a part of our original GER and is subject to the same conditions and qualifications of that report.

We understand that ATS desires an alternate, higher bearing value for use in drilled shaft foundation design. Following is a summary of the depths below existing grades and corresponding elevations to residual soil and bedrock that was encountered in the borings.

Boring No.	Surface Elevation (feet)	Approximate Depth to Residual Soil (feet)	Corresponding Residual Soil Elevation (feet)	Approximate Depth to Highly Weathered Bedrock (feet)	Corresponding Highly Weathered Bedrock Elevation (feet)
1	858.5	25	833.5	Not encountered	-
2	858.5	Not encountered	-	24.5	834
3	860.5	27	833.5	29	831.5
4	860.5	26.5	834	30	830.5

Based on our analysis, straight-sided drilled shafts extended into highly weathered and broken bedrock a minimum of 10 feet can be designed using a net allowable end bearing pressure of 10,000 psf. This allowable end bearing pressure includes a factor of safety of at least 3. Settlement of drilled shaft foundations designed and constructed in accordance with the recommendations in this addendum and our original GER is expected to be on the order of ½-inch.

Based on the conditions encountered in the borings, we estimate that drilled shafts will need to be extended to approximate elevations of 823 feet, or lower, at the north site (Borings 1 and 2), and to approximate elevations of 820.5 feet, or lower, at the south site (Borings 3 and 4). Due to the variability of the highly weathered and broken limestone, various depths of penetration should be anticipated in order to reach competent bearing bedrock. The contractor should be prepared to excavate/core and case the excavations below the elevations noted above. Comments regarding drilled shaft construction in the highly weathered and broken Cedar Valley formation are included in our original GER.

We trust that our supplemental recommendations are sufficient for your current needs. We appreciate the opportunity to be of continued service to you on this project. If you have any questions regarding this addendum, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Jason Heinz, P.E.
Geotechnical Department Manager
Iowa No. 18345

Ted Bechtum, E.I.
Staff Geotechnical Engineer

Cc: Addressee (pdf via email)
Mr. William Cline, P.E. (pdf via email)