

CITY OF DE PERE

Public Works - Engineering Department

925 S. Sixth Street, De Pere, WI 54115 | 920-339-4061 | www.de-pere.org



January 18, 2022

ADDENDUM NO. 1 PROJECT 21-16 MYSTIC CREEK SUBDIVISION CONSTRUCTION

TO: Prospective Bidders

FROM: City of De Pere

Notice is hereby given that the contract documents for the Project 21-16 are amended as hereinafter set forth. If you will be submitting a bid for Project 21-16, you must sign this addendum and include it with your submittal.

This addendum consists of 281 pages.

The purpose of this addendum is to provide revised plan sheets and specifications for the lift station. **Additionally, due to permitting requirements, the City anticipates a construction start date for this project of May 2, 2022.**

CHANGES TO APPENDIX :

Delete Appendix A, Lift Station Construction Specifications by Robert E. Lee and Associates and insert Revised Appendix A, Lift Station Construction Specifications by Robert E. Lee and Associates dated January 18, 2022. Changes to Appendix A include:

1. Replaced Sections

- | | |
|----------------|---|
| a. 00 41 13.2 | Base Bid, Substitute, and "Or Equals" Schedule |
| b. 01 21 00 | Allowances |
| c. 01 45 24 | Testing and Inspection of Pipeline Construction |
| d. 09 90 00 | Painting and Special Coatings |
| e. 10 14 00 | Signage |
| f. 26 05 00 | Common Work Results |
| g. 26 05 19 | Line-Voltage Power Conductors and Cables |
| h. 26 05 26 | Grounding and Bonding |
| i. 26 05 29 | Hangers and Supports |
| j. 26 05 53 | Identification |
| k. 33 01 30.16 | Sewer Cleaning & Televising |
| l. 33 32 19 | Submersible Pump Lift Station |
| m. 33 34 00 | Force Main |
| n. 40 05 13.19 | Stainless Steel Pipe and Fittings |
| o. 46 42 56.19 | Submersible Centrifugal Pumps |

2. Added Sections

- a. 01 32 19 Submittals
- b. 26 05 04 Cleaning, Inspection, and Televising
- c. 26 05 23 Control-Voltage Electrical Cables
- d. 26 05 33 Raceways and Boxes
- e. 26 27 02 Equipment Wiring Systems
- f. 26 27 26 Wiring Devices
- g. 26 27 28 Disconnect Switches
- h. 26 28 13 Fuses
- i. 26 29 00 Low-Voltage Controllers
- j. 26 90 00 Process Instrumentation and Control
- k. 26 90 05 Control Panel Construction
- l. 26 90 06 Electrical Control Components
- m. 26 90 72.43 Submersible Pressure Transducers
- n. 26 90 72.76 Level Switches
- o. 40 05 13.53 Ductile Iron Pipe

3. Deleted Sections

- a. 26 05 37 Boxes
- b. 33 42 13 Corrugated Metal Culvert Pipe

CHANGES TO PLANS

- 1. Delete sheet C128 and insert C128-R1
- 2. Delete sheet C508 and insert C508-R1
- 3. Delete sheet C509 and insert C509-R1
- 4. Delete sheet E001 and insert E001-R1
- 5. Delete sheet E101 and insert E101-R1
- 6. Delete sheet E102 and insert E102-R1
- 7. Delete sheet E501 and insert E501-R1

Sincerely,

DEPARTMENT OF PUBLIC WORKS



Eric P. Rakers, P.E.
City Engineer



Acknowledged by: _____ Date: _____

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DIVISION 00

PROCUREMENT AND CONTRACTING REQUIREMENTS

SECTION 00 41 13.2
BASE BID, SUBSTITUTE, AND "OR EQUALS" SCHEDULE

At the time of bid, Bidder shall identify one or more proposed "or equals" and/or substitutes meeting the requirements of paragraph 6.05 of the General Conditions for the following items identifying the comparative cost with the specified "named" item. The purpose of this schedule is to identify any proposed substitute and "or equals" for these specific items.

If Engineer and Owner believe consideration of the proposed items will result in a cost savings, then the apparent low bidder shall submit sufficient information for evaluation; in accordance with paragraph 6.05 of the General Conditions.

The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or "or-equal" items. Whenever it is specified or described in the Bidding Documents that a substitute or "or-equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the Effective Date of the Agreement.

Note: Contractor SHALL circle the named equipment manufacturer being provided under the base bid.

Specification Section	Named Equipment	Proposed Substitute "Or Equal"	Estimated Base Bid Price Adjustment Deduct From
46 42 56.19	Gorman-Rupp, Sulzer		\$
			\$
			\$
			\$
			\$
			\$
			\$
			\$
			\$
			\$
			\$
			\$

01

DIVISION 01

GENERAL REQUIREMENTS

SECTION 01 21 00

ALLOWANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section includes project allowances to cover items not precisely determined by the Owner prior to bidding. The allowances shall be included in bid price.
- B. Related Sections and Divisions: Applicable provisions of the General Conditions shall govern the work in this section.
- C. If the cost of materials, service or equipment exceeds that set forth above, the Contractor shall be reimbursed for the additional cost by the Owner. If the cost of materials, services or equipment is less than as set forth above, the Owner shall be credited for the difference between cost as stated below and actual cost.

1.02 SCHEDULE OF ALLOWANCES

1.	Electrical Service	\$10,000
2.	Control Panel and SCADA System Modifications	<u>\$50,000</u>
	TOTAL	\$60,000

1.03 ALLOWANCE DESCRIPTION

- A. Costs included in allowances: Cost of product to Contractor or Subcontractor, less applicable trade discounts; include delivery to site and applicable taxes.
- B. Compensation to the Contractor shall be for the direct costs only and shall not include any Contractor mark-ups on services or for service coordinating allowance items, except additional bond costs if the Allowance total is exceeded. Costs not included in the allowance: Unless specified otherwise, allowances DO NOT include costs for product handling at the site, including unloading, uncrating, and storage; protection of products from elements and from damage; labor for installation and finishing. These costs SHALL BE included in the Base Bid Price and no demand for additional payment on account of any thereof will be valid.
- C. Engineer Responsibilities
1. Consult with Contractor in consideration and selection of products, suppliers and installers.
 2. Select products in consultation with Owner and transmit decision to Contractor.
 3. Prepare change order, if required.
- D. Contractor Responsibilities
1. On notification of selection by Engineer, execute purchase order with designated equipment supplier.
 2. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
 3. Promptly inspect products upon delivery for completeness, damage and defects. Submit claims for transportation damage.

1.04 ELECTRICAL SERVICE ALLOWANCE

- A. This allowance item covers the cost of a new electrical service for the lift station.

1.05 CONTROL PANEL AND SCADA SYSTEM MODIFICATIONS ALLOWANCE

- A. This allowance item covers the cost for provide a new lift station control panel, wet well instrumentation, and SCADA system modifications in accordance with the plans and specifications. All work for this allowance shall be contracted through Mark Hoff at P.J. Kortens and Company, Inc.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

NOT APPLICABLE

- END OF SECTION -

SECTION 01 32 19

SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This Section includes administrative and procedural requirements for submittals required for performance of the work, including the following:
1. Contractor's progress schedule.
 2. Submittal schedule.
 3. Shop drawings.
 4. Submittal Transmittal Data Sheet.
 5. Product data.
 6. Samples.
 7. Quality assurance submittals.
 8. Submittal List
- B. Related Sections and Divisions:
1. Applicable provisions of the General Conditions shall govern the work in this section.
 2. Requirements for submittals are described in other sections of the specifications.

1.02 IDENTIFICATION OF SUBMITTALS

- A. The Contractor shall mark each submittal and re-submittal by providing the information described in 1.06, Submittal Transmittal Data Sheet.
- B. The Contractor shall sign and date each submittal indicating that submittal was reviewed by the Contractor and meets the requirements of the plans and specifications. Unsigned submittals will not be reviewed by the Engineer and returned.

1.03 CONSTRUCTION SCHEDULE

- A. The Contractor shall prepare and submit a detailed progress schedule in accordance with the General Conditions. The construction schedule shall be of sufficient detail to assure adequate planning and execution of the work and provide an appropriate basis for monitoring and evaluation of the progress of work.
- B. The progress schedule shall indicate the sequence of all work including the start date, completion date and duration.
- C. The progress schedule shall incorporate shop drawing and sample submittals schedule.
- D. If, at any time during the Project, Contractor fails to complete an activity by its latest scheduled completion date, Contractor shall, within 3 working days of notification by Engineer, submit to Engineer written statement as to how and when work force will be reorganized to return Contract to current schedule.

- E. When it becomes apparent from progress evaluation and updated schedule data that milestone completion or Contract completion dates will not be met, Contractor shall take some or all of following actions.
 - 1. Increase construction staffing in such quantities and crafts as shall substantially eliminate backlog of work.
 - 2. Increase number of working hours per shift, shifts per work day, work days per week, or amount of construction equipment, or combination thereof sufficient to substantially eliminate backlog of work.
 - 3. Reschedule work items to achieve concurrency of accomplishments.
- F. Addition of equipment or construction forces, increasing working hours or other method, manner or procedures to return to current Construction Progress Schedule will not be considered justification for amending Contract Documents or treated as acceleration.
- G. The progress schedule shall be updated throughout the construction period. The Contractor shall revise the schedule monthly and submit with the monthly payment request. The progress schedule will be reviewed at the monthly construction progress meetings.

1.04 SUBMITTAL SCHEDULE

- A. Contractor shall make all submittals far enough in advance of scheduled installation dates to ensure adequate time for review and approval by the Engineer. This schedule shall also take into account possible revisions and resubmittals.
- B. To avoid the need to delay installation as a result of the time required to process submittals, allow sufficient time for submittal review, including time for resubmittals.
 - 1. Allow 4 weeks for submittals.
 - 2. Allow 2 weeks for re-submittals.
 - 3. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the work to permit processing

1.05 SHOP DRAWINGS

- A. All shop drawings shall be addressed to Engineer.
- B. Shop drawings shall be submitted under a submittal transmittal data sheet as described in 1.06. An electronic copy of the submittal transmittal data sheet will be provided by e-mail.
- C. Shop drawings shall include technical data including drawings, diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and other pertinent data. Shop drawings shall be submitted for all manufactured or fabricated items.
- D. Only shop drawings that are pertinent to the project for which they are submitted shall be provided to the Engineer for review. The Engineer reserves the right to reject any submittal containing extraneous information resulting in rejection of the entire submittal, and a new submittal shall be required which contains only pertinent project information.
- E. Shop drawings shall be checked, approved, signed, and dated by the Contractor in accordance with the General Conditions before submitting to the Engineer for review and comment.

- F. Do not use shop drawings without an appropriate final stamp indicating action taken.
- G. Except for submittals for the record or information, where action and return is required, the Engineer shall review each submittal, mark to indicate action taken, and return promptly. The Engineer/Architect will stamp each submittal with a uniform action stamp. The Engineer/Architect will mark the stamp appropriately to indicate the action taken.
- H. Shop drawings that require resubmission shall be revised as follows:
 - 1. Revise initial drawings and data and resubmit as required.
 - 2. Provide an itemized list of all changes other than those requested by the Engineer in the cover letter.
- I. Submittal Format During COVID-19
 - 1. Electronic submittals are **REQUIRED**. Submittals shall be e-mailed to the Shop Drawing Coordinator to be logged before forwarding to the Project Manager for review and approval.
 - 2. Absolutely **NO** physical dropping off of submittals or via USPS to our office is permitted.
 - 3. If a submittal is too large to e-mail, contact Engineer for instructions to determine an alternative submittal method.

1.06 SUBMITTAL TRANSMITTAL DATA SHEET

- A. Shop drawings shall be submitted by specification section. The Contractor shall submit a submittal transmittal data sheet with each shop drawing; refer to the form at the end of this section. Include all required submittal information as indicated in the specification section. Combining specification sections on submittal sheets is **NOT PERMITTED**.
- B. The submittal transmittal data Sheet must be filled out correctly or the submittal will be returned.

1.07 PRODUCT DATA

- A. Contractor shall provide product data as required to supplement shop drawings.
- B. Submittal Transmittal Data Sheet shall be provided for each product data submittal.
- C. Product data shall include illustrations, schedules, installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
- D. Contractor shall mark each copy of the product data to identify products, models, options and other pertinent.
- E. Contractor shall include all Safety Data Sheets (SDS) required by OSHA.

1.08 QUALITY ASSURANCE SUBMITTALS

- A. Submit quality-control submittals, including design data, certifications, manufacturer's instructions, manufacturer's field reports, and other quality-control submittals as required under other sections of the specifications.
- B. Submittal Transmittal Data Sheets shall be provided for each quality assurance submittal.

C. Inspection and Test Reports shall be submitted as required by other sections of the specifications.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Contractor shall furnish operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Manuals.

1.10 INSTALLATION AND TRAINING CHECKLISTS

A. Contractor shall provide the Installation and Training checklists in accordance with Section 01 78 43, Installation and Training Checklists.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

NOT APPLICABLE

- END OF SECTION -

SECTION 01 45 24

TESTING AND INSPECTION OF PIPELINE CONSTRUCTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section specifies various types of tests and inspection procedures to be used on installed pipelines for determining water and pressure tightness and alignment.
- B. Related Sections and Divisions:
1. Applicable provisions of the General Conditions shall apply to this section.
 2. Section 01 32 19, Submittals
 3. Section 33 01 30.16, Sewer Cleaning & Televising
 4. Section 33 34 00, Forcemain
 5. Section 33 32 19, Submersible Pump Lift Station
 6. Section 40 05 13.53, Ductile Iron Pipe
 7. Section 40 05 13.19, Stainless Steel Pipe and Fittings
 8. Section 40 05 15, Methods and Materials for Piping Installation

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
1. ASTM 02774 Standard Practice for underground installation of thermoplastic pressure piping.
 2. ASTM D3034 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 3. ASTM D3350-84 Polyethylene Plastic Pipe and Fittings Material
 4. ASTM F679S Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
 5. ASTM F1417 Installation Acceptance of Plastic Gravity Sewer Lines using low pressure air.
- B. American Water Works Association (AWWA):
1. AWWA C651 Disinfecting Water mains
- C. American National Standards Institute (ANSI):
1. ANSI B16.5-81 Pipe Flanges (150 lb.)
 2. AWWA C600 Installation of Ductile Iron Water Mains and their appurtenances.
- D. American Water Works Association (AWWA):
1. AWWA C207-86 Standard for Steel Pipe Flanges for Waterworks Service – Size 4 inches through 144 inches

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.01 PREPARATION OF PIPELINE BEFORE TESTING

- A. The pipes shall be clean of debris and materials prior to testing.
- B. Televising shall be performed immediately after cleaning.

3.02 STANDARD GRAVITY PIPELINE INFILTRATION TEST

- A. Measurement of infiltrating flow utilizing weir or a dam with measuring container at downstream end of pipeline sector being tested.
- B. Conditions to Prevail Before Infiltration Test Commences
 - 1. Groundwater level shall produce a minimum positive head of 2 feet over all sections of pipeline being tested.
 - 2. Groundwater level shall be measured by the Contractor prior to the infiltration test utilizing a measurement method acceptable to Engineer.
 - 3. Weir or dam shall be in place 12 hours before measurement of flow.
 - 4. Any source of water, sewage or other liquid except infiltrating groundwater shall be eliminated before conducting test.
- C. Maximum Limits of Infiltration
 - 1. Infiltration shall be limited to the maximum allowed as specified in the section for Materials and Methods of Construction for the pipeline specified.
 - 2. When infiltration limits for gravity pipelines are not given in the appropriate section for Materials and Methods of Construction, the following limits shall apply:
 - a. Two hundred gallons in 24 hours for each inch of the diameter of pipe being tested, for every one mile of pipe.
 - b. Infiltration rate for manholes shall be computed using the total number of vertical feet of manhole expressed as the equivalent largest diameter sewer entering the manhole.
- D. Equipment and Personnel to be supplied by the Engineer
 - 1. Measuring weirs.
 - a. "V" notch 30°, 60°, or 90° with end contractions.
 - b. Sharp crested with edge ground to 45°.
 - c. Install in manhole or pipe in such a manner that leakage is zero.
 - d. Discharge for "V" notch weirs shall be based on the following formula:
When:
 $Q = \text{Cu. ft. per second}$
 $C = .57$
 $L = \text{Width of notch in ft. at H distance above the apex.}$
 $H = \text{Head of liquid above the apex of notch in feet.}$
 $g = 32.174$
 - e. End contractions shall not be less than 3/4 L.
 - 2. Shallow measuring vessel calibrated to gallons and tenths of gallons.

3. Stop watch with sweep hand indicating seconds and tenths of seconds (certified accurate by a state licensed watchmaker).
4. Sufficient personnel to conduct tests.
5. Either weir method or stopwatch and container method may be used at discretion of Engineer.

E. Equipment and Personnel to be provided by Contract.

1. Qualified observer.
2. Personnel to assist in placing and removing weirs.
3. Contractor responsible for safety during tests including:
 - a. Providing signs.
 - b. Providing safety equipment including safety equipment for confined entry.
 - c. Providing signalmen when necessary.

3.03 STANDARD GRAVITY PIPELINE EXFILTRATION TEST

- A. The Contractor may perform an exfiltration test when groundwater level is less than 2 feet above sections of pipeline being tested.
- B. The following shall be completed prior to testing:
1. Pipeline shall be tested with a minimum positive head of 2 feet in all sections.
 2. Pipeline and manholes shall be filled with water until the water level is a minimum of 2 feet above the highest section of pipe or a minimum of 2 feet above the groundwater level, whichever elevation is higher.
 3. Groundwater level shall be measured by the Contractor prior to the infiltration test utilizing a measurement method acceptable to Engineer.
- C. The following is the recommended test procedure:
1. Plug section to be tested.
 2. Laterals on the line being tested shall be provided with a temporary cleanout to permit adequate release of trapped air in laterals.
 3. Fill line and manhole with water as per paragraph B.
 4. Let line stand for 12 hours adding water periodically to retain test level as it is reaching its maximum absorption and entrapped air is escaping.
 5. After 12 hours, refill line to test level and let stand for 1-hour test period.
 6. Measure and record loss of water in gallons per hour.
 7. Subtract manhole loss as previously determined, to get actual line loss.
 8. Repair and retest until results of final test hour are within allowable leakage limits.
- D. Exfiltration shall be limited to 8.34 gallons per hour per inch diameter per mile of pipe.

3.04 STANDARD PRESSURE AND LEAKAGE TEST FOR PRESSURIZED PIPELINES

- A. Measure drop in pressure and leakage from liquid filled and pressurized pipelines.
- B. Conditions to prevail before commencement of test.
1. Disinfect all testing equipment and fittings.
 2. Backfill to at least minimum 4 feet compacted backfill material.
 3. Length of pipeline tested shall not exceed 2,000 feet.

3. Reaction backing shall achieve the required 28-day compressive strength prior to applying hydrostatic test pressures, and shall conform to all requirements of ACI 205, Hot Weather Concrete and ACI 306, Cold Weather Concrete.
4. Fill with water.
 - a. Fill each valved section with water slowly, expelling air completely from the pipeline, valves, and hydrants.
 - b. Where permanent air vents are not located at all high points or dead ends, Contractor shall install corporation cocks at such points so that air can be expelled as the line is filled with water.
 - 1) Close all these corporation cocks before applying pressure or leakage tests.
 - 2) At the conclusion of the leakage and pressure test, the corporation cocks shall be removed and plugged, or left in at the discretion of the Owner.
5. Pressurize to normal working pressure.
 - a. After test connections are made and pipeline is filled with water, the pipeline shall be subjected to water pressure normal for that segment of the system being tested.
 - b. Examine system for any visible leakage at this stage.
 - 1) Repair any visible leaks.
 - 2) Re-pressurize to normal working pressure and continue to repair and re-pressurize until all visible leaks have been stopped.

C. Pressure Test

1. Test pressure shall be not less than 150 lbs. per sq. inch at the lowest point of elevation of the segment being tested.
 - a. The minimum test pressures specified above may require that the installed system be tested in several segments in order to attain the proper pressure.
 - b. If test pressures other than indicated above are called for in the sections for Materials and Methods of Construction, those pressures shall be used.
2. Pressurize the system being tested to pressure required above by adding water with high-pressure test pump.
3. Repair any visible leaks occurring due to test pressure application.
4. Repeat pressurizing of system to test pressure until no visible leaks can be found.
5. Duration of pressure test.
 - a. Test period shall be two continuous hours with no visible leaks occurring.
 - b. Pressure during test period shall be sustained.
 - 1) If the pressure drops below 150 psi during the 2-hour test period, then a leakage test shall be performed unless the pressure drops less than 0.5 psi for a test segment 500 feet or longer.
6. Contractor shall provide pressure gauge with 4-inch face and snubber. Pressure shall read in one-pound increments.
7. If it is found unnecessary to add water during the duration of the pressure test, the leakage test may be waived with the approval of the Engineer.

D. Leakage Test

1. Leakage test shall be conducted after completion of the pressure test.
2. At the option of the Contractor, pressure and leakage tests may be run concurrently.
 - a. This option must have the approval of the Engineer.
 - b. If this option is agreed upon, then the test procedures required for pressure tests shall prevail for both pressure and leakage tests.

3. When leakage test is conducted after satisfactory completion of the pressure test, the test section shall be subjected to 100 pounds per square inch gauge pressure at the lowest elevation of the section of the main being tested.
 - a. If leakage test pressures other than indicated above are called for in the sections for Materials and Methods of Construction, those pressures shall be used.
4. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section of it, necessary to maintain the specified leakage test pressure after the main has been filled with water and the air expelled.
 - a. Pressure during test period shall be sustained within plus or minus 5 lbs. of the required test pressure by adding water with test pump.
 - b. Meter the amount of water added.
5. Leakage shall not exceed the number of gallons per hour as determined by the following formula:

$$GPH = \frac{ND\sqrt{P}}{7400}$$

When:

GPH = Gallons Per Hour

N = Number of Joints Under Test

D = Nominal Pipe Dia. in Inches

P = Average Test Pressure in lbs/sq. in.

6. When the section under test contains various diameters of pipe, the available leakage will be the sum of the computed leakage for each size of pipe.
7. Should any test section fail to meet the leakage test, the Contractor shall immediately make the necessary repairs at his own expense.
8. Duration of final leakage test shall be one continuous hour with leakage within the allowable limits during the test hour.

E. Contractor shall provide all equipment required to perform the test.

3.05 LOW PRESSURE AIR TEST

- A. Contractor shall perform a low-pressure air test on gravity pipelines in lieu of infiltration or exfiltration tests when pipeline is not submerged in groundwater. Test shall conform to ASTM F1417.
- B. Contractor shall provide all equipment required to perform the test.
- C. Testing Procedure
 1. Determine test time as follows:
 - a. Test times for pipeline segments with uniform pipe size shall be taken from test timetable list below for 8-inch through 36-inch nominal pipe sizes.
 - b. Test times for pipeline segments longer than those shown and/or of non-uniform pipe size shall be calculated utilizing appropriate formulas in ASTM F1417.

Test Timetable

Minimum Specified Time Required For A 1.0 Psig Pressure Drop For Size And Length Of Pipe Indicated

Pipe Diameter, in.	Minimum Time, min: s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.694L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

- c. Specified test time (minutes) required for pressure drop from 3-1/2 to 2-1/2 psi when testing one pipe diameter only.
- d. Interpolate test times for segment lengths not specifically listed.
2. Pressurize pipeline to 4.0 psi and allow to stabilize (stabilization of air temperature may cause pressure drop).
3. For pipe sizes larger than 36 inches, each individual pipe joint shall be tested at 4.0 PSI. Each joint shall be placed under pressure and shall remain under pressure for a minimum of 60 seconds with no pressure drop allowed.
4. When pressure has stabilized, start test at 3.5 psi and record time.
5. If pressure drops more than 1.0 psi during the determined test time, the test will be considered failed.

D. Low Pressure Testing requirements are not applicable for relay projects where existing laterals are present.

3.06 TELEVISION OF PIPELINES

A. Televising of pipelines shall be in accordance with Section 33 01 30.16, Sewer Cleaning and Televising.

3.07 DEFLECTION TEST

A. Perform deflection tests on all PVC and HDPE gravity pipelines.

B. Not less than 30 days after the installation and backfilling of sewers, including any service connections, the Contractor shall, in the presence of the Engineer, test deflection of the pipe with a mandrel (Go-No-Go device). The mandrel shall be hand-pulled. All pipe with deflections in excess of 5% of the base internal diameter, as determined by ASTM D 3034, ASTM F 679, or ASTM F 794, shall be excavated, rerounded, backfilled and retested after an additional period of at

least 30 days. Mandrels shall have nine ribs and be only hand-pulled through the test section. The Contractor shall furnish the mandrels. The length of the minimum radius portion of the mandrel shall not be less than one-third of the nominal diameter of the pipe tested. The pipe shall be flushed and cleaned by the Contractor prior to testing. No flow will be permitted in the pipe while testing for deflections.

1. All expense for trenching, backfill, compaction, paving, and related work that is required because of failure to meet deflection test requirements shall be borne by the Contractor.
2. Acceptance of plastic pipe sewers shall be made only after these deflection test requirements have been met.

C. Mandrel sizes shall be in accordance to the following:

1. PVC (5% Deflection)

Nominal Size (Inches)	Base ID	SDR35/PS46 5% Deflection Mandrel Size (Inches)	Base ID	SDR26/PS115 5% Deflection Mandrel Size (Inches)
4	3.895	3.70	3.811	3.62
6	5.742	5.45	5.612	5.33
8	7.665	7.28	7.488	7.11
10	9.563	9.08	9.342	8.87
12	11.361	10.79	11.102	10.55
15	13.898	13.20	13.575	12.90
18	16.976	16.13	16.586	15.76
21	20.004	19.00	19.545	18.57
24	22.48	21.36	21.964	20.87
27	25.327	24.06	24.744	23.51
30	29.132	27.68	28.461	27.04
36	34.869	33.13	34.120	32.41

2. PVC, HDPE or C.C.F.M.P. (5% deflection)

- A. Pipe sizes larger than 36-inch diameter deflection shall be physically measured within 1-inch of each joint and the midpoint of each pipe section. Deflection shall not exceed 5% of the manufacturers stated inside diameter for any given size.

3.08 REPLACEMENT AND REPAIRS

- A. The Contractor shall replace or repair any section of pipeline found to be defective so that the pipeline meets the requirements of the specification.

3.09 DISINFECTION

- A. The following shall be disinfected in accordance with AWWA C651:

1. New water main construction.
2. Existing water main when cut into or repaired.

- B. The lines shall be disinfected and flushed until the system is safe.

- C. At least one sample shall be collected from every 1,200 feet of water main, plus one set of samples from the end of each main and a minimum of one from each new branch.
- D. The Contractor shall provide the Owner with two copies of lab test results certifying that the water sampled is free of contamination tests shall be done prior to standard pressure and leakage test for pressurized pipelines and after completion of pressure and leakage test.

3.10 TRACER WIRE TESTING

- A. Contractor shall test all tracer wire.
- B. A power source shall be provided which will transmit a measurable amount of DC current the length of the tracer wire or length of the test area. Current readings shall be taken with the test current "off", then "on" to differentiate between test current and stray current.
- C. If continuity is not achieved, the Contractor shall perform required repairs and repeat the test.

3.11 BASIS OF PAYMENT

- A. Testing of pipe segments is considered to be incidental to the work and payment for testing the piping segments is included in the cost to provide and install the pipe.

– END OF SECTION –

ATTACHMENT TO FORM
EXAMPLE CALCULATION SHEET

GIVEN: P_i = 10 psig
 T_i = 21.1 °C = 70°F

and at time t = 60 minutes

P_t = 10.05 psig
 T_t = 23.0 °C = 73°F

Calculate Corrected Initial Pressure

$$P_c = \frac{(10.0 + 14.7)(23.0 + 273) - 14.7}{(21.1 + 273)}$$

$$P_c = 24.85 - 14.7 = 10.15 \text{ psig}$$

Calculate Percent Pressure Loss

$$\% \text{ Pressure Loss} = \frac{10.15 - 10.05}{10.15} \times 100 = \underline{0.98\% < 1\% \text{ ok}}$$

Note: The difference between the corrected pressure reading (P_c) and the gauge reading (P_t) cannot differ by more than 1% of the corrected pressure reading (P_c) (i.e., .105 @ 10.5 psig) over a time interval of 60 minutes.

SANITARY SEWER LOW PRESSURE AIR TEST

PROJECT: _____

CONTRACTOR: _____

LOCATION: _____

DATE: _____

Test Location

Test Location

MH #

To MH #

Length of Main

Size of Main

Length of Lateral

Size of Lateral

Length of Main

Length of Lateral

Type of Pipe

Req'd Holding
Time

Start Pressure

End Pressure

Test: Pass

Fail

No Go

Witnessed By

Test Location

MH #

To MH #

Length of Main

Size of Main

Length of Lateral

Size of Lateral

Length of Main

Length of Lateral

Type of Pipe

Req'd Holding
Time

Start Pressure

End Pressure

Test: Pass

Fail

No Go

Witnessed By

MH #

To MH #

Length of Main

Size of Main

Length of Lateral

Size of Lateral

Length of Main

Length of Lateral

Type of Pipe

Req'd Holding Time

Start Pressure

End Pressure

Test: Pass

Fail

No Go

Witnessed By

Test Location

MH #

To MH #

Length of Main

Size of Main

Length of Lateral

Size of Lateral

Length of Main

Length of Lateral

Type of Pipe

Req'd Holding Time

Start Pressure

End Pressure

Test: Pass

Fail

No Go

Witnessed By

HYDROSTATIC TEST REPORT

Project: _____ Contract: _____

Location of Water main: _____

Date of Test: _____ Tested By: _____

TEST SECTION:

Size (in.)	No. of Joints	Elevation		Allowable Leakage ^a (GPH)
		High	Low	
			Total	

Type of Pipe and Joints: _____

Average Length of Pipe Sections: _____ ft. Total Length: _____ ft.

Pressure applied at:^b _____

PRESSURE TEST:

Initial Test Pressure: _____ psi Duration of Pressure Test: _____ hrs

Final Test Pressure: _____ psi Pressure Drop During Test: _____ psi

Remarks:^c _____

LEAKAGE TEST:

Pressure During Test: _____ psi Duration of Leakage Test _____ hrs

Allowable Leakage of Test Section _____ GPH (Total from above)

Actual Leakage _____ GPH

Percent of Allowable _____

Leakage shall not exceed the number of gallons per hour as determined by the following formula:

$$GPH = \frac{ND}{7400} \sqrt{P}$$

When:

GPH = Gallons Per Hour

N = Number of Joints Under Test

D = Nominal Pipe Dia. in Inches

P = Average Test Pressure in lbs/sq. in.

b. Describe location and elevation of point of application of pressure

c. Include results of inspection of the test section and description of repair of any defects

COMMENTS: PASS _____ FAIL _____

SECTION 01 60 00

MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This Section includes administrative and procedural requirements governing the Contractor's selection of products for use in the Project.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 01 32 19, Submittals.

1.02 MATERIALS - QUALITY ASSURANCE

- A. It is the intent of these specifications to procure a quality product by an established manufacturer of the latest design. All components of systems shall be engineered for long, continuous, uninterrupted service. The cost of the equipment shall include all royalties and costs arising from patents and licenses associated with furnishing the specified equipment.
- B. All materials shall be designed to withstand stresses encountered in continuous operation, fabrication and erection. All equipment shall be of corrosion-resistant materials or shall be suitably protected by the supplier with corrosion-resistant industrial coatings. Provisions shall be made for ease of lubrication, adjustment and replacement of parts.
- C. Material for which no detailed specifications are given shall:
 - 1. Meet the particular industry standard for the material used.
 - 2. Meet the specifications of ASTM, ANSI or SAE for metals and plastics for the use intended.
 - 3. Not be used unless it has previously been used for a like purpose for a sufficient length of time in the field or under field-simulated laboratory conditions to demonstrate its successful use.
- D. Source Limitations
To the fullest extent possible, provide products of the same kind from a single source.
 - 1. When specified products are available only from sources that do not, or cannot, produce a quantity adequate to complete project requirements in a timely manner, consult with the Engineer/Architect to determine the most important product qualities to consider before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to the fullest extent possible.
- E. Compatibility of Options
When the Contractor is given the option of selecting between 2 or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
1. Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Provide equipment and personnel to handle products by methods that avoid soiling or damage.
 4. Deliver products to the site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 5. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that quantities are correct, products are undamaged, and properly protected. Inform the Engineer or Owner before the inspection occurs, so that they may participate in the inspection if so desired.
 6. Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units. Seals and labels shall be intact and legible.
 7. Store products in accordance with manufacturer's instructions. Store heavy materials away from the Project structure in a manner that will not endanger the supporting construction.
 8. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
 9. Arrange for fabricated items or products stored outside to be placed on sloped supports above the ground. Items subject to deterioration shall be covered by weather proof sheet covering which is ventilated to prevent condensation.
 10. Store loose granular materials on solid surfaces which are well drained and prevent contamination by foreign matter.
 11. Arrange for periodic inspection of stored materials to insure that materials remain undamaged and are maintained under required conditions.
 12. All shipment, delivery and storage charges shall be at the expense of the contractor.

1.04 MAINTENANCE OF STORAGE

- A. Contractor shall periodically inspect stored products on a scheduled basis.
- B. Contractor shall verify that storage facilities comply with manufacturer's product storage requirements, and verify that manufacturer required environmental conditions are maintained continually.
- C. Contractor shall verify that surfaces of products exposed to the elements are not adversely affected and that any weathering of finishes is acceptable under requirements of Contract Documents.
- D. Contractor shall perform scheduled maintenance of equipment in storage as recommended by the manufacturer. A record of the maintenance shall be kept and turned over to Engineer when the equipment is installed.

PART 2 – PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.02 INSTALLATION OF PRODUCTS

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place, accurately located and aligned with other Work.
 - 1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

3.03 INSTALLATION REQUIREMENTS

- A. Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, and conditions as directed by the respective manufacturers, unless otherwise specified.
- B. Erect equipment in neat workmanlike manner, align, level and adjust for satisfactory operation; install for easy maintenance, inspection, operation, and replacement.
- C. Mechanical equipment shall operate without objectionable noise or vibration. Piping shall be provided with flexible couplings to prevent noises or vibration transmission.
- D. After installation, Contractor shall protect all materials and equipment against weather, dust, moisture, and mechanical damage.
- E. Contractor shall be responsible for all damages that occur in connection with the care and protection of all materials and equipment until completion and final acceptance of the work by Owner. Damaged material and equipment shall be immediately removed from the site.

3.04 FIELD QUALITY CONTROL

- A. Qualifications of Manufacturers Field Personnel
 - 1. Personnel shall be authorized by the manufacturer to erect start-up and initiate warranty of the equipment provided.
 - 2. Personnel shall come to the site with the required tools and electrical instruments.
 - 3. Personnel shall have full knowledge of electrical controls pertaining to the equipment and control panels furnished.
 - 4. Failure to provide personnel with full qualifications shall be cause for service trip to be disqualified as part of the requirements and may because for reimbursement for costs incurred by the Owner due to services required for a qualified start-up inspection.

- END OF SECTION -

SECTION 01 75 00

STARTUP, TESTING AND OPERATOR TRAINING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: This section includes the procedures for checking, starting, and field testing of equipment and operator training after installation. The installation, startup, and testing tasks for a system shall be completed and approved by the Engineer before any operator training can be performed on that system.
- B. Related sections and division
 - 1. Applicable provisions of the general conditions shall govern the work in this section.
 - 2. Section 01 78 43, Equipment Installation, Startup, Testing and Training Checklists and Certifications and Receipt of Spare Parts
 - 3. Individual equipment specifications.

1.02 DEFINITIONS

- A. System: A system means the overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment.
- B. Subsystem: A subsystem is a portion of a larger system.
- C. Functional Acceptance Test (FAT): Tests necessary to demonstrate that installed equipment and systems function as specified and operate in the manner intended.
- D. Startup: The process of placing a system in operation, including evaluation and verification of the operating characteristics of the system.

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Installation checklist and certification in accordance with Section 01 78 43 before start up testing is begun.
 - 2. Installation completion schedule.
 - 3. Functional Acceptance Test plan and test forms for each equipment item, subsystem, and system.
 - 4. Schedule for startup submitted a minimum of 14 days in advance of proposed start of startup testing.
 - 5. Approvable operation and maintenance manuals for each equipment item and system to be tested a minimum of 14 days before scheduled start up.
 - 6. Qualification and experience records of proposed manufacturer's representatives who will assist with equipment testing and with training sessions.
 - 7. Start-up period operation records.
 - 8. Start-up and training checklists and certifications in accordance with Section 01 78 43.

1.04 INSTALLATION CHECK AND INITIAL TESTING

A. Contractor's Responsibilities: The Contractor shall:

1. Provide services of manufacturer's representatives of products and systems for checking, testing, and startup specified for each equipment item. Manufacturer's representatives shall be authorized by the manufacturer to perform start-up and initiate warranty of equipment provided. Personnel shall come to the job site with all the required tools and testing instruments required for their work and shall have full knowledge of electrical controls pertaining to equipment and control panels.
2. Resolve assembly or installation problems attributable to, or associated with, the products and systems, whether or not specifically required in the Specifications.
3. Clean up equipment and surrounding areas.
4. Provide safe access to the work area to facilitate initial testing and any training activities.
5. Confirm presence of any gauges, valves or other appurtenances required for proper operation and testing of the equipment.
6. Check for proper rotation, alignment, speed, excessive vibration, and quiet operation.
7. Promptly correct all defects noted during installation check at Contractor's expense.
8. Perform initial equipment and system adjustment and calibrations with the assistance of manufacturer's representative. Conduct Functional Acceptance Testing as required to demonstrate suitability of equipment for startup and performance testing.
9. Submit installation checklist and certification in accordance with Section 01 78 43. Submittal of the installation checklist, certifications, and functional acceptance testing is a prerequisite for startup and performance testing.

1.05 STARTUP AND PERFORMANCE TESTING

A. Contractor's Responsibilities: The Contractor shall:

1. Prepare startup and testing schedule and incorporate startup and testing activities in the progress schedule for the work.
2. Notify Engineer and respective equipment manufacturers at least 21 calendar days prior to the date when each equipment system is scheduled to be initially started; also submit testing plan stating schedule, quantity and source of utilities, chemicals, and other materials needed.
3. Provide labor, materials, tools, instruments, and services for checking, start-up, and testing specified for each equipment item, except for items specified to be furnished by Owner. Instruments that may be required include, but are not limited to, flow meters and gauges for monitoring of performance, even if not otherwise specified.
4. Provide services of manufacturers' representatives, subcontractors, electricians, instrumentation technicians, and pipe fitters. Designate one person (other than field superintendent) to be responsible for coordinating and expediting startup and testing responsibilities, and to be present during all pre-startup meetings and available to Owner's personnel during the startup and performance testing.
5. Develop a standard testing log to be used as a record of testing of each equipment item and subsystem. This log shall:
 - a. Be subject to approval of Engineer,
 - b. Include equipment name and associated subsystems,
 - c. Have provisions for recording dates of completion for installation checking, inspection by manufacturer, verification of instrumentation and controls, and completion of subsystem tests, and
 - d. Provide space for any remaining problems with equipment and for signatures of Contractor and manufacturer's representative and Engineer indicating acceptance.

6. Furnish any spare parts and special tools specified for the respective equipment.
7. Furnish O & M information needed for O & M Manual.
8. Complete startup of all subsystems that may be associated with the system including but not limited to plumbing, electrical, instrumentation, and HVAC systems.
9. Provide safe access to the work area to facilitate startup and training activities.
10. Submit startup and performance testing checklist and certification in accordance with Section 01 78 43. Submittal and approval of the startup and performance checklist and certification is a prerequisite for acceptance of the system for substantial completion.

B. Owner's Responsibilities: The Owner will:

1. Furnish for Contractor's use during startup and testing:
 - a. Electrical power
 - b. Potable water
 - c. Non-potable water.
 - d. Process water.
2. Provide sampling labor, materials, and laboratory analysis.
3. Furnish Owner's representative to witness all tests.

C. Startup Completion

1. Startup of any portion is considered complete when, in the opinion of the Engineer, the system or designated subsystem has operated properly for seven continuous days without failure. The 7-day startup period is in addition to specified testing and training.
2. Successful startup of all systems shall be accomplished prior to determination of substantial completion as defined in the General Conditions.
3. Failure during startup shall include any of the following events:
 - a. Failure of Contractor to maintain 24-hour alarm response personnel during startup period.
 - b. Failure to meet specified performance requirements for more than four consecutive hours.
 - c. Failure of a system that is not permanently corrected within 4 hours after such failure occurs.
4. "Permanently corrected" shall consist of all the following:
 - a. Work repaired and replaced to conform to specified requirements.
 - b. Parts and components replaced as recommended by original manufacturer and conforming to reviewed submittals.
 - c. Piping and valves properly installed and connected.
 - d. Wiring properly terminated and enclosed in raceways.
 - e. Accessories, including spare parts and lubricants, furnished as specified.
5. Any failure shall halt the startup then in progress. Startup shall be restarted from the beginning after permanent corrections are made.

D. Operation Period: The operation period begins when the facility has been substantially completed as defined in the General Conditions.

1.06 TRAINING OF OWNER'S PERSONNEL

A. Installation Completion Schedule: Required for scheduling the training of Owner's operating personnel by equipment manufacturers.

1. List estimated completion dates for the equipment and systems requiring services of manufacturers' representatives.

2. Submit the installation completion date for each equipment item or system not less than 21 calendar days prior to the time that associated equipment is installed and is in a suitable condition for training the Owner's personnel.
 3. Revise the schedule to facilitate training of appropriate personnel, as deemed necessary by Owner, and to ensure full participation by manufacturers' representatives.
- B. Contractor's Personnel: Designate and provide Contractor's personnel to be responsible for coordinating and expediting training duties. The person(s) shall be present during training coordination meetings with the Owner and shall be familiar with the Operation and Maintenance (O&M) Manual information.
- C. Manufacturer's Representative: Contractor shall furnish manufacturer's representative(s) to provide detailed instructions to Owner's personnel for operation and maintenance of the specified equipment.
1. Training services include shall include classroom instructions and onsite, hands-on instruction on the equipment as stated in the Specifications.
 2. Manufacturer's representative shall be familiar with O&M requirements as well as with the specified equipment and associated subsystems.
- D. Training Sessions: The Contractor shall provide Manufacturer's representative to conduct training sessions for each system.
1. Initial classroom training shall include review of descriptive material and the O& M Manual. Review shall include but not be limited to routine and emergency operation of the equipment, instrumentation and controls and safety. Classroom training is a prerequisite for field training on the equipment.
 2. Field training shall be conducted on the equipment following successful startup. Field training shall include but not be limited to hands-on operation of all controls and functions of the equipment and review of all maintenance and safety procedures.
 3. A classroom review session shall be held following completion of the field training to review the training and provide a forum for questions.
 4. The Owner reserves the right to videotape all training sessions, including manufacturer representatives' hands-on equipment instruction.
 5. Access to the Work Area: The Contractor shall provide safe access to the work area to facilitate training.

PART 2 -- PRODUCTS

NOT APPLICABLE

PART 3 -- EXECUTION

3.01 PREPARATION FOR STARTUP AND PERFORMANCE TESTING

- A. Startup Preparation: Equipment shall be determined ready for startup based on the following:
1. Notification by Contractor of readiness of equipment and systems for startup.
 2. Submittal of startup plan stating detailed procedures including quantity and source of utilities, chemicals, and other materials needed for each test.
 3. Submittal and acceptance of O & M Manuals incorporating review comments.
 4. Submittal of manufacturer's checklist and certification of proper installation.
 5. Submittal of completed functional acceptance test forms.
 6. Cleanliness of equipment, devices, connected work, and areas around the equipment.

7. Completion of startup for any associated subsystems.
8. Availability and acceptability of manufacturer's representative to assist testing of respective equipment and satisfactory fulfillment of other specified manufacturers' responsibilities.
9. Pre-testing Meeting: Contractor shall arrange a meeting with the Owner and Engineer to review the Contractor's detailed testing plan for each equipment item and system, at least 2 days prior to the first test run.

B. Prior to Initial Testing of equipment:

1. Inspect and clean equipment, devices, tanks, connected piping, and the surrounding area so they are free of foreign material.
2. Provide safe access for Owner personnel to the system for observation of startup activities.
3. Lubricate equipment in accordance with manufacturer's instructions.
4. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.
5. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
6. Check power supply to electric-powered equipment for correct voltage.
7. Obtain manufacturer's certification of proper installation, where specified.
8. Owner shall operate existing systems that have undergone successful startup.

3.02 FUNCTIONAL TESTING

A. Subsystem Tests: Startup and operate the individual components and subsystems that make up each equipment system. Functional testing of a complete system shall not begin until subsystem testing is completed to the Engineer's satisfaction.

B. Equipment and System Tests: Contractors shall functionally test each separate piece of equipment, and each system requiring simultaneous operation of interdependent equipment, in accordance with the following procedures:

1. Separate items of equipment demonstrated to function properly during subsystem testing shall require no further functional testing, if documentation of subsystem testing is accepted by Engineer.
2. Functional testing of each system shall begin after subsystems and equipment units have been satisfactorily tested.
3. Functional testing will begin at a time mutually agreed upon by the Engineer, Owner, manufacturer's representative(s), and Contractor.
 - a. The Owner or Engineer may be present during tests.
 - b. Notify Engineer, Owner, and manufacturer's representative at least 14 days prior to scheduled date of tests.
4. Conduct functional testing until every equipment item in each system has demonstrated satisfactory operation. Demonstrate all operational features and controls while system and equipment operate in automatic modes.
5. Startup testing of a system shall not be allowed until the initial testing of the complete system, including all subsystems in which the system operates, have been completed and documented in accordance with Section 01 78 43.
6. If the Engineer accepts the installation and startup checklists and certifications, including functional testing of a system, the system may be scheduled for startup testing. If the Engineer determines that the functional tests do not meet the specifications, the system will be considered nonconforming.

3.03 PERFORMANCE TESTING

- A. Performance testing shall use plant fluid or material that the equipment or system is designed to handle during normal service conditions, unless otherwise specified.
- B. Equipment and Subsystem Tests: Contractor shall:
 - 1. Clean and check equipment and devices, as specified under Article TESTING PREPARATION, prior to starting equipment and subsystem performance tests.
 - 2. Performance testing will begin at a time mutually agreed upon by the Engineer, manufacturer's representative(s), and Contractor.
 - a. The Engineer will be present during tests.
 - b. Notify Engineer, Owner, and manufacturer's representative at least 14 days prior to scheduled date of performance testing and confirm the date 5 days prior to testing.
 - 3. Obtain supplies and materials, including water and chemicals; provide sufficient advance notice for suppliers.
 - 4. Operate the necessary equipment units as specified in the respective O & M Manuals for a continuous period of 24 hours.
 - 5. Follow Engineer-approved testing plan and detailed procedures specified for each equipment unit and subsystem including sample collection and analysis if required.
 - 6. Complete acceptable performance testing of all equipment and subsystems included in a system, and submit test documentation, before starting the system performance test.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section includes providing operation and maintenance data in accordance with this section and the individual equipment specifications.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Individual Equipment Specifications.

1.02 SUBMITTALS

- A. Form and Format
 - 1. One (1) copy of the O&M Manual data shall be submitted in pdf format on a compact disk (CD) or a USB jump drive.
 - 2. Three (3) copies of the O&M Manual data must be bound within new, white, heavy-duty 3-ring presentation binders with clear-view overlay on the front, back and spine of the binder. Each O&M Manual data binder shall have two typed labels with the project name, REL Contract No., and O&M data name on both the binder fronts and binder spines. A minimum of 12-point font size with Times New Roman font style requested for the binder labels.
 - 3. Paper shall be 20-pound minimum for typed pages. Computer generated data shall be by laser printers.
 - 4. Each binder shall have a table of contents & directory. Tabbed divider sheets shall be white with typed labels that coincide with the table of contents. The tabs shall be in the same sequence as the table of contents and be readable from the left to the right.
 - 5. All tabbed divider sheets shall be heavy weight and have reinforced binder strip to maintain the long-term integrity of the paper.
 - 6. Large data sheets shall be folded and presented in an 8-1/2 inch x 11-inch pocket folder within each O&M Manual binder.
 - 7. Drawings, photographs, and envelopes shall be furnished with reinforced binder holes suitable for the above-mentioned binders and be labeled with appropriate identification.
 - 8. Photocopies shall be legible and suitable for photocopying. All materials shall be reproducible.
 - 9. All components of the submittal shall be typed.
- B. Schedule
 - 1. All four (4) copies of the operation and maintenance data shall be submitted prior to the project being 50% complete and prior to equipment installation.

1.03 QUALITY ASSURANCE

- A. The operation and maintenance data shall be prepared by trained personnel experienced in the operation and maintenance of the described products, equipment, materials, and finishes.

1.04 CONTENTS

A. Table of Contents

1. Provide a table of contents with each operation and maintenance manual provided.
 - a. Provide a reinforced tabbed divider for each section listed in the table of contents. Main sections shall be numbers; sub-sections shall be letters.

B. Directory

1. For each item of equipment, list name, address, and telephone number of:
 - a. Contractor.
 - b. Engineer.
 - c. Manufacturer.
 - d. Supplier.
 - e. Local source of service
 - f. Local source for spare parts and replacement.

C. Data to be Included:

1. Include only product data sheets which are pertinent to the specific product of installation.
2. Mark-up each product data sheet to:
 - a. Identify specific product or part installed.
 - b. Identify data applicable to installation.
 - c. Delete reference to inapplicable data.
3. Supplement product data sheets with test and drawings as necessary to illustrate:
 - a. Relationship of component parts to equipment and processes.
 - b. Controls, regulation and accessories.
 - c. Capacities, performance curves, engineering data.
4. Provide detailed operation and maintenance, troubleshooting and lubrication instructions for each component of equipment. Include disassembly, repair, reassembly and adjustment.
5. Provide a complete parts list and spare parts stocking recommendations.
6. Provide start-up and shutdown procedures in a logical and consistent format. Include all points of regulation and control (valves, switches).
7. Describe normal and emergency operating procedures in detail.
8. Provide all warranty information including any restrictions or precautions which might affect validity.
9. Provide other data required under pertinent section of these specifications.
10. Provide complete instrumentation loop diagrams with tabulated listing of all loop components.
11. Submit as installed control diagrams by controls manufacturer before issuance of certificate of substantial completion.

1.05 EQUIPMENT MAINTENANCE DATA CARD

- A. An "Equipment Maintenance Data Card" MUST be completed for each piece of equipment on the form provided.

PART 2 – PRODUCTS

NOT APPLICABLE

PART 3 – EXECUTION

NOT APPLICABLE

- END OF SECTION -

Equipment No.

EQUIPMENT MAINTENANCE DATA CARD

Unit				
Components:		Electrical		
Manufacturer:		Equipment:		
Supplier:		Manufacturer:		
Installation Date:		Type:		
Capacity:		Serial No.:		
Model:		Voltage:	Amps:	RPM:
Serial No.:		Phase:	Frame:	HP:
Item	Work to be Done	Frequency	Time	Comments

SECTION 01 78 36

WARRANTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties.
- B. Related Sections
 - 1. Applicable provisions of the General Conditions shall govern terms of the Contractor's special warranty of workmanship and materials.
 - 3. Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in the individual Sections of Divisions 2 through 46.
- C. Disclaimers and Limitations

Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.02 DEFINITIONS

- A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.03 WARRANTY REQUIREMENTS

- A. Starting date for all warranties shall be the date of Substantial Completion as indicated on Certificate of Substantial Completion, except that warranties for work completed after the date of substantial completion shall begin on date of acceptance of such work by the Owner.
- B. Related Damages and Losses

When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- C. Replacement Cost

Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Document. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse

Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

- E. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.

1.04 SUBMITTALS

- A. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Prepare warranties as various components of the project are completed.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

NOT APPLICABLE

- END OF SECTION -

SECTION 01 78 43

EQUIPMENT, INSTALLATION, TRAINING AND RECEIPT FOR SPARE PARTS CHECKLISTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section includes completing the installation and training checklists.
- B. Related Sections and Divisions.
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. All related equipment specifications.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.01 CHECKLISTS

- A. Contractor shall complete the Equipment Installation Checklist. Checklist shall be completed and submitted to the Engineer after installation.
- B. Contractor shall complete the Equipment Training Checklist. Checklist shall be completed and submitted to the Engineer after each day of training is completed.
- C. Contractor shall complete the receipt for Spare Parts/Equipment Checklist and submit to the Engineer.

- END OF SECTION -

Equipment Installation Checklist

Project _____

Equipment_____

Specification Section_____

I hereby certify the equipment supplier/manufacture has inspected this equipment and that it has been properly installed, adjusted and calibrated. I further certify that this equipment may now be operated for test purposes and/or normal use.

Manufacturer's Representative

Signature_____

Date_____

Name (print)_____

Representing_____

Contractor

Signature_____

Date_____

Name (print)_____

Representing_____

Vendor Days Used_____

Warranty Commencement Date: *(check one)*

- ☐ Substantial Completion Date as Stated in Certificate
- ☐ Other Date_____
- (Only to be used if after the substantial completion date, unless partial utilization or substantial completion is authorized.)

This form shall be completed and submitted to ENGINEER prior to training of OWNER's personnel.

The ENGINEER verifies the above "Vendor Days Used" and "Warranty Commencement Date".

Signature_____

Date_____

Representing_____

Attach equipment testing report including any vendor reports

Equipment Training Checklist

Project _____

Equipment _____

Specification Section _____

Critical Maintenance Training

I hereby certify that the equipment supplier/manufacturer has instructed OWNER's personnel in the start-up of this equipment and all critical maintenance necessary to operate equipment until post startup training.

Contractor Signature _____
(Name/Representing)

Date _____

Vendor Days Used _____

I hereby certify that my operating personnel received _____ hrs. of instructions from

Operator Signature _____
(Name/Representing)

Date _____

Attendees: _____

Post Start-Up Training

I hereby certify that the equipment supplier/manufacturer has instructed Owner's personnel in the start-up, operation and maintenance of this equipment as required in this specification.

Contractor Signature _____
(Name/Representing)

Date _____

Vendor Days Used _____

I hereby certify that my operating personnel received _____ hrs. of instructions from

Operator Signature _____
(Name/Representing)

Date _____

Attendees: _____

Receipt For Spare Parts/Equipment Checklist

Item: _____

Contract Specification Section: _____

Sub-Section: _____

Page: _____ By: _____ Date: _____

Item No.	Item Description	Unit	Quantity		Designated Storage Location	Remarks
			Req.	Rec.		

The above items have been stored or erected at the designated storage location. All quantities and items are in accordance with Contract Specification requirements.

Owner: _____ By: _____

Title: _____

Date: _____

Contractor: _____ By: _____

Title: _____

By: _____

Engineer: Robert E. Lee & Associates, Inc.

03

DIVISION 03

CONCRETE

SECTION 03 11 00

CONCRETE FORMWORK

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. This section covers the work necessary to furnish and install, complete, concrete formwork as specified herein.

1.02 SUBMITTALS

- A. Shop Drawings: Furnish the following:
1. Alternate Form Ties – Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
 2. Samples: Prior to start of work, submit one sample each as follows:
 - a. Form liners.
 - b. Form ties.

1.03 SEQUENCING AND SCHEDULING

- A. Schedule work for embedded, buried, or other items of work that affects form layout before completing concrete formwork.

PART 2 – PRODUCTS

2.01 FORM MATERIAL

- A. Wall Forms:
1. General:
 - a. Form Surfaces: In “new and undamaged” condition of either plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel of sufficient strength and surface smoothness to produce specified finish.
 - b. Concrete Finish Requirements: As specified in Section 03 31 13, Concrete.
 - c. Design joints in forms to remain watertight and withstand placing pressures without bulging outward or creating surface patterns.
 - d. Do not use formwork that leaks mortar.
 - e. Where poor formwork is used and finish obtained is less than specified, upgrade finish to an acceptable finish at no additional cost.
 - f. Panel Deflections: Limit as required to achieve tolerances specified herein.
 2. Circular Structures:
 - a. Forms shall conform to circular shape of structure.
 - b. Straight panels may be substituted for circular forms if they do not exceed 2 feet in width and in addition to the requirements, each panel does not provide an angular deflection more than 3-1/2 degrees per joint, and do not conflict otherwise with these Specifications and/or Drawings.
 3. Rustications and Corner Strips: Non-absorbent material, compatible with form surface, fully sealed on all sides, to prohibit loss of paste or water between the two surfaces.
 4. Form Sealer:
 - a. Manufacturer:

- 1) Burke Co., Burke Uni-Kote.
- 2) Grace construction Materials Co., FormFilm.
- 3) Sternson Construction Products, Formaseal.
- 4) Or equal.

B. Column Forms:

1. Rectangular Columns: As specified for walls.

C. All Other Forms: Materials as specified for wall forms, unless otherwise approved by Engineer.

2.02 FORM DESIGN AND WINDOWS

A. General:

1. Design formwork prior to fabrication, placing order, or use on jobs.
2. Design shall account for tolerances, form ties, finishes, architectural features, rebar supports, construction joint locations, and other non-structural formwork requirements specified.
3. Design formwork strong enough to hold high liquid heads without form distortion and to meet tolerances as specified herein. Coordinate form design with admixture company information and concrete slump.
4. Forms for walls shall contain pouring and observation windows to allow placement of concrete through windows or staged to allow visual observation at all times of fresh concrete to ensure correct placement and vibration.
5. Free Fall Limit of Concrete: As specified in Section 03 31 13, Concrete.
6. Structurally design forms, falsework, shoring, and other structural formwork and meet applicable safety regulations, current OSHA regulations, and other codes.
7. An engineer registered in State of Wisconsin shall prepare formwork, falsework, and shoring designs to meet these Specifications and to meet all federal and state requirements.
8. Make designs available to any governing agency upon request.
9. Meet applicable portions of ACI 347, ACI 318 current edition, and these specifications.

2.03 REINFORCING SPACERS AND REBAR SUPPORTS

A. Columns:

1. Provide a positive plastic tipped or stainless steel spacer between column reinforcing and column forms to ensure adequate cover.

B. Walls: Provide a positive spacer between wall reinforcing and wall forms to ensure adequate cover.

C. Floors and beams: Provide a positive plastic tipped or stainless steel support between reinforcing and slab or beam forms. Provide supports with sand plates supporting reinforcement for slabs on grade.

2.04 FORM TIES

A. General:

1. Inserts:
 - a. Conical or spherical type inserts.
 - b. Fixed so they remain in contact with forming material.

- c. Construct so no metal is within 1 inch of concrete surface when forms, inserts, and tie ends are removed.
 2. Do not use wire ties.
 3. Ties shall withstand form pressures and limit form deflection to specified tolerances.
 4. Flat bar ties for panel forms shall have plastic or rubber inserts with minimum 1-inch depth and sufficient dimensions to permit proper patching of tie hole.
- B. Water Stop Ties:
1. Provide for water-holding structures or dry structures with access such as basements, pipe tunnels, etc., that are below finish grade or whose wall is common to water holding basin or channel.
 2. Ties shall have either an integral steel water stop 0.103-inch thick and 0.625 inch in diameter tightly and continuously welded to tie, or neoprene water stop 3/16-inch thick and 15/16 inch in diameter whose center hole is 1/2 diameter of snap tie, or a molded plastic water stop of comparable size.
 3. Flat snap ties meeting these Specifications may be provided.
 4. Water Stop: Considerably larger in area than tie cross sectional area, oriented perpendicular to tie and symmetrical about center of tie.
 5. Construct ties to provide positive means of preventing rotation or disturbance of center portion of tie during removal of ends and prevent water leaking along tie.
- C. Alternate Form Ties – Through-Bolts:
1. Form ties consisting of tapered through-bolts as shown with minimum 1 inch in diameter at smallest end, or through-bolts utilizing a removable tapered sleeve of same minimum size may be provided as an option. Through hole requires preparation of concrete surface prior to patching; see detail.
 2. Elastic Vinyl Plug:
 - a. Size to allow insertion using insertion tool to elongate plug, place it at correction location, and allow plug to return to original length and diameter upon removal to form watertight seal.
 - b. Manufacturer:
 - 1) Dayton Sure-Grip and Shore Co., Miamisburg, OH, Dayton Sure Plug.
 - 2) Or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. General:
1. Notify engineer one full working day prior to concrete placement so forms can be inspected.
 2. Correct defective work found in Engineer's inspection, prior to delivery of concrete.
- B. Wall Forms:
1. Do not reuse form surfaces that have been damaged and are no longer in smooth "new and undamaged" condition unless otherwise approved in writing.
 2. Provide specified smooth form surfaces meeting tolerance requirements prior to each reuse.
- C. Forms to Support Form Liners For Architectural Concrete:

1. Build of materials and in a manner that is sufficiently rigid and strong to withstand, without excessive deflection, movement, or leakage, high hydraulic pressures resulting from rapid filling and heavy-high frequency vibration.
2. Limit deflection in formwork to 1/360 of each component span and tolerances specified herein.
3. Lay out form joints in a uniform pattern or as shown.

D. Form Ties:

1. Locate on exposed surfaces in uniform pattern or as shown.
2. Construct so tie remains embedded in wall, except for removable portion at each end.

3.02 FORM TOLERANCES

A. General:

1. Surface, design, and construct forms to meet ACI 318 and the following minimum tolerances for specified finishes.
2. Failure of forms to produce specified tolerances will be grounds for rejection of concrete work. Upgrade concrete finish or replace to meet specification requirements.

B. Wall Tolerances:

1. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance as specified herein.
2. Surface Finish: As specified in Section 03 31 13, Concrete.
3. Wall Type W-T1:
 - a. Plumb within 1/4 inch in any 10 feet or within 1 inch in entire height from top to bottom for walls over 40 feet high.
 - b. Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in any direction or at any location.
 - c. Wall Thicknesses: Maximum 1/4-inch minus or 1/2 inch plus from dimension shown.
4. Wall Type W-T2:
 - a. Plumb within 1/4 inch in any 10 feet or within 1/2 inch in entire height from top to bottom for walls over 20 feet high.
 - b. Depressions In Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in any direction or at any location.
 - c. Wall Thicknesses: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.

C. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as shown or as required within tolerances specified herein.
2. Slab Finish Tolerances and Slope Tolerances: Floor surface shall not have crowns so high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow a block of twice the tolerance in thickness to pass under the supported 10-foot straightedge.
 - a. Slab Type S-T1: Steel gauge block thicknesses shall equal 5/16 inch.
 - b. Slab Type S-T2: Steel gauge block thicknesses shall equal 1/8 inch.
3. Slab Type S-F1 and S-F2:

- a. Finish Slab Elevation: Within 1/2 inch of elevation specified except slabs which are designed and detailed to drain to floor drain or gutter shall adequately drain regardless of tolerances.
- b. Repair floor slopes in an approved manner if necessary to provide complete drainage.
- c. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown.

D. Beams and Columns Tolerances:

- 1. Exposed Straight Horizontal and Vertical Surfaces: Flat planes within specified tolerances.
- 2. Beam Type B-T1:
 - a. Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
 - b. Elevations: Within 1/2 inch plus or minus except where tops of beams become part of finished slab. In this case, refer to slab tolerances.
- 3. Column Type C-T2:
 - a. Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
 - b. Plumb within 1/4 inch in any 10 feet with maximum 1/2 inch out-of-plumb at top with respect to bottom.

E. Forms for Sidewalks and Driveways:

- 1. Standard steel forms or wood forms constructed and fastened to prevent movement.
- 2. Set forms to true lines and grades, and securely stake in position.

3.03 FORM SURFACE PREPARATION

- A. Thoroughly clean form surfaces in contact with concrete of previous concrete, dirt, and other surface contaminants prior to coating surface.
- B. Exposed Wood Forms in Contact with Concrete: Apply two full coats of specified form sealer.
- C. Steel Forms:
 - 1. Sandblast or otherwise remove mill scale and other ferrous deposits from contact surface of forms.
 - 2. Coat contact surfaces of forms with release agent.
 - 3. Release Agent: Prevent discoloration of concrete from rust, and nontoxic after 30 days.

3.04 BEVELED EDGES (CHAMFER)

- A. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
- B. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer's approval of size prior to placement of bevel form strip.

3.05 FORM REMOVAL

- A. Contractor shall assume responsibility for damage resulting from improper and premature removal of forms.
- B. Satisfy applicable OSHA requirements with regard to safety of personnel and property.

C. Leave forms and shoring for elevated structural slabs or beams in place in accordance with ACI 318, Chapter 6, and until concrete has reached compressive strength equal to specified 28-day compressive strength as determined by test cylinders.

D. Do not remove supports and reshore prior to obtaining adequate field cured cylinder results.

3.06 CONCRETE FINISHES

A. As specified in Section 03 31 13, Concrete.

3.07 BACKFILL AGAINST WALLS

A. Do not backfill against walls until concrete has obtained compressive strength equal to specified 28-day compressive strength.

B. Place backfill simultaneously on both sides of wall, where, required to prevent differential pressures.

3.08 FIELD TESTS

A. Wall Finish Tolerances: Test for compliance with tolerances as specified.

B. Slab Finish Tolerances and Slope Tolerances:

1. Floor flatness measurements will be made the day after floor is finished and before shoring is removed, to eliminate effects of shrinkage, curling and deflection
2. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
3. Compliance with designated limits in four of five consecutive measurements is satisfactory unless obvious faults are observed.
4. A check for adequate slope and drainage will also be made to confirm compliance with these Specifications.

3.09 MANUFACTURER'S SERVICES

A. Form Liner Manufacturer: Provide manufacturer's jobsite representative to assist with proper methods of application and use of form liner.

PART 4 – MEASUREMENT AND PAYMENT

4.01 LUMP SUM ITEMS

A. Payment for work in this Section will be included as part of the lump sum bid.

- END OF SECTION -

SECTION 03 15 13

WATERSTOPS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: This section includes providing waterstops for concrete construction.
 - 1. Related Sections and Divisions
 - a. Applicable provisions of the General Conditions shall govern the work in this section.
 - b. Section 03 31 13, Cast-In-Place Concrete.

1.02 REFERENCE

- A. Corps of Engineers Specifications (CRD):
 - 1. CRD - C572 - Corps of Engineers Specifications for Polyvinyl Chloride Waterstops.
 - 2. ASTM D412.

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Producer's certification that supplied material conforms to requirements of applicable specification for each type and size used.
 - 2. Producer's certification that supplied material will not contaminate a potable water system when used in construction of potable water tanks or reservoirs.
 - 3. Sample of each type and size of waterstop used when requested by Engineer.

PART 2-PRODUCTS

2.01 PVC WATERSTOP

- A. Polyvinyl chloride (PVC) waterstops shall be of the serrated type and conform to CRD C572.
- B. Waterstops shall meet the following minimum requirements.
 - 1. Tensile strength 1,800 PSI.
Elongation 30 percent
Shore a durometer 50
 - 2. Tests for materials shall be in accordance with ASTM D412. no reclaimed PVC will be allowed.
 - 3. PVC waterstops shall be ribbed with center bulb. Thickness shall be 3/16-inch for 6-inch waterstop and 3/8-inch for 9-inch waterstop thickness for labyrinth type waterstops shall be 3/16". Labyrinth waterstop shall meet the head pressure requirements as shown on the drawings.
- C. Available Manufacturers
 - 1. Greenstreak
 - 2. W.R. Meadows, Inc.

2.02 HYDROPHILIC WATERSTOPS

- A. Use at construction joints where new concrete meets existing concrete as shown on the drawings.
- B. Material shall be non-bentonite modified chloroprene rubber.
- C. Waterstop shall be Greenstreak Hydrotite CJ-1020-2K-ADH with Leakmaster LV-1 adhesive or equal.

PART 3 - EXECUTION

3.01 PVC WATERSTOP

- A. Preparation
 - 1. Keep waterstop material free of mud, oil or other surface contamination that adversely affect bonding capacity.
- B. Placement
 - 1. Provide waterstop in construction and expansion joints in:
 - a. Walls and slabs separating a dry interior from earth or liquid.
 - b. All walls and slabs of liquid holding tanks.
 - c. Other locations shown on plans.
 - 2. Do not embed center bulb.
 - 3. Do not nail split legs to bulkhead adjacent to bulb.
 - 4. Securely tie waterstops to reinforcement to prevent displacement while concrete is placed or consolidated.
 - a. Tie to reinforcing bars a minimum of every 12 inches.
 - b. Secure waterstops between last rib and end of waterstop.
- C. Splicing
 - 1. Use maximum practicable length in order that number of end joints will be held to a minimum.
 - 2. When splicing is required, butt weld waterstops using thermostatically controlled electric heating tools.

3.02 HYDROPHILIC WATERSTOPS

- A. Preparation
 - 1. Clean surfaces of all mud, laitance, oils or other surface contaminants.
 - 2. Remove water from surfaces and dry to surface dry condition.
- B. Placement
 - 1. Provide at locations shown on plans.
 - 2. Provide minimum confinement/cover or as required by manufacturer.
 - 3. Protect from displacement while concrete is placed or consolidated.

C. Splicing

1. Cut ends square with shears or sharp blade to fit splices together without overlaps.
2. Splices shall be sealed using cyanacrylate adhesive and leakmaster.
3. Seal watertight any exposed cells of hydrotite using leakmaster.
4. Follow approved manufacturer recommendations.

- END OF SECTION -

SECTION 03 21 00

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: Work includes furnishing, fabricating, and erecting all steel and fibers required for reinforcement of cast in place concrete as shown on the drawings.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 03 31 13, Cast In Place Concrete.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A82 Steel Wire, Plain, for Concrete Reinforcement
 - 2. ASTM A185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement.
 - 3. ASTM A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- B. American Concrete Institute (ACI):
 - 1. ACI 315 Manual of Standard Practices for Detailing Reinforced Concrete Structures.
 - 2. ACI 318 Building Code Requirements for Structural Concrete.
- C. Concrete Reinforcing Steel Institute (CRSI):
 - 1. CRSI Manual of Standard Practice

1.03 SUBMITTALS

- A. Submit the following:
 - 1. Before proceeding with the fabrication of the reinforcement, submit shop drawings showing the number, size, length, bending and arrangement of the reinforcement.
 - 2. All shop drawings shall be in accordance with ACI 315.
 - 3. Quality control submittals, when requested shall consist of a certified copy of each heat analysis performed by producer and certified copies of reinforcement strength tests.

1.04 PRODUCT HANDLING

- A. Delivery:
 - 1. The reinforcement shall be delivered to the site bundled, tagged and marked.
 - 2. Metal tags indicating the bar size, lengths, and other pertinent information corresponding to markings shown on placement drawings shall be used.
- B. Storage:

1. The reinforcement shall be stored at the site in a manner to prevent damage and accumulation of dirt and excessive rust.
2. Protect reinforcing steel and welded wire fabric from surface contamination and from distortion.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcing bars shall comply with ASTM A615, Grade 60, deformed. Reinforcing bars required to be welded shall be ASTM A 706 low alloy.
- B. Steel wire shall conform with ASTM A82, plain, cold-drawn steel.
- C. Welded wire fabric shall comply with ASTM A 185, welded steel wire fabric.
- D. Reinforcement supports including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement shall be:
 1. Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI manual.
 2. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 3. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).
 4. When the supports bear directly on the ground and it is not practical to use steel bar supports, precast concrete blocks may be used to support the bottom lift of the reinforcement. The precast blocks must be solid and of a higher strength than the concrete being placed. The blocks must provide adequate support to the reinforcement and be of proper height to provide reinforcing cover. The use of face brick, hollow concrete block, rocks, wood or other unapproved objects will not be permitted.
- E. Polypropylene fibers engineered and designed for secondary reinforcement of concrete slabs shall comply with ASTM C1116, Type III. Fibers shall be not less than ¾-inch long or greater than 1½-inch long as manufactured by Fibermesh or equal.

2.02 FABRICATION

- A. General:
 1. Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances which comply with CRSI manual.
 2. In case of fabrication error, do not rebend or straighten reinforcement in a manner that will weaken the material.
 3. Unless otherwise noted, all end hooks dimensions shall conform with ACI standard hooks.
- B. Reinforcement with any of the following defects will not be permitted:
 1. Bar lengths, depths, and bends exceeding the specified tolerances.
 2. Bend or kinks not indicated on the drawings or final shop drawings.
 3. Bars with reduced cross section due to excessive rusting or other causes.

- C. Fabricate to dimensions shown on plans and ACI 318.

PART 3 - EXECUTION

3.01 PLACING REINFORCEMENT

- A. General - Comply with the CRSI Manual's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.
1. Avoiding cutting or puncturing vapor retard/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.
 2. Bars partially embedded in concrete shall not be field bent except as shown on the plans or permitted by the Engineer.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers.
- D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Polypropylene fiber reinforcement for slabs may be used in lieu of WWF with engineer's approval. Use fiber reinforcement at a minimum rate of 1.5 pounds fiber per batch yard of concrete or greater if required by fiber manufacturer.

- END OF SECTION -

SECTION 03 31 13

CAST-IN-PLACE CONCRETE--STRUCTURES

PART 1- GENERAL

1.01 SUMMARY

A. Work Included:

1. All cast-in-place concrete materials and work.
2. Concrete admixtures.
3. Formwork for cast-in-place concrete.
4. Cleaning and finishing of formed surfaces.
5. Required testing and submittals.

B. Related Sections and Divisions:

1. Applicable provisions of the General Conditions shall govern work in this section.
2. Section 03 11 00, Concrete Form Work.
3. Section 03 21 00, Concrete Reinforcement.
4. Section 03 15 13, Waterstops.

1.02 REFERENCES

A. American Concrete Institute (ACI):

1. ACI 211.1 Selecting Proportions for Normal and Heavy Weight Concrete.
2. ACI 301 Specification for Structural Concrete for Buildings.
3. ACI 302.1 Guide for Concrete Floor and Slab Construction.
4. ACI 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
5. ACI 305 Hot Weather Concreting.
6. ACI 306 Cold Weather Concreting.
7. ACI 308 Standard Practice for Curing Concrete.
8. ACI 309 Standard Practice for Consolidation of Concrete.
9. ACI 318 Building Code Requirements for Reinforced Concrete.
10. ACI 347 Recommended Practice for Concrete Formwork.

B. American Society for Testing and Materials (ASTM):

1. ASTM C31 Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 Concrete Aggregates.
3. ASTM C39 Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 Ready-Mixed Concrete.
6. ASTM C143 Test for Slump of Portland Cement Concrete.
7. ASTM C150 Portland Cement.
8. ASTM C158 Test for Water Retention by Concrete Curing Materials.
9. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete.
10. ASTM C172 Standard Test Methods for Sampling Fresh Concrete.

11. ASTM C173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C164 Test Methods for Temperature of Freshly-Mixed Portland Cement Concrete.
13. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
14. ASTM C260 Air Entraining Admixtures for Concrete.
15. ASTM C309 Liquid Membrane-Forming Compounds for Curing Concrete.
16. ASTM C494 Chemical Admixtures for Concrete.
17. ASTM C618 Fly Ash and Raw or Calcified Natural Pozzolans for Using Portland Cement Concrete.
18. ASTM C1107 Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
19. ASTM D994 Preformed Expansion Joint Filler for Concrete.
20. ASTM E329 Standard Recommended Practice for Inspection Testing Agencies for Concrete, Steel, and Bituminous Materials as used in Construction.

1.03 SUBMITTALS

A. Submit the following information:

1. Gradation of fine and coarse aggregate – ASTM C33.
2. Specific gravity and dry rodded density of each aggregate.
3. Test of deleterious substances in fine and coarse aggregate – ASTM C33.
4. Design mix for all mixes.
5. 7 and 28-day compressive strengths for each concrete mix proposed.
6. Certified mill test results for cement identifying brand, type, and chemistry of cement.
7. Brand, type, principal ingredients and amount of each admixture.
8. Field quality control test results.

PART 2 - PRODUCTS

2.01 FORMWORK

- A. Form work shall be as specified in Section 03 11 00, Concrete Formwork.

2.02 PORTLAND CEMENT

- A. Portland cement shall conform to ASTM C150 and shall be Type I. Type III may be used only when approved by the Engineer. All Portland cement shall be from one supplier and mill.

2.03 FLY ASH

- A. Fly ash shall conform to ASTM C618, Class C or F. Loss on ignition shall not exceed 5 percent.

2.04 ADMIXTURES

- A. No admixtures shall contain calcium chloride, thiocyanates or more than 0.05% chloride ions. Written certification of these requirements by the admixture manufacturer shall be submitted to the Engineer for approval with the mix design.

B. Air-Entraining Admixture

ASTM C260 for exterior permanently exposed normal weight concrete and for all vehicular use areas; 5% to 7.5% as measured with air meter conforming to ASTM C173 or ASTM C231.

C. Water-Reducing Admixture

Use ASTM C494 Type A. To be used unless noted. Chloride ion content of admixture shall not exceed chloride ion content of municipal drinking water and shall be limited to produce no detrimental effect on other components, such as metal deck, reinforcing, metal conduit, and shall be verified by supplier. Follow the manufacturer's recommendations. Products shall be equal to:

"Pozzolith 220 N", Master Builders

"WRDA 82", W. R. Grace

D. Water-Reducing Retarding Admixture

ASTM C494 Type D. Chloride ion content of admixture shall not exceed chloride ion content of municipal drinking water. Use only if acceptable to the Engineer. Products shall be equal to:

"Pozzolith 220 N", Master Builders

"Daratard 17", W. R. Grace

E. Non-Corrosive, Non-Chloride Accelerator

ASTM C494, Type C or E. Chloride ion content of admixture shall not exceed chloride ion content of municipal drinking water. Product shall have been subjected to long-term testing (3 years duration, minimum), using an acceptable accelerated corrosion test method such as that using electrical potential measures. Use only if acceptable to the Engineer. Products shall be equal to:

"Pozzutec 20", Master Builders

"Daraset 20", W. R. Grace

F. High Range Water Reducing Admixture (Superplasticizers)

ASTM C494 Type F or G. Chloride ion content of admixture shall not exceed chloride ion content of municipal drinking water and shall be limited to produce no detrimental effect on other components, such as metal deck, reinforcing, metal conduit, and shall be verified by supplier. Use only if acceptable to the Engineer. Products shall be equal to:

"Rheobuild 1000", Master Builders

"Daracem-100", W. R. Grace

2.05 WATER

A. Water shall be clean and free from deleterious amounts of acids, oils, alkali, organic matter and mineral substances.

2.06 WATERSTOPS

- A. Polyvinyl chloride (PVC) waterstops shall be as specified in Section 03 15 13.

2.07 CURING MATERIALS

- A. Liquid Applied
 - 1. Liquid Membrane –Sonneborn Kure-N-Seal 25LV or equal. Apply upon completion of concrete finishing or form removal.
- B. Sheet or Membrane
 - 1. Plastic film, ASTM C171:
 - a. 10 mil thickness
 - b. White during warm weather.
 - c. Black during cold weather.
 - 2. Reinforced paper, ASTM C 17 1.
 - 3. Cotton mats, FS DDD-M-148.

2.08 CONCRETE SPECIALTIES

- A. Vapor Barrier
 - 1. Vapor barrier shall be 6 mil polyethylene with joints lapped 6 inches and taped with a waterproof tape.
- B. Bonding Agents
 - 1. Epoxy resin bonding compounds shall be Concresive liquid LPL for horizontal applications and paste LPL for vertical applications, as applicable and as manufactured by Adhesive Engineering; or Sikadur 32, Hi-Mod as manufactured by the Sika Chemical Corporation, or equal.
 - 2. Use of all bonding compounds shall be as shown on the drawings or as specified. Application shall be as recommended by the manufacturer.
- C. Epoxy Anchoring System

Epoxy anchoring system shall be a two-part, epoxy-based system thoroughly blended in a disposal mixing nozzle attached to the cartridge. Systems shall be Epcon C6 by ITW Red Head, or equal.

2.09 CONCRETE MIXES

- A. Test Mixes
 - 1. Have an approved commercial testing laboratory prepare design mixes for each class of concrete specified for use on job.
 - a. Design mixes in accordance with ACI 318 and ACI 211.1.
 - b. Laboratory shall make, cure, and test all specimens required by the applicable standards.
 - c. Design job-mixed concrete on the basis of water - cement ratio.
 - d. Mixes shall be homogeneous, readily placeable, and uniformly workable.
 - 2. Mixes shall conform to the following requirements:

Class	28-day Comp. Str. (PSI)	Max. Size Aggregate	ASTM C33 Aggregate	Min. Cement Content ** (Bags/C.Y.)	Air Content (%)*	Slump
A1	4000	1-1/2 inch	Size No. 4	5.5	5±1	3-inch - 4-inch
A2	4000	3/4 inch	Size No. 67	6.0	6±1	3-inch - 4 inch
A3	4000	3/8 inch	Size No. 8	6.0	7-1/2±1	3-inch - 4-inch
A4	4000	No. 16	Fine	7.0	8±1	6-inch Max.
B1	3000	1-1/2 inch	Size No. 4	4.5	5±1	3-inch - 4-inch
B2	3000	3/4 inch	Size No. 67	4.75	6±1	3-inch - 4-inch

*Required only where concrete is used for liquid containment or subject to freeze/thaw cycles.

**Minimum cement content applies to concrete in direct contact with earth or water.

3. When strength data from field experience or trial batches are not available, maximum permissible water-cement ratios shall be:
 - a. Non-air-entrained:
 - 1) Class A: 0.44
 - 2) Class B: 0.58
 - b. Air-entrained:
 - 1) Class A: 0.35
 - 2) Class B: 0.46
4. Maximum water/cement ratio when strength data from field experience or trial batches as required by ACI 318 are available:
 - a. Class A: 0.44
 - b. Class B: 0.58
5. Concrete which is to have a trowel-finished surface, maximum air content shall be 3%.
6. Fly ash may be substituted for cement on an equal weight basis up to a maximum of 20%.

B. Structural Concrete Mix Proportioning

1. Proportions of aggregate to cement shall be such as to produce a readily workable mixture with method of placement employed on job, but without allowing materials to segregate, or excess free water to collect on surface.
2. Combined aggregates shall be such that weight of fine aggregate shall not be less than 30 percent nor more than 45 percent of total.
3. Maximum size for coarse aggregate.
 - a. Not larger than one-fifth of narrowest dimension between sides of forms.
 - b. Not larger than one-third depth of slab.
 - c. Not larger than three-fourths of minimum clear spacing between reinforcing bars.
 - d. Not larger than 1-1/2 inch.

C. Concrete Usage

1. Class A4: Coating hardened concrete at construction joints, coating precast concrete plank prior to placement of bonded concrete topping, and optional first lift in forms with congested reinforcement and/or waterstop.
2. Class A: All locations except where Class B is specified.
3. Class B: Slabs reinforced with welded wire fabric, equipment bases, fence post footings, fillets in tanks, and where specifically stated in plans or specifications.

- D. Mixing
 - 1. Measure materials by weight in conformance with ASTM C94 and ACI 304.
 - 2. Mix and deliver concrete in ready-mix equipment conforming to ASTM C94 and ACI 304.

PART 3 - EXECUTION

3.01 FORM WORK

- A. Form work shall be as specified in Section 03 11 00, Concrete Formwork.

3.02 INSTALLING EMBEDDED ITEMS

- A. Encase pipes, anchor bolts, electrical conduits, steps, castings, and other inserts as shown on plans or as specified and finished by other trades.
- B. Place inserts in advance of pouring and brace to prevent movement during pouring process.
- C. Embedded conduits and pipes shall not be larger in outside dimension than one-third the overall thickness of wall, beam or slab.
- D. Embedded conduits and pipes shall not be spaced closer than 3 diameters or widths on center.

3.03 PLACEMENT OF CONCRETE

- A. Environmental Requirements
 - 1. Hot weather concreting.
 - a. Follow ACI 305 whenever mean surrounding air temperature equals or exceeds 80 degrees F (27 degrees C).
 - b. Do not place concrete whenever air temperature equals or exceeds 90 degrees F (32 degrees C).
 - 2. Cold weather concreting.
 - a. Follow ACI 306 whenever mean surrounding air temperature is below 40 degrees F (4.5 degrees C).
 - 3. Do not place concrete during rain, sleet, or snow, unless protection is provided.
- B. Placement of Concrete
 - 1. Conveying concrete.
 - a. Convey concrete from mixer to place of final deposit by methods that will prevent separation or loss of materials.
 - b. Equipment for chuting, pumping, or pneumatically conveying concrete shall be capable of providing a supply of concrete at site of Work without separation of ingredients and without interruptions sufficient to permit loss of plasticity between successive placements.
 - c. Unless otherwise approved, conform to ACI 304.
 - 2. Depositing concrete.
 - a. Deposit concrete as nearly as practicable to its final position to avoid segregation due to rehandling or flowing to its final position. Concrete shall not be dropped more than 6 feet unless a suitable chute or tube is used.

- b. Carry on concreting at such a rate that concrete is at all times plastic, and flows readily into spaces between reinforcing.
- c. Do not deposit concrete that has partially hardened or that has been contaminated by foreign materials.
- d. Do not use retempered or remixed concrete.
- e. After concreting is started, it shall be carried on as a continuous operation until placing of a panel or section is completed.
- f. Top surfaces of vertically formed lifts shall be generally level.
- g. Thoroughly consolidate concrete by suitable means during placement, and thoroughly work concrete around reinforcement and embedded fixtures, and into corners of forms.
- h. Vibrators may be used to aid placement, provided they are used under experienced supervision and forms have been designed to withstand their action.
- i. Unless otherwise approved, conform to ACI 304.

3.04 CONSTRUCTION JOINTS

- A. Construction joints shall be located as shown on plans, or if not located, locate so as to not impair strength and appearance. Construction joints shall be perpendicular to main reinforcement and reinforcement shall be across the joint.
- B. Clean surface of hardened concrete and remove laitance and standing water. Roughen surface of concrete to 1/4-inch amplitude.
- C. Wet construction joints and coat with Class A4 concrete immediately before new concrete placement.

3.05 CURING

- A. Maintain concrete surfaces moist for the first 7 days after placement.
- B. Under hot weather conditions, conform to ACI 305.
- C. Under cold weather conditions, conform to ACI 306.
- D. When a liquid-membrane-forming compound is used, protect exposed steel, key-ways or concrete to be surfaced from curing compound.
- E. During curing period, protect concrete from damaging mechanical disturbances, water flow, loading, shock, and vibration.
- F. Formed Surfaces
 - 1. Ceilings, walls, columns and beam sides may be cured by leaving forms in place, by wet cure, or by use of a liquid curing compound.
 - a. Spray surface of forms left in place during curing period as frequently as drying conditions may require to keep concrete surfaces moist. For vertical surfaces, apply water to run down on inside of forms, if necessary, to keep concrete surfaces moist.

- b. Apply liquid curing compound immediately after form removal. Apply at rate recommended by manufacturer.

G. Slabs (Flatwork)

1. Start curing activities as soon as free water has disappeared from surface of concrete after placing and finishing.
2. Wet cure slabs, which are to be covered with bonded concrete topping.
3. Cure other flatwork using a liquid curing compound or wet cure.
 - a. All floor surfaces shown in the room finish schedule to be exposed concrete shall receive 2 coats of sealing and hardening compound applied in strict accordance with manufacturers recommendations. The first coat is applied upon completion of finishing the concrete. The second coat is applied upon completion of final cleanup. All areas shall be clean and free from laitance, dust, grease or oil. Contractors shall verify compatibility of sealing-hardening compound with any previously applied curing compounds. All floor surfaces to receive finishes shall be water cured.

3.06 CONCRETE WALL FINISHES

A. Type W-1:

1. Fill snap-tie holes with non-shrink, non-metallic grout.
2. Knock off projections.
3. Patch honeycomb areas and rock pockets. Small air holes (less than 1/2 inch) do not require patching.

B. Type W-3:

1. Fill snap-tie holes with approved non-shrink, non-metallic color matched grout.
2. Grind off projections, fins, and rough spots.
3. Repair other defects such as honeycomb areas, rock pockets, and rough spots resulting from form release agent failure or other reasons with color matched non-shrink grout.
4. Where surfaces are required to be painted as shown on the painting schedules, the surfaces shall be sandblasted in addition to steps 1 through 3.

C. Type W-4, Rubbed Wall Finish:

1. Only water curing will be permitted on walls being rubbed unless an approved dissipating curing compound is approved.
2. Grind off projections, fins, and rough spots.
3. Repair defects such as honeycomb areas, rock pockets, and rough spots resulting from form release agent failure or other reasons.
4. Perform rubbing immediately upon completion of curing operation, and finish no later than 5 days after curing has been completed.
5. The mortar shall be a mixture of cement and silica sand in proportions used in concrete being finished.
 - a. Spread mortar uniformly over entire surface using a sponge float, filling air voids and imperfections level with adjacent concrete surface. It is the intent to provide a light texture finish on the concrete surface without “plastering” the surface. Finish wall uniformly by floating in a circular motion or pattern.

D. Type W-5, Abrasive Blast – Sandblast:

1. Intent of this procedure is to remove surface skin to a depth no more than 1/16 inch, and expose only fine aggregate and air holes near the surface, thus producing a uniform texture and matching approved sample or mockup panel.
2. Perform sandblasting within 7 days after end of curing period of concrete.
3. Sandblast areas at same age or within +2 days of same age.
4. The same person shall accomplish sandblasting on one structure.
5. Abrasive: Use clean silica sand free of foreign material sand supplied in sealed sacks.
6. Blast surface with 100 psi air pressure at rate of 2 to 3 square feet per minute with nozzle held approximately 2 feet from surface and perpendicular thereto.
7. Modification of procedure will acceptable if proven on sample and mockup panel.

3.07 CONCRETE SLAB FINISHES

A. General:

1. Do not excessively use “jitterbugs” or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar to accumulate.
2. Do not dust surfaces with dry materials.
3. Thoroughly compact slabs and floors by vibration.
4. Round off all edges of slabs and tops of walls with a steel edging tool, except where a cove or chambered finish is shown. Steel edging tool radius shall be 1/4-inch for all slabs subject to wheeled traffic.
5. After applying the final floor finish and after curing as specified in Section “Curing,” cover slabs with Visqueen or other material to keep floor clean and protect it from material and damage due to other construction work.

B. Type S-1, Concrete Slab Finish Steel Troweled Finish:

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation shown.
2. While concrete is still green, but sufficiently hardened to bear a person’s weight without deep imprint, float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on floats to bring moisture to surface.
4. After surface moisture has disappeared, trowel concrete to produce smooth, impervious surface, free from trowel marks.
5. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.
6. Do not use dry cement or additional water during troweling. Excessive troweling will not be permitted.
7. Power finishing:
 - a. An approved power machine may be used in lieu of hand finishing for finishing concrete floors and slabs in accordance with directions of machine manufacturer.
 - b. Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.

C. Type S-2, Slab Finish Float:

1. Finish slabs to receive fill and mortar setting beds by screeding with straightedges to bring surface to required finish plane.
2. Float slab to compact and seal surface.

3. Remove all laitance and leave surface clean.

D. Type S-3, Ceilings:

1. When forming is removed, grind off projections on underside of slab, repair rock pockets and honeycomb area defects including small shallow air pockets.
2. If underside of slab is exposed to view finish as per W-4 or W-5.

E. Type S-6, Sidewalk & Exterior Slab Finish:

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float to a true plane.
3. Broom surface at right angles to direction of traffic.
4. Lay out surfaces in blocks with an approved grooving tool sawcut as shown or as directed by Engineer.

F. Type S-7 for Clarifier

1. Finish.
2. Provide coarse broom finish for grout as specified or Section 03 60 00, Grout.

G. Concrete Curb:

1. Grade subgrade to proper elevation and compact.
2. Securely stake and brace forms to true line at proper elevation.
3. Place concrete as hereinbefore specified.
4. Float top surface of curb smooth, and finish all discontinuous edges with steel edger.
5. After concrete has taken its initial set, remove front form and give exposed surfaces an S-6 finish.

3.08 CONCRETE FINISHES

A. General

1. Every type of concrete finishes and finish tolerances are listed even though some of the finishes are not used in this project so that the Contractor can see by comparison how each of required finish fits into the progressive finishes.

B. Schedule of Concrete Finishes: The following schedule of concrete finishes is not intended to cover all areas of concrete finish, but to show some of the major areas of different types of finishes and tolerances.

SCHEDULE OF CONCRETE FINISHES

Area	Type of Finish	Required Form Tolerances
EXTERIOR WALL SURFACES		
Above grade when using a form liner (above a point 6" below finish grade)	W-5	W.B.
Above grade (above a point 6" below finish grade)	W-4	W.B.
Backfilled (below a point 6" below finish grade)	W-1	W.A.
INTERIOR WALL SURFACES		
Wet wells, basins, channels, and tanks	W-3	W.A.
Interior building walls	W-4	W.A.
EXTERIOR SLABS		
Roof slab (exposed and traffic use)	S-6	S.B.
Roof slab (backfilled above)	S-2	S.A.
Sidewalks, exterior slabs	S-6	S.A.
Stairs treads and landings	S-6	S.B.
INTERIOR SLABS		
Floor slab (building)	S-1	S.B.
Wet well, aeration basin, and channel	S-1	S.A.
Clarifiers	S-7	S.A.
Stairs and landings	S-6	S.A.
Ceilings	S-3	S.A.
BEAMS AND COLUMNS		
Beams	B-1 or B-2	B.A.
Columns	C-1 or C-2	C.A.
MISCELLANEOUS SURFACES		
Curbs	S-6	W.A.
Equipment pads (interior and exterior)	S-1 Horizontal Surfaces W-4 Vertical Surfaces	S.A.
Non-accessible wall surfaces	W-1	W.A.

3.09 BEAMS AND COLUMN FINISHES

- A. Type B-1:
 - 1. Knock off all fins and projections.
 - 2. Repair all rock pockets and honeycomb areas.
- B. Type B-2; exposed to view
 - 1. Grind beams to remove all form marks.
 - 2. Repair all rock pockets and honeycomb areas.
 - 3. Finish as per type W-4.
- C. Type C-1:
 - 1. Knock off all fins and projections.
 - 2. Repair all rock pockets and honeycomb areas.

- D. Type C-2; Exposed to view
1. Grind column to remove all form marks.
 2. Repair all rock pockets and honeycomb area.
 3. Finish as per type W-4.

3.10 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. Sampling and testing for quality control during concrete placement shall conform to ASTM E329 and shall include the following:
1. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
 - a. Slump: ASTM C143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - b. Air Content: ASTM C173, volumetric method for lightweight or normal weight concrete; ASTM C231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degrees F (4 degrees C) and below, when 80 degrees F (27 degrees C) and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimen: ASTM C31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C39; one set for each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch, if fewer than five are used.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- B. Test results will be reported in writing to Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- C. Nondestructive Testing

Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

D. Additional Tests

The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed.

E. The cost of testing services shall be included in the lump sum base bid price.

3.11 REPAIR OF LEAKS

A. If leaks are observed, they shall be repaired as follows:

1. Locate and mark leaking areas.
2. The leaking areas shall be inspected for recommendations by a representative of a manufacturer that specializes in concrete repair systems.
3. Recommendations shall be submitted for approval of the type of concrete repair method required to correct the leaking areas for the life of the tank.
4. Upon approval of the concrete repair methods and materials, repair the leaking areas accordingly.
5. After repair, the structure shall be re-tested as above. Testing and repair shall continue until all leaks or moist spots have disappeared to the satisfaction of the Engineer.

- END OF SECTION -

05

DIVISION 05

METALS

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section included providing miscellaneous metal work including HVAC and electrical supports as shown on drawings, as specified herein, and as needed for complete installation.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 09 90 00, Painting and Special Coatings
 - 3.

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Material (ASTM):
 - 1. ASTM A36 Spec. for Structural Steel.
 - 2. ASTM A48 Gray Iron Castings.
 - 3. ASTM A53 Spec. for Welded and Seamless Steel Pipe.
 - 4. ASTM A123 Spec. for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip.
 - 5. ASTM A153 Spec. for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 6. ASTM A307 Spec. for Carbon Steel Externally and Internally Threaded Standard Fasteners.
 - 7. ASTM A325 Spec. for High-Strength Bolts for Structural Steel Joints.
 - 8. ASTM A500 Spec. for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 9. ASTM A615 Spec. for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 10. ASTM D2146 Spec. for Propylene Plastic Molding and Extrusion Materials.
- B. American Welding Society (AWS):
 - 1. AWS D1.1 Structural Welding Code - Steel.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Tag miscellaneous metals including anchor bolts, concrete anchors, sleeves and bases for ease of identification at site.

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Material sizes, connections, anchors and painting.
 - 2. Installation procedures.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Steel Plates and Shapes shall conform to ASTM A36.
- B. Steel Pipe shall conform to ASTM A53, Grade B
- C. Structural Tubing shall conform to ASTM A500, Grade B
- D. Aluminum Structural Shapes and Plates shall conform to Alloy 6061-T6
- E. Interior Stainless shall conform to Type 304 or 316
Exterior or Submerged stainless steel shall be Type 316
- F. Connection Bolts:
 - 1. Structural Steel: ASTM A325.
 - 2. Wood: 316 Stainless Steel.
 - 3. Aluminum: 316 Stainless Steel.

2.02 FABRICATION & FINISH

- A. Connections
 - 1. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items required for fabrication and erection.
 - 2. Weld shop connections.
 - 3. Bolt or weld field connections.
- B. Workmanship
 - 1. Grind exposed welds to 1/8 inch minimum radius.
 - 2. Grind burrs, jagged edges, and surface defects smooth.
 - 3. Use bolt length such that bolt does not project more than 1/4 inch beyond face of nut.
- C. Galvanizing
 - 1. Galvanize after fabrication, in accordance with ASTM A123 or A153, as applicable.
 - 2. Ship and handle to avoid damaging zinc coating.
 - 3. Repair field damaged galvanizing as specified in 3.08 of this specification.
- D. Painting
 - 1. Painting shall be as specified in Section 09 90 00, Painting and Special Coatings.

2.03 MANHOLE STEPS

- A. Steps shall be steel reinforced plastic.
- B. Plastic shall be a polypropylene conforming to ASTM D2146.
- C. Reinforcement shall be a deformed 1/2 inch diameter bar (minimum) conforming to ASTM A615, Grade 60.
- D. Minimum design live load shall be a single concentrated load of 300 lbs. when in place.
- E. Minimal dimensions:
 - 1. 12 inches wide.

2. Project 5 to 7 inches from wall.
3. Space 16 inches on center.

2.04 ANCHOR BOLTS

- A. Anchor bolts for equipment and machinery, where permanently anchored into concrete, shall be Type 316 stainless steel. The diameter, length, and any bend dimensions shall be as required by the equipment or machinery manufacturer. Unless otherwise required, use 3/4-inch minimum diameter and other geometry shown on the drawings. Furnish a minimum of two nuts and a washer of the same material for each bolt.
- B. Anchor bolt sleeves shall be polyethylene, length as required by the equipment or machinery manufacturer, Wilson Anchor Bolt Sleeve Co., or equal.

2.05 STAINLESS STEEL FASTENERS LUBRICANT (ANTI-SEIZING)

- A. Where stainless steel nuts and machined bolts, anchor bolts, concrete anchors, and all other threaded fasteners are used, Contractor shall apply an anti-seizing lubricant to the threads prior to making up the connections. The lubricant shall contain substantial amounts of molybdenum disulfide, graphite, mica, talic, or copper.

2.06 ANCHORING SYSTEMS FOR CONCRETE

- A. Wedge Anchors:
 1. Wedge anchors shall be 100 percent 316 stainless steel and shall not be used below a point 1 foot 6 inches above the peak (maximum water surface in any water-holding structure. See adhesive anchors specified elsewhere in this Specification.
 2. Wedge anchors shall be 316 stainless steel, manufactured by ITT Phillips Drill Division, Michigan City, IN; Hilti Kwik-Bolt, stud type, manufactured by Hilti, Inc., Stamford, CT; Weg-It, stainless steel bolts, completely assembled, manufactured by Wej-It Corporation, Broomfield, CO; Parabolt Concrete Anchors, manufactured by Molly Division of Emhart Corp., Temple PA; or equal. Furnish sizes shown on Drawings. Provide ICBO (International Conference of Building Officials) or other similar building code organization recommendations regarding safe allowable design loads.
- B. Expansion Anchors:
 1. Expansion anchors shall be 316 stainless steel. In the wet or damp areas, use wedge anchors as specified above or epoxy anchors in submerged conditions as hereinafter specified; 316 stainless steel expansion anchors may be used as defined for stainless wedge anchors.
 2. Self-drilling anchors, snap-off type or flush type. Provide anchors for use with stainless steel bolts. Non-drilling anchors shall be flush type for use with a bolt or stud type with projecting threaded stud. Provide ICBO or other similar code organizations' recommendations regarding safe allowable design loads. ITT Phillips Drill Division, Michigan City, IN; Hilti HDI Drop-In anchors, Hilti, Inc., Stamford, CT; or equal.
- C. Epoxy Anchors:
 1. Provide for anchoring metal components at or below a point 1 foot 6 inches above maximum water surface elevation in water-holding structures, or buried in earth conditions.

2. Anchor Rod: 316 stainless steel threaded rod free of grease, oil, or other deleterious material with a 45-degree chisel point.
3. Epoxy Adhesive:
 - a. Meet ASTM C 881, Type 1, Grade 3, Class A, B, or C.
 - b. Two-component, 100 percent solids, nonsag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments, gray in color.
4. Mixed Epoxy Adhesive:
 - a. Nonsag paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runoff, holding the following properties:
 - 1) Slant Shear Strength, ASTM C 881/882, No Failure In Bond Line, Dry/Moist Conditions: 5,000 psi.
 - 2) Compressive Strength, ASTM D 695: 14,000 psi minimum.
 - 3) Tensile Strength, ASTM D 695: 4,5000 psi.
 - 4) Heat Deflection Temperature, ASTM D 648: 136 degrees F, minimum.
5. Epoxy Adhesive Packaging:
 - a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
 - b. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of pre-drilled hole.
 - c. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes anchor rods.
 - d. Cartridge Markings: Include manufacturer's name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
6. Storage of Epoxy Adhesive:
 - a. Store epoxy cartridges on pallets or shelving in a covered storage area.
 - b. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired.
 - c. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.
7. Manufacturers:
 - a. Adhesives Technology Corp., 21850 88th Place South, Kent, WA 98031; Anchor-It Fastening Systems, HS 200 Epoxy Resin;
 - b. Or Equal.

2.07 ANCHOR SYSTEMS FOR MASONRY WALLS

- A. Stainless steel sleeve anchor, Hilti HLC, or equal.
- B. Wedge anchors may be used in solid grouted masonry walls.
- C. Drive anchors are not acceptable.

2.08 ANCHOR SYSTEMS FOR GYPSUM BOARD WALLS

- A. Use Toggler bolt, Hilti, or equal.

2.09 METAL WEIR PLATES, BAFFLES, AND SUPPORTS

- A. Shall be 304 stainless steel, unless indicated otherwise, or furnished with equipment.

2.10 ACCESS HATCHES

- A. Frame
 - 1. ¼ inch min. channel aluminum with anchor flange around perimeter and neoprene cushion.
 - 2. Bituminous coating on outside of frame.
 - 3. Provide 1-1/2 inch drain coupling in the corner of the channel frame locate as shown on the plans. Provide all SCH. 40 PVC drainage piping as shown on the drawings.
- B. Doors
 - 1. ¼-inch minimum aluminum diamond plate, reinforced as required to support a 300 psf live load.
 - 2. Counterbalanced for ease of operation.
 - 3. Automatically lock in the open position.
 - 4. Snap lock with removable handle.
 - 5. Double leaf doors shall be fitted with 316 stainless steel chains on each end to guard opening when doors are open.
 - 6. Access doors for valve vaults and meter vaults shall include ladder extension, Halliday L1E, Bilco "Ladder Up", or equal.
- C. Fall Protection Grating
 - 1. Hatches shall be provided with hinged, grating panel that operates independently of the access door. Panel shall be 300 PSI load rated, safety orange or yellow, lockable, and include a positive latch to maintain an upright position. Hinge shall be tamper proof. Panel shall be fiberglass or aluminum.
- D. Hardware
 - 1. Stainless Steel.
- E. Guarantee
 - 1. Manufacturer shall guarantee door to be free of defects in material and workmanship for period of five years.
- F. Acceptable Manufacturers
 - 1. Halliday, Bilco, or equal.

2.11 CAST IRON CASTINGS

- A. Conform to the following:
 - 1. ASTM A48, Class 30.
 - 2. Free of blowholes, shrinkage, distortion, and other defects.
 - 3. Provide where shown on plans or schedule.
- B. Acceptable manufacturers.
 - 1. Neenah Foundry Company.
 - 2. East Jordan Iron Works, Inc.
 - 3. Or equal.

2.12 ALUMINUM CASTINGS

- A. Conform to the following:
 - 1. Free of blow holes.
 - 2. Free of blowholes, shrinkage, distortion, and other defects.
 - 3. Provide where shown on plans or schedule.
- B. Acceptable manufacturers.
 - 1. Neenah Foundry Company.
 - 2. East Jordan Iron Works, Inc.
 - 3. Or equal.

2.13 ABRASIVE NOSINGS FOR CONCRETE STAIRS

- A. Except as otherwise indicated, provide flush type abrasive nosings on all stairs. Nosing shall consist of a homogeneous epoxy abrasive, with minimum 50 percent aluminum base. The epoxy abrasive shall extend over and form the curved front edge of the nosing to a depth of at least 1/2 inch. The base of the nosing shall be extruded aluminum alloy, 6063-T5, heat-treated. All aluminum surfaces in contact with concrete or dissimilar metals shall be coated as specified in Section 09 90 00, Painting.
- B. Anchoring system shall be double-set anchors consisting of two rows of integrally extruded anchors.
- C. Nosings shall be protected with a factory applied heavy-duty polyethylene cloth moisture-proof tape.
- D. Size shall be 3-inch wide by 3/8-inch thick by length which is 4 inches less than width of stair tread for cast-in-place concrete stairs and 3/8 inches less than width of stair tread for concrete filled pan stairs.
- E. Color shall be as indicated in the Finish Schedule.
- F. Supply Spectra Type WP-3J and WP-3C as manufactured by Wooster Products, Inc.; Amcolun Type BF3 and DSA3 as manufactured by American Abrasive Metals Company; or equal. Use first type listed for concrete filled pan treads and second type for cast-in-place concrete treads.

2.14 CHECKERED PLAT & FRAMES

- A. Aluminum: Alloy 6061-T6, tread plate, thickness as indicated, 1/4-inch minimum, fasten all accessories by welding or stainless steel bolts or screws.

2.15 MISCELLANEOUS ITEMS

- A. Fabricate and finish miscellaneous steel framing, supports and items, including but not limited to the following:
 - 1. Lintels—hot dip galvanized.
 - 2. Equipment bases--painted.
 - 3. Guard Posts—hot dip galvanized.
 - 4. Bar Screens—stainless steel.
- B. Use plates, shapes, bars and tubing of the material, size, shape and arrangement indicated on the plans.

2.16 ALUMINUM STAIRS

- A. Provide as detailed on plans.
- B. Include components such as framing, platforms, hangers, columns, struts, clips, brackets, bearing plates and platforms.
- C. Close ends of stringers with plates, continuously welded and ground smooth.

2.17 LADDERS

- A. All ladders utilized on the project shall be of aluminum construction, unless specifically indicated otherwise on the Drawings.
 - 1. Aluminum: Fabricate the aluminum ladders with rails and rod rungs as shown. Punch inside face of rails, pass rungs through the rails, and weld as shown on the drawing. Fabricate brackets for fastening the ladder to the wall and weld to the ladder. Ladder shall conform to the applicable requirements of OSHA, the State Basic Safety Code, or other regulatory authority. Hot-dip galvanize steel ladder after fabrication.
 - 2. Ladder Safety Post: All ladders installed beneath sidewalk doors, roof hatches, skylights, or other floor or roof openings shall be equipped with a telescoping tubular safety post, spring balanced and automatically locking in the raised position, with release level for unlocking. Post shall be same material as ladder and spring mechanism shall be corrosion-resistant steel alloy. Post shall be Halliday L1E, Bilco "Ladder Up" safety post, or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Workmanship and finish of all metalwork specified under this section shall be the highest grade and equal to the best practice of modern shop[s] for the respective work. Exposed surfaces shall have smooth finish and sharp, well-defined lines. Provide all necessary rabbets, lugs, and brackets so that the work can be assembled in a neat, substantial manner. Conceal fastenings where practical. Drill metalwork and countersink holes as required for attaching hardware or other materials. Fabricate materials as specified. Weld connections, except where bolting is directed. Items requiring special fabrication methods are mentioned herein. Fabrication of all other items shall be of equal quality. Methods of fabrication not otherwise specified or shown shall be adequate for the stresses and as directed by the Engineer.
- B. Grind all exposed edges of welds smooth on walkways, guardrails, handrails, stairways, channel door frames, steel column bases, and where indicated on the Drawings. All sharp edges shall be rounded to a 1/8-inch minimum radius; all burrs, jagged edges, and surface defects shall be ground smooth.
- C. Welds and adjacent areas shall be prepared such that there is 1) no undercutting or reverse ridges on the weld bead 2) no weld spatter on or adjacent to the weld or any other area to be painted, and 3) no sharp peaks or ridges along the weld bead. All embedded pieces of electrode or wire shall be ground flush with the adjacent surface of the weld bead.

1. Aluminum: Fabricate aluminum as shown, and in accordance with the Aluminum Association Standards and the manufacturer's recommendations as approved. Grind smooth sheared edges exposed in the finished work.

3.02 WELDING

- A. The technique of welding employed, appearance, quality of welds made, and the methods of correcting defective work shall conform to codes for Arc and Gas Welding in Building Construction of the AWS and AISC. Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign material, except that mill scale, which will withstand vigorous wire brushing may remain. A light film of linseed oil may likewise be disregarded. No welding shall be done when the temperature of the base metal is lower than zero degrees F. Finished members shall be true to line and free from twists.
- B. All welding operators shall be qualified in accordance with the requirements of current AWS Standard Qualification Procedure D1.1, Chapter 5, and welders of structural and reinforcing steel shall be certified for all positions of welding in accordance with such procedure. Qualification test shall be run by a recognized testing laboratory at the Contractor's expense. Previous recent qualification by the State of Wisconsin will be acceptable.
- C. All welding operators shall be subject to examination for requalifications using the equipment, materials, and electrodes employed in the execution of the Contract work. Such requalification, if ordered by the Engineer, shall be done at the expense of the Contractor.
 1. Aluminum: Aluminum shall be welded with Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) processes in accordance with the manufacturer's recommendations as approved, and in accordance with the recommendations of the American Welding Society contained in the Welding Handbook, as last revised. Grind smooth all exposed aluminum welds.

3.03 INSTALLATION OF FABRICATED METALWORK

- A. Install in accordance with the shop drawings, the Drawings, and these Specifications. Perform field welding and erection work by skilled mechanics. Install fabricated metalwork plumb or level as applicable. The completed installations shall, in all cases, be rigid, substantial, and neat in appearance. Erect structural steel in accordance with the applicable portions of AISC Code of Standard Practice, except as modified. Install commercially manufactured products in accordance with manufacturer's recommendations as approved.
- B. Aluminum: Erection of aluminum shall be in accordance with the Aluminum Association. Mill markings shall not be removed from concealed surfaces. Exposed surfaces not otherwise coated shall have the inked or painted identification marks removed after the material has been inspected and approved by the Engineer.

3.04 ANCHOR BOLTS

- A. All anchor bolts shall be accurately located and held in a place with templates at the time the concrete is poured.

3.05 CONCRETE ANCHORS

- A. Installation shall not begin until the concrete or masonry receiving the anchors has attained its design strength. An anchor shall not be installed closer than six times its diameter to either an

edge of the concrete or masonry, or to another anchor, unless specifically detailed otherwise on the Drawings. Install in strict conformance with manufacturer's written instructions. Use manufacturer's recommended drills and equipment.

- B. Epoxy Anchors: Do not install when temperature of concrete is below 35 degrees F or above 110 degrees F.

3.06 ABRASIVE NOSINGS

- A. Provide abrasive nosings on all concrete steps not being supplied or coated with alternate type of nosing or nonskid material.

3.07 ACCESS COVERS

- A. Covers shall be accurately and substantially positioned prior to placing concrete, such that the covers are flush with the floor surface. The covers shall be protected from damage resulting from concrete placement. Exposed surfaces shall be thoroughly cleaned of all concrete spillage such that a clean, uniform appearance is achieved.

3.08 GALVANIZING AND REPAIR

- A. Galvanizing of steelplates, shapes, bars (and products fabricated from these items, and strip 1/8-inch thick or thicker, shall conform to ASTM A 123. Pipe, welded or seamless steel, shall conform to ASTM A 120. Material thinner than 1/8 inch shall either be galvanized before fabrication in conformance with the requirements of ASTM A 525, Coating Designation G 210; after fabrication, in conformance with the requirements of ASTM A 123, except that the weight of zinc coating shall average not less than 1.2 ounces per square foot of actual surface area with no individual specimen having a weight of less than 1.0 ounce. Unless otherwise provided, galvanizing shall be done before or after fabrication, for material which is thinner than 1/8 inch, at the option of the Contractor. Galvanizing will not be required for stainless steel, monel metal, and similar corrosion-resistant parts.
- B. All welded areas shall be thoroughly cleaned prior to galvanizing to remove all slag or other material that would interfere with the adherence of the zinc. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating.
- C. Galvanizing of chain link fence fabric, when specified or shown on the Drawings, shall conform to ASTM A 117.
- D. In like manner, galvanizing of iron and steel hardware, and nuts and bolts, shall conform to ASTM A 153. Galvanizing shall be performed after fabrication. Galvanizing of tapped holes will not be required.
- E. Fabrication shall include all operations such as shearing, cutting, punching, forming, drilling, milling, bending, welding, and riveting.
- F. Components of bolted assemblies shall be galvanized separately before assembly.
- G. The minimum pitch diameter of the threaded portion of all bolts, anchor bars, or studs shall conform to ANSI B1.1, having Class 2A tolerance before galvanizing. After galvanizing, the

pitch diameter of the nuts or other internally threaded parts may be tapped over ANSI B1.1, Class 2B tolerance, by the following maximum amounts:

3/8 inch through 9/16 inch	0.016-inch oversize
5/8 inch through 1 inch	0.023-inch oversize
1-1/8 inch and larger	0.033-inch oversize

- H. Galvanized surfaces to be painted shall be prepared in the field in accordance with Section 09 90 00 Painting.
- I. Except for inlet grates not otherwise required to be welded, all edges of tightly contacting surfaces, where galvanized is required, shall be completely sealed by welding before galvanizing.
- J. Galvanized surfaces that are abraded or damaged at any time after the application of the zinc coating shall be repaired by solvent cleaning the damaged area (Steel Structures Painting Council SP 1) and hand or power tool (Steel Structures Painting Council SP 2 or SP 3) the damaged areas, removing all loose and cracked coating; after which the cleaned areas shall be painted with one of the following coatings:
 - 1. One coat of Inorganic Zinc Silicate (MIL-P-23236, Class 3).
 - 2. Two coats of Galvanizing Repair Paint (MIL-P-21035).
 - 3. Two coats of Zinc Dust Paint (MIL-E-15145, Formula 102).
- K. Paint shall be applied to a cleaned surface. Abrasive blasting is required for inorganic zinc silicate.

3.09 ELECTROLYTIC PROTECTION

- A. Where aluminum is in contact with dissimilar metals, or to be embedded in masonry or concrete, protect surfaces in accordance with Section 09 90 00, Painting. Allow paint to dry before installation of the material. Protect painted surfaces during installation; should coating become marred, prepare and touch up surface per paint manufacturer's instructions.

3.10 PAINTING

- A. Thoroughly clean all ferrous metal items and give a shop coat of metal primer. Preparation of surfaces and application of primer shall be in accordance with the paint manufacturer's printed directions and recommendations as approved; and in accordance with Section 09 90 00 Painting, utilizing the appropriate painting system.

3.11 PREPARATION FOR SHIPMENT

- A. Insofar as is practical, the items provided hereunder shall be factory assembled. The parts and assemblies that are necessity shipped unassembled, shall be packaged and clearly tagged in a manner that will protect the materials from damage, and facilitate the identification and final assembly in the field.

- END OF SECTION -

09

DIVISION 09

FINISHES

SECTION 09 90 00

PAINTING AND SPECIAL COATINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section includes the methods and materials to be used for all exterior and interior painting work.
- B. All piping, equipment, structures, and appurtenances shall be coated prior to being placed into service.

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM D7091 Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
- B. International Concrete Repair Institute (ICRI):
 - 1. 210.3R Guideline for Using In-Situ Tensile Pull-Off Tests to Evaluate Bond of Concrete Surface Materials
 - 2. 210.4 Guide for Nondestructive Evaluation Methods for Condition Assessment, Repair, and Performance Monitoring of Concrete Structures
 - 3. 310.1R Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion
- C. National Association of Corrosion Engineers International (NACE):
 - 1. All current specification created in partnership with SSPC
- D. National Association of Pipe Fabricators (NAPF):
 - 1. NAPF 500-03 Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coating and/or Special Internal Linings
- E. Society of Protective Coatings (SSPC):
 - 1. All current specifications within SSPC Painting Manual

1.03 QUALITY ASSURANCE

- A. Materials shall be used in conformance with the instruction of the manufacturer or supplier.
- B. Where painting materials will come in contact with potable water, manufacturer shall provide current written acceptance for their coating system from the state's governing authority.
- C. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.

1.04 SUBMITTALS

- A. Submit the following data in accordance with Section 01 32 19, submittals including:
1. Name of contractor or subcontractor who will perform painting, coating or surface preparation work.
 2. Name of manufacturer of coating materials together with a list of materials to be used and the mil thickness to be applied.
 - a. Material list shall give brand name and generic type.
 - b. Material list shall identify primer required.
 - c. A manufacturer's data sheet for each material to be used on the project.
 3. Supply two copies of color chart for Owner's selection.

1.05 DELIVERY AND STORAGE

- A. Packing and Shipping:
1. Deliver products in manufacturer's original unopened containers. Each container shall have manufacturer's label, intact and legible.
 2. Include on label for each container:
 - a. Manufacturer's name
 - b. Type of paint
 - c. Manufacture time stamp
 - d. Manufacturer's stock number
 - e. Color name and number
 - f. Instructions for thinning, where applicable
- B. Storage and Protection:
1. Store materials in a designated protected area, per manufacturer's printed data sheet instructions.
 2. Cover bulk materials subject to deterioration because of dampness, weather, or contamination, and protect while in storage.
 3. Maintain materials in original, sealed containers, unopened and with labels plainly indicating the manufacturer's name, brand, type, grade of material, and batch numbers.
 4. Remove from the work site containers that are broken, opened, water marked, and/or contain caked, lumpy, or otherwise damaged materials. They are unacceptable.
 5. Store the material in a climate controlled designated area where the temperature will not exceed the manufacturer's storage recommendations. Heat the storage area to the manufacturer's recommended minimum mixing temperature.
 6. Keep equipment stored outdoors from contact with the ground, away from areas subject to flooding, and covered with weatherproof plastic sheeting or tarpaulins.
 7. Store all painting materials in a location outside the tank.
 8. Do not store or have on-site unapproved material, material from different manufacturers, or materials from different projects.

1.06 SITE CONDITIONS

- A. Environmental Requirements.
1. Temperature.
 - a. Follow manufacturer's instructions for system being applied.
 2. Atmospheric conditions.
 - a. Paint shall not be applied to wet or damp surfaces.

- b. Paint shall not be applied during rain, snow, fog, or mist.
 - c. The temperature shall be at least 5 degrees above the dew point. Minimum application and substrate temperatures shall be as recommended by the manufacturer for the product being used.
 - d. Dew or moisture conditions should be anticipated and if such conditions are prevalent, exterior painting shall be delayed until conditions are dry.
 - e. Exterior painting should be completed well in advance of probable time of day condensation will occur, in order to permit the film an appreciable drying time prior to formation of moisture.
 - f. Atmosphere shall be free of air born dust.
3. Adequate illumination shall be provided using explosion proof lights and equipment where required.

PART 2 - PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

A. Sherwin Williams, Induron, Wasser, or equal.

2.02 PAINTING SYSTEMS

Table 1
Coating Systems For Application On Concrete And Concrete Block

System Type	Application	Generic Type	Primer Coat	Finish Coat	Min Dry mil Thickness	Surface Preparation
C-1	Concrete, Concrete Block, in Corrosive Environments	Polyamine Epoxy	Concrete: Self-priming Block: Polyamine Primer	Polyamine Epoxy (Color as Selected by Owner)	6-8 mils primer 6-8 mils finish 12-16 mils total	Concrete: Allow new concrete to cure for 28 days. Moisture content at the surface shall be less than 5%. Prepare surface per Section 03 31 13 and per manufacturer's instructions. Temperature must be 50° and rising unless an approved accelerator is added. Block: Allow mortar to cure for 28 days. Level protrusions and splatter. All surfaces must be clean and dry.
C-2	Concrete Floors	Polyamide Epoxy	Polyamide Epoxy, (Color as Selected by Owner) Thinned per manufacturer's instructions	Polyamide Epoxy (Color as Selected by Owner)	6-8 mils primer coat 6-8 mils finish 12-16 mils total	Concrete: Allow new concrete to cure for 28 days. Moisture content at the surface shall be less than 5%. Prepare surface per Section 03 31 13 and per manufacturer's instructions. All surfaces must be clean and dry.

System Type	Application	Generic Type	Primer Coat	Finish Coat	Min Dry mil Thickness	Surface Preparation
C-3	Interior Concrete Walls, Ceilings, and Concrete Block	Latex	Concrete and Concrete Block: Latex Block Filler	Vinyl Acrylic Latex (Eggshell) Color as selected by owner.	Concrete and Block: Block filler plus two finish coats. 150 sq. ft./gal primer coat 200 sq. ft./gal finish coats	Concrete: Allow new concrete to cure for 28 days. Wet blast with abrasive. Block: Allow mortar to cure for 27 days. Level protrusions and splatter. All surfaces must be clean and dry.
C-4	Exterior Concrete & Masonry	100% Acrylic Elastomeric	Acrylic Latex Alkali Resistant Primer	100% Acrylic Elastomeric (Color as Selected by Owner)	2 mils primer 2 finish coats 7 mils per coat 16 mils total	Follow manufacturer's instructions
C-5	All Exposed, Nonsubmerged, Unpainted, Exterior Masonry Surfaces	Concrete Block and Brick: Silane based sealer.	NA	NA	Apply two coats per manufacturer recommendations	All surfaces must be clean and dry.
C-6	Below grade exterior building walls	Cold-applied tar damp-proofing	NA	W.R. Meadows Sealastic Emulsion Type II (Color as Selected by Owner) Brush or Spray-on	30 mils wet	Concrete surface shall be clean & free of all loose material.
C-7	Concrete, submerged to 6 inches above high water line	Polyamine Epoxy	Concrete: self-priming	Polyamide Epoxy (Color as Selected by Owner)	6 mils primer 6 mils finish 12 mils total	Concrete: Allow new concrete to cure for 28 days. Brush-off blast. Apply per manufacturer's instructions
C-8	Concrete, chemical containment areas	Polyamide Epoxy	Concrete: self-priming	Polyamide Epoxy (Color as Selected by Owner)	6 mils primer 6 mils finish 12 mils total	Concrete: Allow new concrete to cure for 28 days. Brush-off blast. Apply per manufacturer's instructions

Table 2
Coating Systems For Application On Metal And Plastic

System Type	Application	Generic Type	Primer Coat	Finish Coat	Min Dry mil Thickness	Surface Preparation
M-1	Non-Submerged Indoors and Outdoors	Polyamide Epoxy and Urethane (exterior only)	One coat Epoxy One coat Epoxy	Interior: One coat Epoxy Exterior: One coat Urethane Color as selected by Owner.	5 mils primer 5 mils finish 10 mils total 5 mils primer (epoxy) 3 mils finish (urethane) 8 mils total	Steel SSPC-SP6
M-2	Submerged or Intermittently Submerged (Except potable water).	Polyamide Epoxy	Polyamide Epoxy	Polyamide Epoxy Color as selected by Owner.	4 mils Primer 6 mils Intermediate 6 mils Finish 16 mils total	Steel immersion. Service: SSPC-SP10
M-3	Electrolytic Protection for Aluminum	Polyamide Epoxy	Polyamide Epoxy	Polyamide Epoxy Color as selected by Owner.	6 mils	SSPC-SP1 Solvent Cleaning

Table 3
Coating System For Application On Piping Systems

System Type	Application	Generic Type	Primer Coat	Finish Coat	Min Dry mil Thickness	Surface Preparation
P-1	Non Submerged Iron Steel & Plastic	Polyamide Epoxy	One Coat Epoxy	One Coat Epoxy Color as selected by Owner.	6 mils primer 6 mils finish 12 mils total	Iron & Steel: SSPC – SP6 Factory apply universal primer verify compatibility with epoxy finishes Plastic: Solvent clean all surfaces
P-2	Submerged Iron, Steel	Polyamide Epoxy	One Coat Epoxy	One Coat Epoxy Color as selected by Owner.	4 mils primer 6 mils intermediate 6 mils finish 16 mils total	SSPC-SP10
P-3	Non-submerged Iron & Steel Insulated Exposed	Polyamide & Acrylic Latex	Polyamide Epoxy	Acrylic Latex Color as selected by Owner.	1 mil primer on piping 2 finish coats on insulation	All surfaces shall be clean & dry.

Table 4
Coating Systems For Application On Wood and Gypsum Wallboard

System Type	Application	Generic Type	Primer Coat	Finish Coat	Min Dry mil Thickness Per Coat	Surface Preparation
A-1	Interior Plaster or Drywall Surface	Latex	1 st Coat: Vinyl latex Primer sealer.	2 nd Coat: Satin, Latex enamel 3 rd Coat: Satin, Latex enamel “orange peel” finish.	--	Dry, Sanded
A-2	Exterior Stained Wood	Alkyd	1 st Coat: latex semi-transparent or solid stain.	2 nd Coat: Latex semi-transparent or solid stain (Selection by Owner)	--	Dry, Sanded
A-3	Interior Stained Wood	Polyurethane	1 st Coat: Oil-Based Wood stain 2 nd Coat: Satin, polyurethane varnish finish	*3 rd Coat: Satin, polyurethane varnish finish *4 th Coat: Satin, polyurethane varnish finish *sand between coats	--	Fill open grained wood with paste wood filler tinted to shade of wood stain prior to staining.
A-4	Interior Painted Wood	Latex	1 st coat: Alkyd enamel undercoater	2 nd Coat: Semi-gloss Latex enamel 3 rd Coat: Semi-gloss Latex enamel	--	Dry, Sanded

PART 3 – EXECUTION

3.01 COLOR CODING AND LABELING OF PIPING AND EQUIPMENT

A. Color Coding

1. Primer color shall be at least two shades lighter in color than the finish to facilitate adequate inspection of field application.
2. The following color code shall be applied for all piping exposed to view in all installations.

Aeration Air	OSHA Safety Green
Acid Drain and Vent	International Orange
Chemical Solutions	OSHA Safety Orange
Chlorine Solution & Vacuum	OSHA Safety Yellow
CONCENTRATED SLUDGE	BROWN
Potable Water	Blue
Digested Sludge	Brown
Equipment Drain	Gray
ENGINE EXHAUST	NOT COATED
Equipment Vent	Gray
Fuel Supply & Return	Black
Grit	Gray
Hot Water & Tempered Water	Blue
Instrument Air	OSHA Safety Green
Mixed Liquor	Brown
Nonpotable Water	Blue with 6-inch wide red bands at 30 inch on center
LIQUIFIED PROPANE GAS	ORANGE
Pumped Drainage	Gray
Polymer	Light Green
Pumped Sanitary Drainage	Gray
Return Activated Sludge	Brown
Raw Sewage	Gray
Roof Drain	Gray
Service Air	OSHA Safety Green
Sanitary Drain & Vent	Gray
Secondary Effluent	Light Gray
Sample	Gray
Supernatant	Brown
Sulfur Dioxide Solution & Vacuum	OSHA Safety Red
Secondary Sludge & Scum	Brown
Tank Drain	Gray
Waste Activated Sludge	Brown

B. Pipeline Identification

1. The Contractor shall furnish and apply pipeline identification labels, complete, as required by this section for new lines shown on piping drawings. Refer to related documents for symbols and label identification.
2. Size of Markers:
 - a. Markers for 3-inch OD and larger pipe (including insulation) shall be 2-inch standard label, self-sticking with numbers and letters as called for herein.
 - b. Markers for pipe under 3-inch OD (including insulation) shall be 1-inch standard label, self-sticking with numbers and letters as called for herein.
3. Application of Pipe Markers:
 - a. Apply marker at main valves to show proper identification of pipe contents.
 - b. Use an arrow marker with each pipe content marker. The arrow shall always point away from the pipe marker and in the direction of flow. If flow can be in both directions, use a double-headed arrow marker.

- c. Apply marker and arrow marker at every point of pipe entry or exit where pipe goes through wall if visible.
- d. Identify long continuous lines with pipe and arrow marker approximately every 30 feet.
- e. On horizontal pipe apply markers on the two lower quarters of the pipe where view is unobstructed. In this position, markers are read at a glance from floor level; and dust will not obscure the marker.
- f. Apply pipe marker and arrow marker on each riser and "T" joint.
- g. Provide a minimum of two markers per room, crawl space, or compartment.
- 4. References:
 - a. Brady Self-Sticking Industrial Products Catalogue, or as approved, conforming to ANSI A13.1 "Identification of Pipe Systems."
- 5. Identification Code Tabulation:
 - a. Yellow background with black letters for ANSI classified inherently hazardous materials: flammable, explosive, chemically active or toxic, extreme temperature or pressure, or radioactive.
 - b. Green background with white letters for ANSI classified inherently low hazard liquid or liquid admixture materials.
 - c. Blue background with white letters for ANSI classified inherently low hazard gas or gaseous admixture materials.
 - d. Red background with white letters for ANSI classified fire quenching materials such as water (for firefighting), foam, CO₂, halon, etc.

3.02 PROTECTION OF FINISHED WORK, EQUIPMENT AND ITEMS NOT TO BE PAINTED

- A. Protect painted areas against damage until paint system is fully cured.
- B. Protect with tarpaulin or drop cloth all floors, walls, glass, finished painted work and equipment from paint spatter or other damage that might result from this work.
- C. Remove, mask, or otherwise protect machines surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- D. Paint, varnish, and mixing cans shall not be placed on bare floors.
- E. Dirty, oily, and dusty covers shall not be used.
- F. No stains or spots shall remain after completion of painting.
- G. Remove hardware accessories, light fixtures, and similar items before painting.
 - 1. Replace above items after finish coat is applied.
 - 2. Masking may be utilized in lieu of removal of items.

3.03 APPLICATION

- A. Application may be by spraying, brushing, or rolling.
 - 1. Method used shall be one as approved by material manufacturer for any one particular product.
 - 2. Notify Engineer/Architect before proceeding as to method to be employed.
 - 3. Spraying:

- a. Care shall be taken that nozzles are as recommended by supplier for product being applied.
 - b. Air pressure recommended by product supplier shall be maintained.
- 4. Brushing:
 - a. Brush in one direction then smooth at right angles to original brushing to produce a uniform thickness of coating.
- 5. Thickness of Coating:
 - a. Where number of coats are indicated, it is intended to show the normal practice to obtain the proper dry mil thickness.
 - b. The dry mil film thickness shall be provided in all cases even though it may require more or less coatings than specified. Coating shall be applied in accordance with manufacturer's recommendations.

B. Spray Painting Out of Doors

- 1. Care should be taken that no spray falls on nearby structures.
- 2. Spraying on exterior surfaces shall be confined to quiet days when it will not affect adjacent property.
- 3. Contractor shall be responsible for any and all damage resulting from drifting spray.

C. Ventilation when painting interior surfaces of tanks, pits, vaults or other enclosures.

- 1. Contractor must provide adequate ventilation at all times.
- 2. Ventilation shall be adequate to remove fumes, preventing injury to workmen, or possibility of accumulating volatile gases.

3.04 PAINTING SCHEDULES

A. Painting and coating work shall be performed in accordance with this specification, finish schedules shown on the plans, and as specified in corresponding specification section.

B. The following surfaces shall be coated:

- 1. New exposed ductile iron, steel, or PVC (chemical piping systems) pipe.
- 2. New motors, bases, equipment, etc., Contractor to verify compatibility with factory and shop applied coatings.
- 3. New galvanized doors.
- 4. New concrete surfaces as indicated on the plans.

C. The following surfaces shall not be coated unless color coding is required by codes, unless otherwise specified, or where coating is shown on the plans:

- 1. Stainless steel.
- 2. Aluminum.
- 3. HDPE.
- 4. Shop finished enameled surfaces.
- 5. Galvanized steel.
- 6. Existing piping and appurtenances.
- 7. Existing equipment.

3.05 WASTE MANAGEMENT

A. Contractor shall remove all access materials, sand blasting debris, protection devices, and any used application equipment.

- B. General Requirements:
1. Place materials defined as hazardous or toxic waste in designated containers.
 2. Return solvent and oil soaked rags for contaminant recovery, laundering, or for proper disposal.
 3. Promptly remove all oil, paint and solvent waste rags from the site and legally dispose of them. Do not burn waste materials.
 4. Do not dispose of paints or solvents by pouring on ground. Place in designated containers for proper disposal.
- C. Containment/Disposal Requirements:
1. Surface Preparation Debris Containment:
 - a. As required by federal, state or local regulation, entire tank and structure shall be enclosed and all surface preparation debris contained.
 - b. Refer to SSPC 61 Guide for Containing Debris Generated during Paint Removal Operations.
 2. Disposal of Surface Preparation Debris:
 - a. Refer to SSPC 71 Guide for the Disposal of Lead-Contaminated Surface Preparation Debris.
 - b. Surface preparation debris shall be disposed of in compliance with applicable federal, state and local regulations.
 3. Containment/Disposal Costs:
 - a. Painter shall be responsible for costs associated with containment and waste disposal that may result from execution of this Project.

3.06 SITE VISITATION REQUIREMENTS

- A. The material supplier shall provide a technical service representative available within 48 hours' notice to assist the Engineer with any questions or concerns regarding the paint coatings. The service representative will check applied coatings for film thickness and for compatibility with specified products.

- END OF SECTION -

10

DIVISION 10

SPECIALTIES

SECTION 10 14 00

SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: Provide plastic and metal signs as indicated.
- B. Related Sections and Divisions: Applicable provisions of the General Conditions shall govern work in this section.

1.02 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 32 19, Submittals including:
 - 1. Indicate sign styles.
 - 2. Lettering font.
 - 3. Foreground and background colors.
 - 4. Locations.
 - 5. Overall dimensions of each sign.

PART 2 - PRODUCTS

2.01 CAUTION AND DANGER SIGNS

- A. Provide CAUTION and DANGER signs as listed on schedule.
- B. CAUTION signs shall be aluminum with black letters on yellow background, Brady Systems, B-120, or equal.
- C. DANGER Signs shall be aluminum with black letters and red and white Danger logo, Brady Systems, B-120, or equal.
- D. Sign sizes shall be as follows:
 - 1. A: 14-inch x 20-inch
 - 2. B: 10-inch x 14-inch
 - 3. C: 7-inch x 10-inch
 - 4. D: 3-inch x 5-inch
- E. Sign types shall be as follows:

<u>TYPE</u>	<u>MESSAGE</u>
I	"DANGER" Automatic Equipment—May Start at Any Time
II	"DANGER" 480 Volts
III	"DANGER" Non-Potable Water, Do Not Drink.
IV	"DANGER" No Smoking
V	"CAUTION" Ear Protection Require Beyond This Point
VI	"DANGER" Keep Out – Wastewater Treatment Facility—No Trespassing
VII	"DANGER" Chlorine Room—Poisonous Gas
VIII	"DANGER" Sulfonator Room—Poisonous Gas

- IX "DANGER" Lockout Power at MCC Before Working on Equipment
- X "DANGER" Confined Space. Enter by Permit Only.
- XI "DANGER" Non-Permit Confined Space. Authorized Personnel Only.
- XII "CAUTION" Check All Valves Prior to Operating

2.02 ROOM SIGNS

- A. Room signs shall be, W. H. Brady Co., B-909, or equal. Owner shall select Color.
- B. Sign shall incorporate handicap accessible symbol where applicable.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Caution and Danger Signs.
 - 1. Install signs after surfaces are finished, in locations as directed by the Engineer.
 - 2. Install signs in accordance with this specification and with manufacturer's instructions.
 - a. Interior clean, dry, flat surfaces: Mount signs using double coated foam tape.
 - b. Interior and exterior concrete and masonry surfaces: Mount signs using plastic anchors and stainless steel screws at each corner of sign. Provide plastic spacers on uneven surfaces so that sign is level and plumb.
 - c. Exterior metal surfaces: Mount signs using stainless steel self-tapping screws, one at each corner of sign.
- B. Room Signs
 - 1. Provide room signs for all areas as shown on the drawings.
 - 2. Install signs as directed by the Engineer.

3.02 SCHEDULES

- A. CAUTION and DANGER signs
 - 1. Provide signage as follows:

<u>TYPE</u>	<u>SIZE</u>	<u>LOCATION</u>	<u>QUANTITY</u>
X	C	Wet Well	1
XI	C	Valve Vault Hatch	1

- END OF SECTION -

22

DIVISION 22

PLUMBING

SECTION 22 05 05

GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: This section includes the furnishing, installation and testing of piping systems, plumbing fixtures, and trim. Piping systems shall include pipe, pipe supports, anchors, fittings, valves and other appurtenances and the installation of in-line equipment and appurtenances furnished by others for process piping systems, plumbing systems and heating, ventilating and air conditioning systems.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the general conditions shall govern the work in this section.
 - 2. Section 01 75 00 – Starting, Testing and Operator Training.
 - 3. Section 01 78 23 – Operation and Maintenance Data
 - 4. Section 09 90 00 – Painting and Special Coating
 - 5. Division 26 – Electrical
 - 6. Division 40 – Process Integration

1.02 CODES AND REGULATIONS

- A. All piping work shall conform with all Federal and State and Local Codes and regulations. If codes or regulations conflict, the most stringent regulation shall apply.

1.03 SUBMITTALS

- A. Submit shop drawings including but not limited to:
 - 1. Valves
 - 2. Floor Drains
 - 3. Piping
 - 4. Insulation
 - 5. Gauges
 - 6. Strainers
 - 7. Plumbing Fixtures
- B. Operation and maintenance manuals shall be provided in accordance with Section 01 78 23, Operation and Maintenance Data.
- C. Submit installation and training checklists in accordance with Section 01 78 43, Equipment, Installation, Training, and Receipt of Spare Parts Checklists.

1.04 CUTTING & PATCHING

- A. All cutting and patching required to install the piping work shall be the responsibility of the Contractor.
- B. No beam or other structural member may be cut without the Engineer's approval.

1.05 OPENINGS, CUTTING AND SLEEVES

- A. Sleeves shall be one inch larger than outside pipe diameter and of sufficient length to pass through entire floor or wall construction, including plaster. Sleeves shall be provided in accordance with Section 40 05 15, Methods and Materials for Pipeline Construction and the drawing details.
- B. Openings for piping in existing buildings shall be carefully drilled or cored to prevent unnecessary damage or weakening of any structural member. No structural member shall be cut without Engineer's approval. Chopping will not be permitted.
- C. Seal all openings between pipe and sleeve at each end with fiberglass and caulk opening with sealant. Provide seals at one end of sleeve passing through a fire rated wall or floor per Wisconsin Administrative Code.

1.06 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. The work shall include all required water and drain connections to heating, ventilating, and air conditioning equipment, and any Owner's equipment requiring such connections.

1.07 EQUIPMENT, INSTALLATION AND PROTECTION

- A. Erect equipment in neat workmanlike manner, align, level and adjust for satisfactory operation; install for easy maintenance, inspection, operation, and replacement.
- B. Mechanical equipment shall operate without objectionable noise or vibration. Piping shall be provided with flexible couplings to prevent noises or vibration transmission.
- C. The Contractor shall be responsible for care and protection of his work and equipment until installation is complete and accepted by the Owner.
- D. All open waste and vent piping must be capped air tight during construction to prevent foreign material from entering the sewer system or sewer gases from entering the building.

1.08 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new and of the make, type, size, and quality specified.

1.09 INSPECTION & TESTS

- A. The Contractor shall arrange for all necessary inspections and tests of piping systems as required by State and local authorities or as specified.

- B. The Contractor shall notify the Engineer when underground lines are ready for inspection and shall test all lines in the presence of the Engineer. After tests prove installation to be satisfactory, excavation may be backfilled.
- C. All labor and material for tests are the responsibility of the Contractor. All defective workmanship or equipment shall be replaced and retested at the Contractor's expense.
- D. Before testing piping systems, remove or isolate any equipment which may be damaged.
- E. Test all piping in accordance with Division 1.

1.10 CLEANING & DISINFECTION

- A. After satisfactory completion of pressure tests, before permanently connecting equipment, clean equipment thoroughly, blow and flush piping as required to remove foreign material.
- B. Disinfect all domestic water lines per the Wisconsin Administrative Code. Valve off and fill the system with a solution containing 50 PPM of chlorine and let stand for 24 hours or a solution containing 200 PPM of chlorine and let stand for 3 hours. Flush with clear water until no chlorine remains and test for bacteria. Submit report on final test indicating water sample free of bacteria.
- C. After all tests are made and the installed work found satisfactory, the contractor shall go over his work to clean all equipment, piping, conduit and leave all in a clean and complete working condition. Remove from site any and all debris that accumulated during installation of the work.
- D. All equipment specified with factory applied finish shall be wiped clean. If painted surface is scuffed or marred, touch up with paint approved for this service.

1.11 IDENTIFICATION

- A. All piping shall be painted and labeled in accordance with Section 09 90 00, Painting & Special Coatings.

1.12 VALVE TAGS

- A. On completion of the work, furnish three glazed, framed, charts for all valves.
- B. The valve identification charts shall show numbers of valve locations and purpose of valve and shall agree with valves on record drawings.
- C. Attach to each valve a tag as described below. The numbers on the tags shall run consecutively to correspond with numbers on the chart. Tags shall be designated as follows: Cold Water (CW), Hot Water (HW), Hot Water Return (HWR), Non Potable Water (NPW), etc.
- D. Tags are to be brass or approved plastic material 2 inch diameter with 3/16 inch hole and 1 inch diameter brass ring. Numerals shall be 5/8 inch high and lettering shall be 1/4 inch high. If brass tags are used, the lettering shall be black. If plastic tags are used, they shall be black and white lettering. Tags shall be fastened to valve stems with short sections of beaded or linked brass chain.

- E. The valve identification chart shall be typed. Provide copies of the valve chart in the maintenance manual.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Approved manufacturer:
 - 1. Contractor's option with Engineer's concurrence.
- B. All materials and equipment furnished shall be current production of manufacturers regularly engaged in the manufacture of such items, and for which replacement parts are available. All materials and equipment shall be new (less than 1 year old when turned over to the Owner).
- C. Piping materials for the various piping and plumbing systems shall be in accordance with Section 40 05 15, Methods and Materials for Pipeline Construction.

2.02 MANUFACTURERS

- A. Plumbing fixtures as manufactured by Kohler, American Standard, Crane, Eljer or equal.
- B. Brass products as manufactured by Engineered Brass Company, McGuire, Brasscraft, or equal.
- C. Faucets as manufactured by Chicago Faucet, Kohler Brass, Zurn Brass, Speakman Brass, or equal.
- D. Floor and wall cleanouts as manufactured by Schier, J.R. Smith, Josam, Zurn, Watts, or equal.
- E. Floor as manufactured by J.R. Smith, Josam, Zurn, Watts, or equal.
- F. Hose bibbs as manufactured by Woodford, Chicago, or equal.
- G. Emergency equipment as manufactured by Guardian, Bradley, Haws, Speakman, Encon, or equal.
- H. Insulation kits for barrier free lavatories and sinks as manufactured by Truebro, Inc., Brocar Products Inc., Pro Wrap, Insul-Guard, or equal.
- I. Water closet seats as manufactured by Bemis, Olsonite, Church or equal.

2.03 FINISHES

- A. All fixture colors to be white and finish to be chrome plated unless otherwise specified.
- B. Wall cleanouts to have flush stainless steel trim plate. Floor cleanouts to have nickel bronze covers.

2.04 PLUMBING FIXTURE LIST

- A. Water closets:
 - 1. WC-1: Kohler K-3481 Wellworth elongated toilet; Bemis 1955SS/C solid plastic seat; EBC No. CAH12X angle supply and stop with chrome plated escutcheon.

- B. Lavatories:
1. L-1: Kohler K-2196-4 Pennington lavatory; Chicago No. 802-VE2805CP faucet with No. 390 handles; Kohler K-77 15 perforated drain; EBC No. TA14O-B trap; EBC No. LA.H12K supplies with stops and chrome plated escutcheons.
- C. Emergency Eye Wash:
1. EEW/SH-I: Guardian Model GCBF19O9 barrier free emergency eye/face wash shower station; 10" diameter stainless steel shower head; 1" U.S. made stay open brass ball valve epoxy powder coated orange stainless steel triangular pull handle; 1 1/4" schedule 40 brass pipe and fittings epoxy powder coated orange with floor flange epoxy powder coated orange (4) OS style spray heads shall have integral flip top dust covers with push type brass ball valve epoxy powder coated orange; 1/4" supply connection; emergency identification sign.
- D. Hose Bibbs:
1. HB-1: Woodford #67 automatic draining hose bibb with integral vacuum breaker/backflow preventer.
 2. HB-2: Woodford #24P-3/4 hose bibb with integral vacuum breaker/backflow preventer and metal wheel handle.
- E. Sampling Tap:
1. Sampling tap shall be single sink faucet smooth end.
 2. Sampling tap shall be T&S Brass, Model B-0715, or equal.
- F. Utility Sink and Fixtures:
1. Utility sink shall be a 20-gallon single compartment sink suitable for wall mounting including brackets, constructed of molded, structural plastic as manufactured by Fiat Products, or equal.
 2. Hot and cold water sink faucet and Chicago faucets Model 1100-GN8AE3-317AB

2.05 INSULATION

- A. All domestic hot, and cold water lines shall be insulated with nominal 1/2-inch wall thickness flexible elastomeric closed cell pipe insulation, Armstrong Armaflex, or approved equal (having flame spread rating of 25 or less).

2.06 VALVES

- A. Valves shall be as specified in Section 40 05 16.61 Valves – Lift Stations.

2.07 VACUUM BREAKERS

- A. Vacuum breakers shall be atmospheric type, max. pressure 125 psi, max temp 212°F, meet ASSE Standards.
- B. Vacuum breaker shall be Appollo 30-203 for 1/2-inch and 30-204 for 3/4-inch.

2.08 GAUGES

- A. Acceptable manufacturers shall be Terice, Ashcroft or equal.

- B. Furnish and install gauges where shown on the drawings or where required to perform start-up testing.
- C. All gauges shall be mounted such that they can be read from the floor.
- D. All gauges shall have pressure ranges as shown on the drawings. If no range is shown, the normal operating pressure shall fall between 50 and 80% of the full scale.
- E. All gauges shall be combination range gauges with inner scale in psi and outer scale in feet of water.
- F. All gauges for water and wastewater applications shall be a minimum 4-inch diameter stainless steel and liquid filled.
- G. Provide each gauge with a 316 stainless steel bourdon tube and a 1/4-inch NPT bottom connection.
- H. Gauges for wastewater, sludge and chemical systems shall have factory installed diaphragm seals suitable for the application.
- I. Provide 1/4-inch ball valve for isolation of all pressure gauges and switches.

2.09 STRAINERS

- A. Acceptable manufacturers shall be Leslie Co or Bailey Co.
- B. Furnish and install strainers where shown on drawings. Size according to the drawings
- C. Unless otherwise noted provide cast iron 'Y' type strainers.
- D. Strainer shall have a bronze or carbon steel body rated for 125 psig.
- E. The strainer screen shall be 304 stainless steel or monel.
- F. The screen perforations shall be .045 inches for water service.
- G. Provide blow-off valve.

2.10 FLEXIBLE CONNECTIONS

- A. Provide twin spherical neoprene flexible connections with flange connections. Connectors shall be constructed of multiple layers of rubber and fabric reinforced with internally spirally wound tempered steel. Connectors shall be rated for 125 psig and 250°F operation. Flexible connection sizes and locations shall be as shown on the drawings.

2.11 FLOOR DRAINS

- A. Floor drains shall be Zurn, or equal, as shown on the plans and in the Plumbing Fixture Schedule.
- B. Floor drains shall have 6-inch round, adjustable strainer top.

- C. Floor drains receiving pump drainage piping shall be provided with Zurn, or equal, funnel converter assembly.
- D. Provide polished bronze top grate for all floor drains.
- E. Each drain shall be provided with a trap.

2.12 CLEAN OUTS

- A. Clean outs shall be Zurn, or equal, as shown on the plans and in the Plumbing Fixture Schedule.
- B. Each clean out shall have a dura-coated cast iron body, be adjustable to meet finished floor conditions, and be gas and watertight.
- C. Clean outs that are in elevated floors shall include a membrane flashing flange to prevent leakage to the lower floor.
- D. Provide brass covers for clean outs.

2.13 HANGERS AND SUPPORTS

- A. Hangers and supports shall be provided in accordance with Section 40 05 15, Methods and Materials for Process Piping Installation: Exposed.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Unless otherwise specified, installation of piping shall be in accordance with Section 40 05 15, Methods and Materials for Process Piping Installation.
- B. The plumbing system shall be installed with hangers and supports in accordance with the Plumbing Code. Insulation saddles shall be used at supports of insulated piping.
- C. The plumbing system shall be installed in accordance with local plumbing requirements and applicable portions of Chapter SPS 382 of the Wisconsin Administrative Code. Where requirements conflict, the stricter standard shall apply.

3.02 FIELD QUALITY CONTROL

- A. Unless otherwise specified, testing shall be in accordance with Section 40 05 15, Methods and Materials for Process Piping Installation.
- B. Building drainage systems shall be tested and inspected in accordance with local requirements and Chapter SPS 382 of the Wisconsin Administrative Code hereinafter called Plumbing code

3.03 FIELD MEASUREMENTS

- A. Field verify all measurements. Do not base on contract drawings.

- B. Identify conflicts with the work of other trades prior to installation of work.
- C. Adjust system to satisfy field requirements.

3.04 DELIVERY, STORAGE AND HANDLING

- A. Receive, sign for and store all equipment in this section.
- B. Maintain original quality and condition of equipment while it is in storage.

3.05 INSTALLATION

A. Floor Drains

1. Drains shall have "P" trap same size as drain. Set top perfectly level and at height to allow proper pitch of floors toward drain as scheduled on the drawing.
2. Provide safin material conforming to SPS 384.30(6) extending a minimum 12 inches beyond drain at all floor drains over excavated areas.

B. Plumbing Fixtures

1. Roughing-In Dimensions - Install the fixtures to the roughing-in dimensions shown on the architectural plans.

C. Water Closets

1. Mounting: Closet bowl to be solidly fastened to closet carrier or floor flange by brass bolts with stainless steel caps. Closet bowl to have solid bearing on wall or floor. The closet bowl shall be thoroughly checked for level and for secure and substantial connection to the closet carrier or floor flange.
2. Seal: Seal between closet bowl and closet carrier or floor flange to be made with molded wax ring gasket to ensure absolute gas and watertight seal.
3. Water Connection: The water connection shall be made to the water closet with trim as specified. All exposed brass shall be chrome plated, and pipes to wall or floors shall be covered with chrome plated escutcheon plates and cover tube to fit pipe.

D. Lavatories And Sinks

1. Waste Connection - Waste connection to be made with heavy chromium plated swing joint "P" traps. The "P" trap shall have standard iron pipe threads for connection to the building drainage system and slip joint with preformed neoprene or plastic gasket for connection to P.O. plug in lavatory.
2. Escutcheon plates and cover tube of the proper size shall be installed between trap and wall.
3. Water Connection - The water connection shall be made to the lavatory with trim as specified. Rough-in all supply pipe stubs so that supply pipes to lavatory will run in a straight, vertical line from stops to faucets.
4. All exposed pipe to walls or floors shall be chromium plated and have escutcheon plates.

E. General

1. All fixtures shall be set in a true and level manner with connection to soil, waste, vent, and water supply pipes. Adjust all valves, pack all stuffing boxes and leave work in a finished, clean and satisfactory working condition.

2. Protect all fixtures after they are set. This Division of the Work is responsible for them until the acceptance of the work, at which time all fixtures shall be in perfect condition and complete working order. Strictly advise all other Divisions to refrain from using toilets, especially before water connections have been made.
3. All bolting and fastening to walls, etc., must be with through type toggles and washer bolting. No screw and plug or expansion shield fastenings will be accepted. All fixture fastenings shall be made with steel bar supports and plates or other approved method.
4. At all wall hung lavatories and electric water coolers, Contractor must install thru going bolts in hole provided in bottom rear drapery to prevent lifting of front rim.
5. Seal all openings between floors, walls and fixtures with a mildew-resistant silicone sealant. Sealant shall be white for white fixtures and clear for colored fixtures.
6. Wall mounted fixtures shall be rigidly supported by a concealed hanger which is attached to structural members so that the load is not transmitted to the fixture drain connection or any other part of the plumbing system.
7. All countertop stainless steel sinks shall be set in a silicone caulk.

F. Barrier Free Requirements

1. All barrier free requirements shall comply with ICC/ANSI A 117.1 requirements and Wisconsin Building Code requirements.
2. Water Closets: The height of barrier free water closets shall be 17" to 19" to the top of the toilet seat from finished floor. Flush controls shall be hand operated or automatic and shall be mounted on the wide side of the toilet area no more than 30" above the floor.
3. Lavatories: Lavatories shall be mounted with the rim or counter surface no higher than 34" above finished floor and shall have a 29" clearance between finished floor and the bottom of the apron. Hot water and drain pipes under lavatories shall be insulated or otherwise configured to protect against contact and there shall be no sharp or abrasive surfaces under lavatories. Faucets shall have lever-operated, pushtype or sensor type controls and shall remain open at least 10 seconds.

3.06 OWNER TRAINING

- A. Provide minimum of one hour training on equipment operation.

- END OF SECTION -

26

DIVISION 26

ELECTRICAL

SECTION 26 05 00 COMMON WORK RESULTS

The electrical work included in all other divisions is the responsibility of the contractor performing the division 26 work unless noted otherwise.

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes basic electrical requirements, which are applicable to all Division 26 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

1. ANSI American National Standards Institute
2. ASTM American Society for Testing and Materials
3. EPA Environmental Protection Agency
4. ETL Electrical Testing Laboratories, Inc.
5. IEEE Institute of Electrical and Electronics Engineers
6. IES Illuminating Engineering Society
7. ISA Instrument Society of America
8. NBS National Bureau of Standards
9. NEC National Electric Code
10. NEMA National Electrical Manufacturers Association
11. NESC National Electrical Safety Code
12. NFPA National Fire Protection Association
13. UL Underwriters Laboratories Inc.
14. DSPS Wisconsin Department of Safety and Professional Services

1.04 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code (SPS 316), the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).
- B. All Division 26 work shall be done under the direction of a currently licensed State of Wisconsin Master Electrician, or as otherwise allowed by DSPS regulations.

1.05 QUALITY ASSURANCE

- A. Manufacturer references (including firms named for systems integration and electrical studies) used in Division 26 shall dictate products/firms to be used unless an alternate has been formally approved by Engineer.
- B. Requests for approval to use an alternate item may be made after the bid. Request must include the following:
 - 1. Reason for substitution (i.e. cost, availability/lead-time, suitability, etc.). If reason is lower cost, include the dollar amount of deduct that will be provided to Owner if substitution is approved.
 - 2. List exceptions to the technical specifications that would be required for the substitution.
 - 3. Provide Manufacturer Data including model number and data sheets for proposed equipment substitutions.
- C. Where approved alternate equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space, and for obtaining the performance from the system into which these items are placed.
- D. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a item, then other national independent testing standards, if available, applicable, and approved by Engineer, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.

1.06 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the Owner and by the Engineer's Project Representative. Any outage must be scheduled when the interruption causes the least interference with normal operations. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- B. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible. Note that operations are required seven days a week.

1.07 PROTECTION OF FINISHED SURFACES

- A. Furnish one can of touch-up paint for each different color factory finish furnished by the Contractor. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

1.08 APPROVED ELECTRICAL TESTING LABORATORIES

- A. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - 1. Underwriters Laboratories Inc.
 - 2. Electrical Testing Laboratories, Inc.

1.09 SEALING AND FIRE STOPPING

- A. Sealing and fire stopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with applicable codes and related sections of this specification.

1.10 INTENT

- A. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- B. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits the Engineer's intent (as determined by the Engineer). Refer to the General Conditions of the Contract for further clarification.
- C. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Owner's and/or Engineer's inspections, tests and approval from the commencement until the acceptance of the completed work.
- E. Whenever a manufacturer's product is named, it shall be used, unless an alternate has been formally approved by Engineer.

1.11 OMISSIONS

- A. No later than seven (7) days before bid opening, the Contractor shall call the attention of the Engineer to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.12 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Where multiple sections apply to a submittal for a system (e.g. control panel includes enclosure, PLC's, etc.) indicate applicable specification sections on component data sheets within the submittal. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.

- C. On request from the Engineer, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
- D. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
- E. The submittals must be approved before fabrication is authorized.
- F. Submittals shall be provided in electronic (PDF) format. Files shall be neatly organized and include:
 - 1. Cover sheet with index, date, and revision number
 - 2. Identifying Tag Numbers for Instruments and Equipment Items
 - 3. Manufacturer's Data Sheet for standard equipment items

1.13 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on drawings, unless prevented by project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of Engineer before proceeding.

1.14 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Electrical details on drawings for equipment to be provided by others are based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

1.15 OFFSITE STORAGE

- A. Prior approval by Owner and Engineer will be needed. The contractor shall submit requests for consideration of off-site materials storage. In general, building wire, conduit, fittings and similar rough-in material will not be accepted for off-site storage. No material will be accepted for off-site storage unless shop drawings for the material have been approved.

1.16 SALVAGE MATERIALS

- A. No materials removed from this project shall be reused unless specifically noted otherwise. All materials requiring removal shall become the property of and shall be disposed of by the Contractor.

1.17 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 23 – Operation and Maintenance Data.

- B. In addition to the general content specified under 01 78 23 – Operation and Maintenance Data, supply the following additional documentation:
1. Manufacturer's wiring diagrams for electrically powered equipment.
 2. Complete Bill-Of-Materials
 3. Manufacturer's O&M manuals for all equipment.

1.18 RECORD DRAWINGS

- A. The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.
- B. The Engineer will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items.
- C. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.
- D. At completion of the project, the Contractor shall submit the marked-up record drawings to the Engineer prior to final payment.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

- A. See Electrical section 26 05 53 – Identification for Electrical Systems.

2.02 SEALING AND FIRE STOPPING

- A. Fire and/or smoke rated penetrations:
1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with applicable codes and related sections of this specification.
- B. Non-rated penetrations:
1. Conduit Penetrations Below Grade:
 - a. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or water-stop type wall sleeve.
 2. Conduit and Cable Tray Penetrations Above Grade:
 - a. At through-wall conduit and cable tray penetrations of non-rated interior and exterior walls, and floors, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 - EXECUTION

3.01 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work to accomplish indicated electrical systems installation unless noted otherwise.

3.02 CONCRETE WORK

- A. The Division 3 Contractor will perform all cast-in-place concrete unless noted otherwise elsewhere. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

3.03 CUTTING AND PATCHING

- A. Refer to Division 1, General Requirements, Cutting and Patching.

3.04 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.

3.05 COORDINATION

- A. The Contractor shall cooperate with other trades and Engineer in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost. The Contractor shall check location of electrical outlets with respect to other installations before installing.
- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
- C. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

3.06 SLEEVES AND OPENINGS

- A. Conduit penetrations in new poured concrete horizontal construction requiring F and T rating: Form opening using hole form or core drill opening. Alternatively provide cast in place fire stopping devices/sleeves.
- B. Conduit penetrations in new poured concrete horizontal construction requiring F rating but no T rating: Same as conduit penetrations in new poured concrete construction requiring F and T ratings except that schedule 40 steel pipe sleeves may also be used.
- C. Conduit penetrations in new poured concrete horizontal construction that do not require F or T ratings: Provide schedule 40 steel pipe sleeve, form opening using hole form or core drill opening.
- D. Conduit penetrations in existing concrete floors: Core drill openings.

- E. Where penetrating conduit weight is supported by floor, provide manufactured product or structural bearing collar designed to carry load.

3.07 SEALING AND FIRE STOPPING

A. Fire and/or smoke rated penetrations:

- 1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 84 00 Fire Stopping.

B. Non-rated penetrations:

- 1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions. Install so that the bolts used to tighten the seal are accessible from the interior of the building or vault.
- 2. At all interior and exterior walls, through-wall conduit penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the sleeve or cored opening and the conduit is completely blocked.

C. Penetrations subject to water intrusion:

- 1. For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:
 - a. Conduit penetration where steel pipe sleeve is used extend steel sleeve 2" above the floor.
 - b. Conduit penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2" above the floor (provided it meets the device's UL listing).
 - c. Conduit penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2"x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8" on center. Seal corners water tight with urethane caulk.

3.08 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

- END OF SECTION -

SECTION 26 05 02

UTILITY SERVICES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

1.02 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards:
 - a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto, Current Edition.
 2. National Electrical Contractors Association (NECA), Standard of Installation, Current Edition.
 3. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
 4. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition.

1.03 DESCRIPTION OF WORK

- A. Provide and install complete and operable utility services as required on the drawings and as specified herein.

1.04 UTILITY SERVICES

- A. Payment of Utility Company charges for service will be paid by an allowance of \$5000 which will be adjusted up or down by a change order to the Contract to reflect actual utility company invoices. Contractor handling charges, overhead, and mark-up shall be included in the base bid and are not included under this allowance.
- B. Arrange with Electric Utility for permanent electric service.
1. Electric Service:
 - a. Utility Company: Wisconsin Public Service Corp..

1.05 RELATED WORK ELSEWHERE - NOT USED

1.06 SHOP DRAWINGS

- A. Submit shop drawings in accordance with the requirements of Division 01.
- B. The following information shall be submitted specifically for utility services:
 - 1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
 - 2. Documentation required by utility company for approval.

1.07 FACTORY TESTING - NOT USED

1.08 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS - NOT USED

1.09 QUALITY ASSURANCE

- A. Service entrance and metering equipment provided under this section shall be UL Listed for the service intended and shall be approved by the utility company.
- B. All materials, equipment, and parts shall be new and unused of current manufacture.
- C. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

PART 2 PRODUCTS - NOT USED

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

- A. The Contractor shall be responsible for coordinating conductor marking and color coding requirements with control system equipment supplier(s).

3.02 FIELD MEASUREMENTS

- A. Verify existing conditions and dimensions.
- B. Verify that service equipment is ready to be connected and energized.
- C. Make arrangements with utility company and obtain required inspections before energizing service(s).
- D. Coordinate location of utility company facilities to ensure proper access is available.

3.03 DELIVERY, STORAGE, AND HANDLING - NOT USED

3.04 INSTALLATION

- A. Install service entrance conduit and conductors in accordance with utility company instructions.
- B. Install metering equipment in accordance with utility company instructions.

END OF SECTION

SECTION 26 05 04
CLEANING, INSPECTION, AND TESTING

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes the required cleaning, inspection, adjustment, maintenance and testing of electrical equipment, as specified herein. This applies to new electrical and existing electrical equipment being furnished, modified, worked on or serviced by this contractor for this project.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

PART 2 - PRODUCTS

2.01 NOT USED.

PART 3 - EXECUTION

3.01 GENERAL INSPECTION AND CLEANING OF ALL ELECTRICAL EQUIPMENT

- A. Inspect for physical damage and abnormal mechanical and electrical conditions.
- B. Any item found to be out of tolerance, or in any other way defective as a result of the required inspection or testing, shall be reported to the Engineer. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.
- C. Compare equipment nameplate information with the latest single line diagram and report any discrepancies.
- D. Verify proper auxiliary device operation and indicators.
- E. Check tightness of accessible bolted electrical joints. Use torque wrench method.
- F. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.
- G. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.
- H. Clean All Equipment:
 - 1. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, bus ducts, MCC's, fire alarm panels, communication/data panels, security panels, etc.
 - 2. Loosen attached particles and vacuum them away.
 - 3. Re-vacuum inside surfaces as directed by the Engineer's Construction Representative or Inspector.
- I. Inspect equipment anchorage.

- J. Inspect equipment and bus alignment.
- K. Check all heater elements for operation and control.
- L. Lubricate nonelectrical equipment per manufacturer's recommendations.

3.02 GROUNDING SYSTEMS

- A. Inspect the ground system for adequate termination at all devices.

3.03 PANELBOARDS/CONTROL PANELS

- A. Torque all the connections per the manufacturers spec. Verify phase wires, color coding, separate neutral and mechanical bonding. Verify circuit breaker operation. Verify the directory.
- B. Vacuum clean the inside of enclosure.

3.04 MOTOR STARTERS AND MOTOR CONTROL CENTERS

- A. Verify the control circuits. Confirm the fusing and the grounding of the control transformers. Torque all of the connections. Confirm the overload elements and the circuit breakers (fuse) for proper sizing. Verify all grounding. Operate and test each motor starter for proper operation.

3.05 CABLES

- A. 600 Volt cable:
 - 1. Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections.
 - 2. Check all cable connectors for tightness (with a torque wrench) and clearances. Torque test conductor terminations to manufacturer's recommendations.

3.06 LIGHT FIXTURES

- A. Check the bonding and proper lamping. Confirm operation of the fixture with the proper switch or sensor.

- END OF SECTION -

SECTION 26 05 19
LINE-VOLTAGE POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes furnishing and installing required wiring and cabling systems including pulling, terminating and splicing.
- B. This section pertains to line voltage power and control conductors for systems 600 volts and less.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- C. Section 26 05 53 – Identification for Electrical Systems.

1.03 REFERENCES

- A. SPS 316- Electrical

1.04 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Submit product data: Provide for each cable assembly type.

1.05 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required for project conditions.
- C. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.
- B. All conductors shall be copper. All ground conductors shall be copper.
- C. Aluminum conductors shall not be used.
- D. Insulation shall have a 600-volt rating.

- E. All conductors shall be stranded.
 - 1. Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device, compression plate, or must be terminated in an approved back wired method.

2.02 BUILDING WIRE

- A. Description: Single conductor insulated wire 90-degree C.
- B. Insulation: Type THHN/THWN-2, XHHW-2 insulation.

2.03 UNDERGROUND WIRE FOR EXTERIOR WORK

- A. Description:
 - 1. Stranded single or multiple conductor insulated wire, 90-degree C.
- B. Insulation:
 - 1. Type USE-2, XHHW-2, RHW-2 insulation.

2.04 WIRING CONNECTORS

- A. Split Bolt Connectors: Not acceptable.
- B. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment terminals. Not approved for splicing.
- C. Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The manufacturer's wire fill capacity must be followed. Use Silicone filled twist type spring connectors in all wet location areas.
- D. All wire connectors used in underground or exterior pull boxes or hand holes shall be gel filled twist connectors or a connector designed for damp and wet locations. Gel filled twist type connectors can be used for copper conductor sizes 6 AWG and smaller for site lighting applications. The manufacturer's wire fill capacity must be followed.
- E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector must be installed with a crimper tool listed for use with the manufacturer and type of compression connector.
- G. Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B Listed. May be used only for connection of a tap conductor in run and tap type applications when main conductor is 8 AWG and larger.

PART 3 - EXECUTION

3.01 GENERAL WIRING METHODS

- A. All wire and cable shall be installed in conduit.
- B. Do not use wire smaller than 12 AWG for power and lighting circuits.
- C. All phase, neutral and ground conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity.
- D. Ground conductor size shall be increased per NEC 250.122(B) when phase and phase/neutral conductors are increased in size.
- E. Make conductor lengths for parallel conductors equal.
- F. Splice only in junction or outlet boxes.
- G. No conductor less than 10 AWG shall be installed in exterior underground conduit.
- H. Identify all wire per section 26 05 53.
- I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

3.02 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use Listed water or silicone-based wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary. Wax based lubricants are not allowed. Pulling lubricant is not required for low friction type products where the cable manufacturer recommends that cables be pulled without lube.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.
- E. Manufacturers maximum pulling tensions shall be not be exceeded and individual pulls shall not exceed 270 degrees.

3.03 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice only in accessible junction boxes.
- B. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.
- C. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
- D. Use solderless twist type spring connectors (wire nuts) with insulating covers for wire splices and taps, 10 AWG and smaller.

- E. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the wiring.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 04.

3.05 WIRE COLOR

A. General:

1. Solid colored insulation is required for all THHN/THWN-2 wire. For other wire types use colored wire or identify wire with colored tape at all terminals, splices and boxes. Wire shall be colored as indicated below.
 2. Use black and red for single phase circuits at 120/240 volts, use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.
 3. Switch legs shall be the same color as their associated circuit.
 4. Traveler conductors run between 3 and 4 way switches shall be colored pink or purple.
 5. UL Listed Panels shall use color designations consistent with the applicable UL requirements.
- B. Neutral Conductors: White for 120/208V and 120/240V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with a different stripe.
 - C. Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.
 - D. Feeder Circuit Conductors: Each phase shall be uniquely color coded.
 - E. Ground Conductors: Green colored insulation for THHN/THWN-2 wire. For other wire types use green colored wire or identify wire with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, contractor shall provide green with yellow tracer.

- END OF SECTION -

SECTION 26 05 23
CONTROL-VOLTAGE ELECTRICAL CABLES

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes furnishing and installing cabling for remote-control, signaling and power-limited circuits.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 05 33 – Raceway and Boxes for Electrical Systems.
- C. Section 26 05 53 – Identification for Electrical Systems.

1.03 REFERENCES

- A. NFPA 70 National Electrical Code.

1.04 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Submit product data: Provide for each cable assembly type.
- C. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency.

1.05 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- C. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.
- B. All conductors shall be copper.
- C. Insulation shall have a 600-volt rating.

- D. All conductors shall be suitable for the application intended. Conductors #12 and smaller may be solid or stranded with the following requirements or exceptions:
1. All conductors terminated with crimp type devices shall be stranded.
 2. Stranded conductors shall be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors shall not be wrapped around a terminal screw but shall be terminated with a crimp type device or in an approved back wired method.

2.02 REMOTE-CONTROL AND SIGNALING CABLE

- A. All other systems cabling shall meet the requirements of NEC Article 725 and the following:
1. Cable for Class 1 Remote-Control, Signaling and Power-Limited Circuits: 600-volt insulation and covered with an overall PVC jacket. Cable shall be Listed, temperature rated, and suitable Type (general purpose, riser or plenum) for the application as required in the National Electrical Code.
 2. Cable for Class 2 or Class 3 Remote-Control, Signaling and Power-Limited Circuits shall be Listed, temperature rated, and suitable Type (general purpose, riser or plenum) for the application as required in the National Electrical Code.
 3. Cable for control-voltage PLC I/O shall include shield and drain wire for each pair, and jacket shall be 600V rated.

2.03 WIRING CONNECTORS

- A. Split Bolt Connectors: Not acceptable.
- B. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- C. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.

PART 3 - EXECUTION

3.01 GENERAL WIRING METHODS

- A. Control-voltage cables shall be installed in conduit. However, they may be installed free-air (without conduit) above accessible ceilings if the cable meets NEC requirements for the application, unless specified to be in conduit in other sections of the specifications. See requirements for free-air cable installation below.
- B. Control cables for controlling HVAC and lighting equipment connected to emergency power shall be routed in raceway.
- C. Do not use wire smaller than 14 AWG for control wiring greater than 60 volts, or 18 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.
- D. Splice only in junction boxes.
- E. Identify wire per section 26 05 53.
- F. Neatly train and lace wiring inside boxes, and equipment.

- G. For control-voltage PLC I/O ground shields at one end only (at PLC panel end), unless specifically noted otherwise.

3.02 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling conditions when necessary.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

3.03 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice only in accessible junction boxes.
- B. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
- C. Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.
- D. Thoroughly clean wires before installing lugs and connectors.
- E. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.04 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 04.

- END OF SECTION -

SECTION 26 05 26 GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes grounding electrodes and conductors, equipment grounding conductors, and bonding for Electrical and Communications systems.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 REFERENCES

- A. ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems
- B. UL 467 Electrical Grounding and Bonding Equipment
- C. IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding

1.04 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance:
 - 1. Equipment Rated 500 KVA and Less: 10 ohms maximum at building service entrance.
 - 2. Equipment Rated 500 to 1000 KVA: 5 ohms maximum at building service entrance.
 - 3. Equipment Rated more than 1000 KVA: 3 ohms building service entrance.
- B. Testing of grounding system resistance is to be witnessed by the Engineer's Electrical Inspector or Construction Representative.
- C. Provide test report of grounding system overall resistance and resistance of each electrode in final O&M manuals and noted on record documents.

1.05 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Product Data: Provide data for grounding electrodes and connections.
- C. Provide samples of ground labels.
- D. Test Reports: Indicate overall resistance to ground [and resistance of each electrode].
- E. Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

1.06 PROJECT RECORD DOCUMENTS

- A. Record locations of all electrical and telecommunications grounding electrodes, busbars and grounding conductors as installed including recorded ground resistance test results.

1.07 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.01 ROD ELECTRODE

- A. Material: Copper clad steel.
- B. Diameter: 3/4-inch (19 mm) minimum.
- C. Length: 10 feet (3.5 m) minimum. Rod shall be driven at least 9' 6" deep.

2.02 MECHANICAL CONNECTORS

- A. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be two-hole, two bolt type.
- B. Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.
- C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.03 COMPRESSION CONNECTORS

- A. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
- B. Each connector shall be factory filled with an oxide-inhibiting compound.
- C. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
- D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
- E. The installation of the connectors shall be made with a compression tool and die system, as recommended by the manufacturer of the connectors, and shall be irreversible.
- F. Pre-crimping of the ground rod is required for all irreversible compression connections to a ground rod.
- G. Terminal lug for communication system grounding shall be compression type and conform to the following:

1. Material: Tin Plated Copper (aluminum not permitted).
2. Wire Size: to match conductor
3. Number of Stud Holes: 2
4. Stud Hole Size: 3/8"
5. Bolt Hole Spacing: per TIA-607-C
6. Tongue Angle: Straight

2.04 EXOTHERMIC CONNECTIONS

- A. As manufactured by Erico Cadweld, Harger Ultraweld or similar.

2.05 CONDUCTORS

- A. Material: Stranded copper (aluminum not permitted).
- B. Grounding Electrode Conductor: Bare seven-strand conductors. Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.
- C. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used at the same facility.
- D. Branch Circuit Equipment Ground shall be proportionately increased in size when routed with phase conductors increased in size.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 GENERAL

- A. Install Products in accordance with manufacturer's instructions.
- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned, and all connections shall be made so that it is impossible to move them. Attach grounds permanently before permanent building service is energized.
- D. All grounding conductor connections to Busbars shall be via two-hole lugs.
- E. Terminate each grounding conductor on its own terminal lug. Sharing a single lug by multiple conductors is not allowed.
- F. All grounding electrode conductors and individual grounding conductors shall be installed in PVC conduit, in exposed locations.
- G. Each grounding electrode conductor shall be labeled at each terminated end as to system served and location of second termination.

3.03 LESS THAN 600 VOLT ELECTRICAL SYSTEM GROUNDING

- A. Supplementary Grounding Electrode: Use driven ground rod on exterior of building
- B. Provide code sized copper grounding electrode conductor from electrical room ground bus to secondary switchboard ground bus, each separately derived system neutral, secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes. Provide bonding jumper around water meter. Provide physical protection as required.
- C. Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.
- D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.04 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Testing of grounding system resistance is to be witnessed by the Engineer's Electrical Inspector or Construction Representative. Provide test report of grounding system resistance in final O&M manuals and noted on record drawings.

3.05 IDENTIFICATION AND LABELING

- A. Label Grounds at point of termination.
- B. Provide additional labeling of each individual terminated ground conductor at bus bar identifying installed source per NEC 250.52 A 1-7.
- C. Record locations of all electrical grounding electrodes, busbars and grounding conductors as installed including recorded ground resistance test results.

3.06 WARRANTY

- A. See Division 1, General Conditions, and General Requirements.

- END OF SECTION -

SECTION 26 05 29 HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes conduit and equipment supports, straps, clamps, steel channel, etc., and fastening hardware for supporting electrical work.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 05 53 – Identification for Electrical Systems

1.03 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Product Data: Provide data for support channel.

1.04 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.01 SUPPORT CHANNEL

- A. Stainless Steel
 - 1. In all areas, all strut, fittings and related hardware shall be made of AISI Type 316 stainless steel.

2.02 CONDUIT SUPPORTS

- A. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. In wet well all supports shall be stainless steel.
- B. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when rigid steel conduit is installed on the interior or exterior surface of any exterior building wall.
- C. Stud wall applications: Spring Steel Clips with Push-in or Snap-Close Conduit Clamps (Conduit Supports): Conduit clamps shall pivot a full 360 degrees. Spring clips shall require a fastener to install onto stud.
- D. Spring Steel Clip products shall be provided with corrosion resistance and be warranted against failure from corrosion for a period of ten (10) years from date of manufacture.

2.03 THREADED ROD

- A. Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and 1/4" for single conduits 1" and smaller.
- B. Threaded rod shall be stainless steel.

2.04 HARDWARE

- A. Corrosion resistant, or as noted for each product above.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet-, junction-, and pull-boxes to building structure using pre-cast insert system, preset inserts, beam clamps, or expansion anchors.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable type anchors.
- C. Powder-actuated fasteners are not permitted.
- D. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not fasten to suspended ceiling grid system.
- E. Do not drill structural steel members unless approved by Engineer.
- F. Install surface-mounted cabinets and panelboards with a minimum of four anchors. At all cabinet and panelboard locations on concrete or concrete block walls, and at ALL locations below grade, provide stainless steel channel supports to stand cabinet one inch off wall (7/8" Uni-strut is acceptable). In above-grade equipment rooms that have drywall walls, the cabinets and panelboards may be mounted to the drywall if backing is provided in the stud walls behind the equipment.
- G. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- H. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

- END OF SECTION -

SECTION 26 05 33 RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 SCOPE

- A. This section describes the products and execution requirements relating to furnishing and installing raceways and boxes and related systems as part of a raceway system for electrical, communications, and other low-voltage systems for the project.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 26 05 26 – Grounding and Bonding for Electrical Systems
- C. Section 26 05 29 – Hangers and Supports for Electrical Systems.
- D. Section 26 27 02 – Equipment Wiring Systems.
- E. Section 26 27 26 – Wiring Devices.

1.03 REFERENCES

- A. Wisconsin Administrative Code SPS 316 - Electrical

1.04 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All steel fittings and conduit bodies shall be galvanized.
- B. All conduit transitional fittings shall be listed for installed application.
- C. No cast metal or split-gland type fittings permitted.
- D. All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.
- E. Mogul-type conduits 2 inch and larger, shall be permitted.
- F. C-conduits shall not be used in lieu of pull boxes.

- G. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

2.02 RIGID METAL CONDUIT (RMC) AND FITTINGS

- A. Conduit: Heavy wall threaded, galvanized steel.
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.
- C. Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

2.03 PVC COATED RIGID METAL CONDUIT

- A. PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.
- B. Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

2.03 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

- A. Conduit: Rigid non-metallic conduit, Schedule 80 PVC minimum, Listed, sunlight resistant, rated for 900 C conductors.
- B. Fittings and Conduit Bodies: NEMA TC 2, Listed.

2.04 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. IMC is NOT allowed.

2.05 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Conduit: Steel, Unthreaded thin wall galvanized tubing.
- B. Fittings: All steel, compression or set screw type. No push-on or indenter types permitted.
- C. Transitional fitting: ½-1": All steel and malleable iron; 1 ¼" and above: All steel, Malleable iron. Die cast fittings shall not be used.
- D. Conduit Bodies: All steel conduit bodies.

2.06 FLEXIBLE METAL CONDUIT (FMC) AND FITTINGS

- A. Conduit: steel, galvanized, spiral strip.
- B. Fittings and Conduit Bodies: All steel, galvanized or malleable iron (except as allowed in specification 26 51 13).

2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) AND FITTINGS

- A. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.08 CONDUIT SUPPORTS

- A. See section 26 05 29.

2.09 CONDUIT WATER SEALANT

- A. Description: Conduit sealant used to prevent water from entering buildings via conduits.
- B. Sealant shall seal conduits against water and gas intrusion, such as Polywater® FST™-250 Foam Duct Sealant, Raychem RDSS Rayflate Duct Sealing System, or approved alternate. Sealant shall be re-enterable, shall be compatible with the conduit and conductor types being used, and shall comply with NEC 225.27, 230.8, and 300.5(G).

2.10 PULL AND JUNCTION BOXES

- A. Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot-welded joints and corners.
- B. Interior Sheet Metal Boxes larger than 12 inches in any dimension shall have a hinged cover or a chain installed between box and cover. Boxes 9 square-feet or larger shall have hinged covers and a single cover shall not exceed 10 square-feet.
- C. Interior Sheet Metal Boxes connected to an exterior underground raceway, shall have a drain fitting located in the bottom.
- D. Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat flanged, surface mounted junction box, UL listed as rain-tight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless-steel cover screws.
- E. Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.
- F. Junction boxes 6-inch by 6-inch or larger size shall be without stamped knock-outs.
- G. Wireways shall not be used in lieu of junction boxes.

2.11 IN GRADE HANDHOLES AND BOXES

- A. Handholes and boxes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
- B. Handholes and covers shall be listed for the structural load at the identified installation location.
- C. Covers: Weatherproof, secured by tamper-resistant locking devices with non-skid finish and labeled "ELECTRIC", "SIGNAL", "CATV" OR "TELEPHONE" dependent on system served.

D. Units shall be designed to prevent frost heaving.

2.12 OUTLET BOXES

A. Sheet Metal Outlet Boxes: Welded, galvanized steel, with stamped knockouts.

B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8-inch male fixture studs where required.

C. Cast Boxes: Cast ferroalloy or aluminum, deep type, gasketed cover, threaded hubs.

PART 3 - EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

A. See CONDUIT INSTALLATION SCHEDULE below for limitations on various types of conduit are allowed.

B. Size power conductor raceways for conductor type installed. Conduit size shall be 3/4 inch, or as specified elsewhere. Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.

C. Size communications and other low-voltage systems raceways as follows:

1. Control, security, signal, video, and other low-voltage applications: 3/4 inch minimum.

D. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

E. Maintain minimum 6-inch clearance between conduit and piping. Maintain 12-inch clearance between conduit and heat sources such as flues and heating appliances.

F. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

G. Group conduit in parallel runs where practical and use conduit rack (lay in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

H. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.

I. Support and fasten metal conduit at a maximum of 8 feet on center.

J. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

K. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

3.02 CONDUIT INSTALLATION

- A. Cut conduit square; de-burr cut ends.
- B. Conduit shall not be fastened to the corrugated metal roof deck.
- C. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- D. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.
- E. Threads to be coated with approved electrically conductive corrosion compound per NEC 300.6. Coating to be listed for installed environment, i.e. food service.
- F. Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or connectors with one locknut, or utilize double locknuts (one each side of box wall).
- G. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.
- H. Provide insulated bushings where raceways contain 4 AWG or larger conductors.
- I. Use pendants supported from swivel hangers in exposed ceiling/ structure locations where necessary to mount boxes supporting luminaires and wiring devices. Installation method shall comply with NEC 314.23 (H).
- J. Install no more than the equivalent of the following for building:
 - 1. Three 90-degree bends between boxes for electrical systems.
 - 2. Two 90-degree bends between boxes for communications and other low voltage systems. Note: Offsets shall be considered 90 degrees.
 - 3. No single bend may exceed 90 degrees.
- K. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2-inch size unless sweep elbows are required.
- L. Bend conduit according to manufacturer's recommendations. Torches or open flame shall not be used to aid in bending of PVC conduit.
- M. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
- N. Provide 1/8-inch nylon pull string in empty conduit, except sleeves and nipples.
- O. Install listed expansion deflection fitting or other approved means shall be used where a raceway crosses a structural joint for expansion, contraction or deflection.
- P. Install expansion joints where direct-buried conduit is subject to Earth Movement by settlement or frost per NEC 300.5(J), especially where conduit exits the ground exposed and enters a box, cabinet, or enclosure attached to a building or structure.
- Q. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

- R. Where conduit passes between areas of differing temperatures such as unheated and heated spaces provide conduit or box with duct seal or other means to prevent the passage of moisture and water vapor through the conduit.
- S. Ground and bond conduit under provisions of Section 26 05 26.
- T. Identify conduit under provisions of Section 26 05 53.
- U. All conduit installed underground (exterior to building) shall be buried a minimum of 24 inches below finished grade, whether or not the conduit is concrete encased. Install warning tape 12" below finish grade over all buried conduits. Underground warning tape shall be detectable, 2" wide minimum, 5 mil thickness, containing a foil core. Tape color shall be red and labeled with the words "CAUTION-BURIED ELECTRIC LINE BELOW" as manufactured by Presco or similar.

3.03 CONDUIT INSTALLATION SCHEDULE

- A. In interior finished spaces (offices, rest rooms, etc.) all conduits shall be concealed, and all boxes shall be flush mounted.
- B. Any outlets, switches, thermostats, etc. less than 8-foot AFF shall also be flush mounted in any interior block walls.
- C. Where flex connections are required from flush wall boxes, use a cover designed for the purpose.
- D. Use the guidelines below for other cases:
 - 1. Underground Installations: RMC
 - 2. Exposed Outdoor Locations: RMC
 - 3. Exposed Indoors: RMC
 - 4. Exposed in or connected to wet well: PVC Coated Rigid Metal
 - 5. Concealed Interior spaces (e.g. attic space): EMT
 - 6. Interior Building Grounding Electrode Conductor(s): Schedule 80 PVC.
 - 7. Motor and equipment connections: Liquid-tight flexible metal conduit (LFMC) in all locations except in plenum spaces where Flexible Metal Conduit (FMC) shall be utilized. Minimum length shall be one foot; maximum length shall be three feet. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.

3.04 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough in.
- C. No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.
- D. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.

- E. In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Engineer and install outlet as instructed by the Engineer.
- F. Determining the proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.
- G. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 by 24 access doors. Boxes must be installed within 12" from edge of the access door.
- H. Locate and install to maintain headroom and to present a neat appearance.
- I. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.
- J. Boxes installed in the building envelop shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and locations per IEC 502.4.3.

3.05 PULL AND JUNCTION BOX INSTALLATION

- A. Pull boxes and junction boxes shall be minimum 4 inches square by 2-1/8 inches deep for use with 1-inch conduit and smaller. On conduit systems using 1-1/4 inch conduit, minimum junction box size shall be 4-11/16 inches square by 2-1/8 inches deep.
- B. Where used with raceway(s) containing conductors of 4 AWG or larger, pull box shall be sized as required unless otherwise noted on the drawings.
- C. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install Engineer approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily accessible.
- D. Provide Pull and Junction boxes for communications and other low voltage applications (a) in any section of conduit longer than 100 feet, (b) where there are bends totaling more than 180 degrees between pull points or pull boxes and (c) wherever there is a reverse bend in run. Locate boxes on straight section of raceway (e.g. do not use boxes in place of raceway bends).
- E. Support pull and junction boxes independent of conduit.

3.06 OUTLET BOX INSTALLATION

- A. Do not install boxes back to back in walls. Provide minimum 6-inch separation.
- B. Power:
 - 1. Recessed (1/4-inch maximum) outlet boxes in masonry, concrete, tile construction, or drywall shall be minimum 4-inch square, with device rings. Device covers shall be square cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes. A single gang box can be used in drywall and masonry, for a single device location, when a single conduit enters box.
 - 2. Shallow 4-inch square by 1 1/2-inch-deep boxes can be used as device boxes for power provided the box and plaster ring is sized for installed device and conductors.

- C. Provide knockout closures for unused openings.
- D. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches of box.
- E. Use multiple gang boxes where more than one device are mounted together; do not use sectional boxes. Provide non-metallic barriers to separate wiring of different voltage systems.
- F. Install boxes in walls without damaging wall insulation.
- G. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- H. Ceiling outlets shall be 4-inch square, minimum 2-1/8-inch-deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.
- I. Align wall mounted outlet boxes for switches, thermostats, and similar devices.
- J. Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.

- END OF SECTION -

SECTION 26 05 34

CONDUIT

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

1.02 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - a. ANSI C80.1 - Electrical Rigid Steel Conduit (ERSC).
 - b. ANSI C80.3 - Steel Electrical Metallic Tubing (EMT).
 - c. ANSI C80.5 - Electrical Rigid Aluminum Conduit (ERAC).
 - d. NFPA 70 - National Electrical Code.
 2. American Society for Testing and Materials (ASTM), Specifications and Standards, current edition:
 - a. ASTM F2160 - Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter.
 - b. ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
 - c. ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
 - d. ASTM D3350 - Polyethylene Plastics Pipe and Fittings Materials.
 3. National Electrical Contractors Association (NECA), current edition.
 - a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
 - b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
 4. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
 - a. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association.
 - b. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association.
 - c. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit; National Electrical Manufacturers Association.
 - d. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association.
 - e. NEMA TC 7 - Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.
 5. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition.
 - a. UL 1 - Standard for Flexible Metal Conduit
 - b. UL 6 - Electrical Rigid Metal Conduit - Steel.
 - c. UL 6A - Standard for Electrical Rigid Metal Conduit - Aluminum and Stainless Steel.

- d. UL 651A Type EB and A Rigid PVC Conduit and HDPE conduit.
- e. UL 651B Continuous Length HDPE.
- f. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit.
- g. UL 2239 - Standard for Safety for Hardware for the Support of Conduit, Tubing, and Cable.

1.03 DESCRIPTION OF WORK

- A. Furnish and install complete and operable conduit system as indicated on the drawings, scheduled in Section 26 05 00, and as specified herein.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Division 01.
- B. Submit the following information specifically for conduit:
 - 1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
 - 2. Clearly identify the types of conduit and fittings proposed.

1.05 FACTORY TESTING - NOT USED

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS- NOT USED

1.07 QUALITY ASSURANCE

- A. All materials, equipment, and parts shall be new and unused of current manufacture.
- B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.08 WARRANTY

- A. See Division 01 for additional requirements.

1.09 EXTRA MATERIALS

- A. See Division 01 for additional requirements.

PART 2 PRODUCTS

2.01 GALVANIZED RIGID METAL CONDUIT (TYPE RMCS)

- A. Manufacturer: Contractor option.
- B. Conduit:

1. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, a defect free interior surface, and a continuous welded seam.
2. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
3. Top-coated with a compatible organic layer to inhibit white rust and increase corrosion resistance.
4. Factory cut threads, 0.75-inch taper per foot, protected after cutting with an application of molten zinc.

C. Conduit Bodies:

1. Ferrous metal construction electro-galvanized inside and out and coated with aluminum acrylic paint.
2. Tapered, threaded hubs with integral bushing.
3. Stainless steel hardware.
4. Cover constructed of same material with solid gasket.

D. Fittings:

1. Ferrous metal construction electro-galvanized inside and out.
2. Components critical to performance such as set screws, split rings, and locknuts constructed of hardened steel or adequately designed to insure positive bonds.

2.02 RIGID NON-METALLIC CONDUIT (TYPE RNC)

A. Manufacturer:

1. Carlon.
2. Or equal.

B. Conduit:

1. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
2. Rated for use with 90 degree C conductors. Material shall comply with NEMA Specification TC-2.
3. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections, which could mar conductors or cables.
4. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.
5. Schedule 80 non-metallic conduit shall be used in locations subject to physical damage. Schedule 40 non-metallic conduit may be used in all other locations.

C. Conduit Bodies:

1. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
2. Rated for use with 90 degree C conductors. Material shall comply with NEMA Specification TC-3.
3. Stainless steel hardware.
4. Cover constructed of same material with solid gasket.

D. Fittings:

1. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.

2. Rated for use with 90 degree C conductors. Material shall comply with NEMA Specification TC-3.

2.03 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (TYPE LMFC)

- A. Manufacturer: CONTRACTOR option.
- B. Usage:
 1. Use in conjunction with galvanized rigid metal conduit.
 2. Use in conjunction with PVC coated galvanized rigid metal conduit.
 3. Use in conjunction with rigid aluminum conduit.
- C. Conduit:
 1. Single strip, helically wound, galvanized steel core inside and outside with smooth interior surface with sunlight resistant thermoplastic jacket suitable for ambient environmental conditions conforming to applicable UL Standards.
 2. Jacket shall be positively locked to core to prevent sleeving.
 3. All runs of flexible conduit shall be as short as practicable, of the same size as the conduit it extends and with enough slack to reduce the effects of expansion and vibration.
- D. Fittings:
 1. Where used in conjunction with galvanized rigid metal conduit, connectors shall be malleable iron or steel, electro zinc plated, with insulated throat and taper threaded hub.
 2. Where used in conjunction with PVC coated galvanized rigid metal conduit connectors shall be malleable iron or steel, electro zinc plated and PVC coated, with insulated throat and taper threaded hub.
 3. Where used in conjunction with rigid aluminum conduit, connectors shall be aluminum, with insulated throat and taper threaded hub.
 4. Particular attention shall be given to maintaining ground bond and firm support through flexible connections.
 5. All fittings shall be liquid tight.

PART 3 CONSTRUCTION METHODS

3.01 FIELD MEASUREMENTS

- A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections. Conduit rough-in shall be based upon shop drawing requirements.
- B. The Contractor shall be responsible for coordinating conduit location and rough-in with actual equipment conditions and requirements.
- C. Field verify all measurements. Do not base conduit rough-in or equipment locations on the contract drawings.
- D. Identify conflicts with the work of other trades prior to installation of electrical equipment and conduit work.
- E. Adjust conduit system installation to satisfy field requirements.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Accept conduit on site. Inspect for damage.
- B. Protect conduit from corrosion and entrance of debris.
- C. Store conduit above grade. Protect from environment with suitable covering.
- D. Protect PVC and PVC coated conduit from sunlight.

3.03 INSTALLATION

A. General:

- 1. Install conduit in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting", all requirements of the NEC, and manufacturer recommended practices.
- 2. Arrange conduit to maintain headroom and present neat appearance.
- 3. Design raceway systems to minimize the number of fittings, couplings, kicks, and offsets.
- 4. Raceways located above lowest floor level:
 - a. Route conduit parallel and perpendicular to walls.
 - b. All raceways shall be level and straight.
 - c. Vertical conduits shall be plumb.
- 5. Raceways located in or under lowest level floor:
 - a. Route conduit in and under slab from point-to-point.
 - b. Do not cross conduits in slab.
- 6. Do not use flexible conduit in place of bends, conduit bodies, or expansion fittings.
- 7. Flexible conduit shall be used at all equipment terminations. Maximum length of 24-inches unless specifically allowed otherwise by Engineer based upon field conditions.
- 8. Do not use cords for equipment connections unless specifically allowed otherwise by Engineer based upon field conditions.

B. Raceway sizing:

- 1. Size raceways as indicated on drawings.
- 2. Where raceways sizes are not indicated on drawings, size in accordance with NEC requirements. Minimum size 3/4-inch.
- 3. Exposed conduit runs not longer than 10-feet in length and terminating at a single device may be 1/2-inch unless prohibited by NEC.

C. Raceway Installation:

- 1. Maintain adequate clearance between conduit and piping.
- 2. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
- 3. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- 4. Bring conduit to shoulder of fittings; fasten securely.
- 5. Use conduit hubs to fasten conduit to NEMA 4X and NEMA 12 boxes.
- 6. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic factory elbows for bends in metal conduit larger than 2-inch size.
- 7. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

8. Suitable pull string shall be installed in each empty conduit, sleeves and nipples excepted.
9. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
10. Remove all debris and moisture from raceways prior to installing conductors.
11. Ground and bond conduit under provisions of Section 26 05 26.
12. Identify conduit under provisions of Section 26 05 53.
13. Install plastic coated conduit in accordance with manufacturer's instructions. All 90 degree bends shall be manufactured elbows. Touch-up PVC coating after installation.
14. All field cut threads shall be coated with Thomas & Betts Kopr-Shield prior to assembly.

D. Structural Coordination:

1. Suitable fittings, designed and listed for the purpose, shall be used to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
2. Install conduit to preserve fire resistance rating of partitions and other elements.
3. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
4. Where conduit passes between areas subject to variable temperatures, seal conduits to prevent air interchange and condensation formation. Use conduit fitting specifically manufactured for this purpose.

E. Raceway Support:

1. General:
 - a. Arrange supports to prevent misalignment during wiring installation.
 - b. Do not permanently support conduit with wire or perforated pipe straps.
 - c. Remove wire used for temporary supports.
 - d. Do not attach conduit to ceiling support wires.
 - e. Channel, rod, and hardware shall comply with the requirements of Section 26 05 29.
2. Hardware:
 - a. Construct conduit support rack with channel and rod to support conduits not supported from structure.
 - b. Support conduit with channel anchored to structure when conduit offset from structure is required.
 - c. Secure conduits to channel with pipe straps.
 - d. Support conduit from structure when conduit offset from structure is not required.
 - e. Secure conduits directly to structure with one-hole strap and conduit spacer.

F. Conduit Separation:

1. Separate conduit systems shall be used for the following circuit categories:
 - a. 120-volt power circuits.
 - b. 480-volt power circuits.
 - c. 120-volt control circuits.
 - d. 24 VDC analog control circuits.
 - e. Intrinsically safe control circuits.
 - f. UTP control cables.
 - g. Manufacturer supplied cables (for example, magnetic flow meter cables).
 - h. Radio frequency coaxial cables (for example, antenna cables).
 - i. Motor feeder circuits. Install only one motor feeder per conduit.

2. The contract drawings show individual homerun equipment connections. The Contractor may combine circuits of common types (as identified above) into single conduits provided the following conditions are met:
 - a. NEC requirements for conductor de-rating are satisfied.
 - b. Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
 - c. No more than eight 24VDC analog circuits are combined in a single conduit, unless specifically stated otherwise on the drawings.

3.04 TESTING AND START-UP SERVICES - NOT USED

3.05 TRAINING - NOT USED

END OF SECTION

SECTION 26 05 53

IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes the products and execution requirements relating to the installation of labels, nameplates, and directories for electrical boxes, wiring devices, and equipment, along with the labeling of power and control wiring.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 shall govern work under this section.
- B. Section 26 05 19 – Line-Voltage Electrical Power Conductors and Cables
- C. Section 26 05 23 – Control-Voltage Electrical Cables

1.03 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Include schedule for nameplates.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.
- B. Wire Labels: All wiring labels shall be white/transparent vinyl or vinyl-cloth, self-laminating, wraparound type. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.
- C. Tape (wiring phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase. Embossed tape shall not be permitted for any application.
- D. Nameplates: Engraved multi-layer laminated plastic. Normal system shall use nameplates with black letters on white background, Emergency system (NEC 700) shall use white letters on red background, Legally Required Standby system (NEC 701) shall use white letters on blue background, and Optional Standby system (NEC 702) shall use black letters on yellow background.
- E. See Box Identification and Wiring Device Identification sections for allowed usage of permanent marker.

PART 3 - EXECUTION

3.01 GENERAL

- A. Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent. Install all labels firmly as recommended by the label manufacturer. Labels shall be installed plumb and neatly on all equipment.
- B. Install nameplates parallel to equipment lines. Secure nameplates to equipment fronts using screws, rivets or manufacturer approved adhesive or cement.
- C. Provide all warning labels to electrical equipment as required per NEC 110.16 and 110.21. Provide available fault current labeling to service equipment as required per NEC 110.24.
- D. Provide a sign at the service-entrance equipment indicating type and location of on-site emergency power sources and on-site legally required standby power sources, per NEC 700.7 and NEC 701.7.
- E. Provide a sign at each service disconnect indicating "Service Disconnect", per NEC 230.70(B).
- F. Provide permanent marking of exposed Emergency (NEC 700) cable or raceway systems, where boxes or enclosures are not encountered, per NEC 700.10(A)(2).

3.02 POWER, CONTROL AND SIGNALING WIRE IDENTIFICATION

- A. Provide wire labels on each conductor in panelboard gutters, all boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control and signaling wires.
- B. All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated, including wiring used for temporary purposes.

3.03 WIRING DEVICE IDENTIFICATION

- A. Wall switches, receptacles, occupancy sensors, photocells, poke-through fittings, access floor boxes, and time clocks shall be identified with circuit numbers and panelboard source (ex. Panel ABC-3). In exposed areas, identifications should be made inside of device covers, unless directed otherwise. Use machine-generated adhesive labels, or neatly hand-written permanent marker.

3.04 SUPPORT WIRE IDENTIFICATION

- A. Support wires that are installed in addition to the ceiling grid support wires to provide secure support for raceways, cables assemblies, boxes, cabinets, and fittings shall be distinguishable from the ceiling grid support wires per NEC 300.11(A). This identification shall be either approximately 6 inches of fluorescent orange paint, or orange tape flags 3/4 inches high-by-2 inches wide (minimum) within 12 inches of the bottom of the support wires.

3.05 ELECTRICAL EQUIPMENT IDENTIFICATION

- A. Provide nameplates of minimum letter height as scheduled below.
- B. All Panelboards (Distribution, Branch, Sub-feed, and Feed-Through), Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation (same designation used by the main distribution center). 1/2 inch (13 mm); identify voltage rating, source and room location of

the source. Panelboards serving NEC 700, 701 or 702 loads shall identify which branch they serve. Both panels in a double tub application shall be labeled.

- C. Circuit Breakers, Switches, and Motor Starters in Distribution Panelboards, Switchboards and Motor Control Centers: 1/2 inch (13 mm); identify circuit number and load served, including location.
- D. Individual Disconnect Switches, Enclosed Circuit Breakers, and Motor Starters: 1/2 inch (13 mm); identify voltage, source and load served.
- E. Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source and location, and secondary load and location.

3.06 PANELBOARD DIRECTORIES

- A. Typed directories for panelboards shall be covered with clear plastic and shall have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

- END OF SECTION -

SECTION 26 27 02 EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes electrical connections to equipment specified under other Divisions and/or Sections, or furnished by Owner, including, but not limited to:
 - 1. Pump Motors
 - 2. Misc. Equipment
 - 3. HVAC and Plumbing motors, AFDs, and panels

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 05 19 – Line-Voltage Electrical Power Conductors and Cables
- C. Section 26 05 23 – Control-Voltage Electrical Cables
- D. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.03 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Product Data: Provide data for cord and wiring devices.

1.04 COORDINATION

- A. Coordinate all equipment requirements with the various contractors and the Engineer. Review the complete set of drawings and specifications to determine the extent of wiring, starters, devices, etc., required.

PART 2 - PRODUCTS

2.01 CORDS AND CAPS

- A. Straight blade Attachment Plug: NEMA WD 1.
- B. Locking blade Attachment Plug: NEMA WD 5.
- C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
- D. Cord Construction: Oil resistant thermoset insulated multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.
- E. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

2.02 OTHER PRODUCTS

- A. Refer to related sections for other product requirements.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energizing.

3.02 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.03 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- B. Provide a green equipment ground conductor for all installed equipment wiring.
- C. Make conduit connections to equipment using flexible PVC-coated metal conduit.
- D. Furnish and install cord set with twist-lock plug, and flush mount single twist-lock receptacle for each 120VAC damper actuator, 120VAC exhaust fan, and 120VAC gas-fired unit heater. The cord and plug connections are to serve as local disconnect.
- E. Also furnish and install all raceways, boxes, and low-voltage wiring for HVAC equipment.
- F. Provide suitable strain relief clamps for cord connections to outlet boxes and equipment connection boxes.
- G. Make wiring connections in control panel or in wiring compartment of prewired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
- H. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.

3.04 HVAC AND PLUMBING CONNECTIONS

- A. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (AFDs), and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
- B. Also furnish and install all raceways, boxes, and field installed low-voltage wiring for HVAC and plumbing equipment.
- C. Contractor shall verify with mechanical contractor the electrical requirements including voltages, horsepower, disconnecting means, starters and variable frequency drives for motors and equipment prior to ordering circuit breakers, disconnects and starters.

- D. AFD Installations: Install AFD input wiring and output wiring in separate conduit systems. Do not mix AFD input power and output power, or control wiring in a common raceway.
- E. Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible PVC-coated metal conduit to a fixed junction box. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- F. Check for proper rotation of each motor.

- END OF SECTION -

SECTION 26 27 26 WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE

- A. This section describes the products and execution requirements relating to furnishing and installing wiring devices and related systems for the project.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Provide product data showing model numbers, configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

2.01 WALL SWITCHES

- A. General: Heavy duty use toggle switch, rated 20 amperes and 120/277 volts AC. Switches shall be UL20 Listed and meet Federal Specification WS-896. All switches shall be heavy duty Specification Grade.
- B. Handle: Ivory made of nylon or high impact resistant material.
- C. Wall Switches for Lighting Circuits and Motor Loads Under 1/2 HP: All switches shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with separate green ground screw. Switches shall be as follows:
 - 1. Hubbell 1221*
 - 2. or approved equal. (* indicates color selection).

2.02 RECEPTACLES

- A. General Requirements: NEMA Type 5 20R, ivory nylon or high impact resistant face. Receptacles shall be UL498 Listed and meet Federal Specification WC-596. All duplex receptacles shall be heavy duty Specification Grade, 20 amp rated.
- B. Generally, all receptacles shall be duplex convenience type unless otherwise noted.
- C. All receptacles installed in outdoor locations, pump rooms, rooftops, and in other damp or wet locations shall be GFCI type with a weather-resistant (WR) rating.
- D. Convenience and Straight blade Receptacles: All receptacles shall be back and side wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with a separate green ground screw. Receptacles shall be as follows:

1. Hubbell 5362*,
 2. or approved equal. (* indicates color selection).
- E. GFCI Receptacles: Weather-Resistant duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class-A, including self-test functionality and reverse line-load misfire function repeatability. WR GFCI receptacles shall be as follows:
1. Hubbell GFR5362SG*
 2. or approved equal. (* indicates color selection).
- F. Locking Blade Receptacles: As indicated on drawings.
- G. Specific use Receptacle Configuration: As indicated on drawings.

2.03 DEVICE PLATES AND BOX COVERS

- A. Decorative Cover Plate: 302/304 lined stainless steel.
- B. Weatherproof Cover: All receptacles installed in wet locations shall have an enclosure that is weatherproof whether or not the attachment plug is inserted. Covers shall be gasketed metal with hinged “in-use” device covers, powder coat painted. Non-metallic covers are not allowed. Covers shall be latching type and shall be lockable. Covers shall be identified as “extra-duty” type per NEC 406.9(B)(1).
- C. Damp Location Cover: All receptacles installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure that is weatherproof when the receptacle is covered (attachment plug not inserted and receptacle covers closed). Covers shall be gasketed metal with hinged device covers, powder coat painted. Non-metallic covers are not allowed.
- D. Surface Cover Plate: Raised galvanized steel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install wall switches with OFF position down.
- B. Install specific use receptacles at heights shown on Contract Drawings.
- C. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- D. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- E. Install devices and wall plates flush and level.
- F. Receptacles shall have a bonding conductor from grounding terminal to the metal conduit system. Self-grounding receptacles using mounting screws as bonding means are not approved.

3.02 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch and sensor with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.03 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Mark all conductors with the panel and circuit number serving the device with a machine generated label, at the device.

- END OF SECTION -

SECTION 26 27 28 DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes disconnect switches, fuses and enclosures.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 REFERENCES

- A. NECA (National Electrical Contractors Association) "Standard of Installation"
- B. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies
- C. NEMA KS 1 – Enclosed Switches
- D. UL 50 – Enclosures for Electrical Equipment
- E. UL 98 – Enclosed and Dead-front Switches

1.04 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Include outline drawings with dimensions, and equipment ratings for voltage, ampacity, horsepower, and short circuit.

1.05 PROJECT CONDITIONS

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section 01 78 23 – Operation and Maintenance Data.

1.06 GENERAL

- A. Provide disconnect switches for loads required by code. Review Mechanical, HVAC, and Plumbing specifications to determine what equipment is furnished with disconnect switches. Provide and install disconnect switches whether equipment is furnished under this contract or not. It is the Electrical Contractors responsibility to determine the need for a disconnect switch for each load. The contractors shall include in their bid the code required disconnect switches whether indicated on the drawings or not.

PART 2 - PRODUCTS

2.01 DISCONNECT SWITCHES

- A. Fusible Switch Assemblies (use only when overcurrent protection is required): NEMA Type Heavy Duty; quick make, quick break, load interrupter, enclosed knife switch with externally

operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: designed to accommodate Class R, Class J or Class CC (motors) cartridge type fuses.

- B. Non-fusible Switch Assemblies: NEMA Type Heavy Duty; quick make, quick break, load interrupter, enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- C. Enclosure:
 - 1. Indoor: NEMA 1 code gauge steel with rust inhibiting primer and baked enamel finish.
 - 2. Outdoors: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA 4 stainless when indicated on drawings.
 - 3. Corrosive Areas and Damp/Wet locations: NEMA Type 4X, 304 stainless steel with brushed finish.
- D. Provide manufacturer's equipment ground kit in all disconnect switches.
- E. In applications where the switch serves as the service entrance disconnect, provide service ground kit, label as service disconnect and provide UL listing for service disconnect.
- F. Disconnects shall be manufactured by Eaton or Square-D.

2.02 FUSES

- A. See drawings and SECTION 26 28 13 – FUSES.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install disconnect switches where indicated on Drawings or required by NEC.
- B. Provide identification as specified in Section 26 05 53.
- C. Provide label on inside of disconnect cover identifying the type and size of fuse to be utilized.

- END OF SECTION -

SECTION 26 28 13 FUSES

PART 1 - GENERAL

1.01 SCOPE

- A. The work under this section includes 250 and 600 volt fuses.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Submit manufacturer's product data sheets with installation instructions.

1.04 REGULATORY REQUIREMENTS

- A. Listed by Underwriter's Laboratories, Inc., and suitable for specific application.

1.05 EXTRA MATERIALS

- A. Provide three (3) spares of each size and type fuse.
- B. Fuse Pullers: Furnish one fuse puller for each type required, based on fuse sized installed on project.

PART 2 - PRODUCTS

2.01 FUSES

- A. Fuses 600 Amperes and Less: Dual element, time delay, 600-volt, UL Class J or as otherwise noted on drawings.
- B. Fuses 601 Amperes and Larger: Low Peak, time delay, 600-volt, UL Class L. Interrupting Rating: 200,000 rms amperes.
- C. Fuses 30 Amperes and less: Time-Delay, 600-volt, UL Class CC. Interrupting rating: 200,000 rms amperes.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fuses shall not be installed until equipment is ready to be energized.

- END OF SECTION -

SECTION 26 29 00 LOW-VOLTAGE CONTROLLERS

PART 1 - GENERAL

1.01 SCOPE

- A. This section pertains to Low-Voltage Controllers (starters) for motors: Manual motor starters, magnetic motor starters, combination magnetic motor starters, which are not located within a motor control center (MCC). Other starters integral to MCC or within packaged equipment control panels are covered elsewhere.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 REFERENCES

- A. ANSI/NEMA ICS 6 – Industrial Control and Systems: Enclosures.
- B. ANSI/UL 248-8 – Low-Voltage Fuses – Part 8: Class J Fuses.
- C. NEMA AB 1 – Molded-case Circuit Breakers, Molded Case Switches, and Circuit-breaker Enclosures.
- D. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts.
- E. NEMA ICS 18 – Motor Control Centers.
- F. NEMA KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches.
- G. NEMA PB 1 – Panelboards.
- H. NEMA PB 1.1 – General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

1.04 SUBMITTALS

- A. Conform with Section 01 32 19 requirements.
- B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time current curves of all equipment and components.
- C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices. Test procedures shall be per the manufacturer's standards.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. Conform with requirements of Section 01 78 23 – Operation and Maintenance Data.
- B. Final As-Built Drawings
 - 1. Elevation Drawings: Include dimensional information and conduit routing locations.
 - 2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
 - 3. Wiring Diagrams:
 - a. Power Diagram: Include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.
 - b. Control Diagram: Include disconnect devices, pilot devices, etc.
 - 4. Major components list.
- C. Product Data Sheets
- D. Test procedures shall be per the manufacturer's standards.

1.06 COORDINATION WITH OTHER TRADES

- A. Motors: In general, all electric motors required for this installation will be supplied with equipment, apparatus and/or appliances covered under other sections of the specifications.
- B. For the sake of consistency and conformity of manufacturer, design and construction, all motors shall conform to the following description unless otherwise noted or required.
 - 1. Motors 1/3 HP and smaller shall be wound for operation on single phase, 60 Hz. service unless otherwise noted.
 - 2. Motors 1/2 HP and above shall be wound for operation on 3 phase, 60 Hz service unless otherwise noted.
 - 3. Refer to drawings in each case in order to verify voltage characteristics required.
- C. Equipment:
 - 1. All building utility motors such as fans, pumps, overhead doors, etc., together with certain "controlling equipment" for same, except motor starters and related apparatus, will be furnished under other sections of the specifications and delivered to the building site unless specifically noted otherwise. The above mentioned "controlling equipment" pertains to electrical thermostats, electro-pneumatic and pneumatic-electric and detection devices, or any other device not purely electrically operating in nature.
 - 2. The starters for these motors shall be furnished and installed by the Electrical Trade unless noted otherwise (See Motor Schedule on Drawings).
- D. The Electrical Trade shall set and connect all specified starting equipment, install all power conduits and wiring and shall furnish and make all connections from starting equipment to motors as required to leave the apparatus in running condition.
- E. Wiring Connections:
 - 1. Furnish branch circuits for all motors to the starting equipment and then to the motors, complete with all control wiring for automatic and remote control where required or

- noted. Conduits to motors shall terminate in the conduit fittings on the motors, the final connection being made with flexible, PVC-coated metal conduit.
2. Provide all necessary labor and material to completely connect all electrical motors and controls (where required) in connection with the building utility equipment, including fans, pumps, overhead door operators, etc.
 3. All conduits and wiring required for control work from the holding coil circuit of the starter, including the furnishing and installation of control devices such as auxiliary contacts, control relays, time delay relays, pilot lights, selector switches, alternators, etc., shall be provided and installed by other trades unless otherwise indicated.

F. Power Branch Circuits:

1. Wire sizes for branch circuits not specifically called for on drawings or in specifications shall be based on 125 percent of the full load current of the motor unless the voltage drop of motor branch circuits exceeds 1-1/2 percent from the distribution panel to the motor; in which case, voltage drop shall govern wire sizes. A power factor of 80 percent shall be used for motors in such calculations.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 MANUAL MOTOR STARTERS

- A. Single-phase Manual Motor Starter: Provide a motor-rated wall switch for motor loads under 1/2 HP. Provide switch with a toggle handle operator and with an optional handle guard in a NEMA Type 1 enclosure to prevent accidental operation of the toggle operator, and to allow the toggle operator to be padlocked in either the On or Off position.
- B. Three-phase Manual Motor Starter: NEMA ICS 2; size as shown on Drawings. AC general-purpose Class A manually operated full-voltage controller for induction motors rated in horsepower, with overload protection, red pilot light and toggle operator.
- C. Enclosure: NEMA Type 1, or as indicated on the drawings.
- D. Provide manufacturer's equipment grounding kit in all starter enclosures.

2.02 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: NEMA ICS 2; AC general purpose Class A magnetic controller for induction motors rated in horsepower; size 0 minimum.
- B. Full Voltage Starting: Non reversing type.
- C. Size: NEMA ICS 2; size as shown on Drawings, size 1 minimum.
- D. Coil Operating Voltage: 120 volts, 60 Hz.

- E. Overload Protection: The overload shall be solid-state, self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. The overload shall have a mechanical test function.
- F. Enclosure: NEMA Type 1, or as indicated on the drawings.
- G. Provide manufacturer's equipment ground kit in all starter enclosures.
- H. Auxiliary Contacts: NEMA ICS 2, two (2) field convertible contacts in addition to seal in contact.
- I. Selector Switches: NEMA ICS 2, HAND-OFF-AUTO in front cover.
- J. Indicating Lights: NEMA ICS 2; green "RUN" LED Push-to-test type in front cover.
- K. Control Power Transformers: Each magnetic starter shall have a fused primary and a fused 120Vsecondary control transformer, sized for the load, 50 VA minimum. Additionally, the X2 terminal of the control transformer shall be grounded.
- L. Combination Motor Starters: Combine motor starters with fusible switch disconnect in common enclosure.

2.03 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTING MEANS

- A. Fusible Switch Assemblies: NEMA KS 1; quick make, quick break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class J fuses.

2.04 FUSES

- A. Fuses 600 Amperes and Less: Dual element, time delay, 250/600V as required by the circuit, UL Class J. Interrupting Rating: 200,000 rms amperes.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that location is ready to receive equipment.

3.02 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions.
- B. Set overload protection in motor starters to match installed motor characteristics.
- C. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

- END OF SECTION -

SECTION 26 90 00
PROCESS INSTRUMENTATION AND CONTROL

PART 1 - GENERAL

1.01 SCOPE

- A. Scope of Instrumentation and Control for Electrical Systems (I&C) work required by this section is indicated on drawings and schedules, and by requirements of this and related sections.
 - 1. Control Sequences are specified in this section.
 - 2. Control Devices by System Integrator are specified in this section.
- B. Contractor shall include in their bid the scope of a qualified systems integrator (SI), as specified later in this section, to perform the following work and provide the following equipment:
 - 1. Design the control system which shall properly and satisfactorily perform the functions as described herein for a working and operable system.
 - 2. Manufacture and supply controls, control panels, and motor control centers as specified herein, which shall be field installed by a qualified Electrical Contractor.
 - 3. Supply Instrumentation as described in this section and as shown on the drawings.
 - 4. Prepare and provide submittals, operation and maintenance manuals (O&Ms), testing, startup, and training to Engineer and Owner personnel per the requirements as described in this and related sections.
- C. Firm for programming, integration, service, and support of controls. Contractor shall include allowance for I&C equipment and services from:
 - 1. PJ Kortens (Appleton WI)
 - a. Contact Mark Hoff, telephone number 920-730-9023

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 26 29 00 – LOW-VOLTAGE CONTROLLERS
- C. Section 26 90 05 – CONTROL PANEL CONSTRUCTION
- D. Section 26 90 06 – ELECTRICAL CONTROL COMPONENTS
- E. Section 26 90 72.43 – SUBMERSIBLE PRESSURE TRANSDUCERS
- F. Section 26 90 72.76 – LEVEL SWITCHES

1.03 REFERENCES

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:
 - 1. FM Global (FM).
 - 2. National Electrical Manufacturers Association (NEMA).
 - 3. National Fire Protection Association (NFPA):

- a. 70, National Electrical Code (NEC).
- 4. National Institute of Standards and Technology (NIST).
- 5. Underwriters Laboratories, Inc. (UL):
 - a. 508A, Industrial Control Panels.
 - b. UL 698A Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations
- 6. Wisconsin Chapter SPS 316, Wisconsin Department of Safety and Professional Services Electrical Code.

1.04 SYSTEM DESCRIPTION

A. Control System Requirements:

- 1. The instrumentation system consists of all primary elements, transmitters, switches, controllers, indicators, panels, signal converters, power supplies, special or shielded cable, special grounding or isolation, auxiliaries, wiring, and other devices required to provide complete control of the facility as specified in the Contract Documents.
- 2. Application software for programmable automation controllers, Human Machine Interface, and Operator Interface Units will be provided, configured, and programmed by the SI. All SI work will be included in this contract.
- 3. Programming will be provided by the SI.

B. System Integrator (SI):

- 1. Furnish and coordinate Instrumentation and Control system through a single System Integrator:
 - a. The SI shall be responsible for functional operations of all process control systems, supervision of installation, final connections, calibrations, preparation of drawings, testing procedures and Operation and Maintenance Manuals, training, demonstration of substantial completion and all other aspects of the instrumentation system, except for those aspects specifically provided by others.
- 2. Coordinate instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, and the Owner's SCADA system. Additional costs due to insufficient coordination as required for an operational system and satisfactory system shall be at the expense solely of this contractor.

1.05 SUBMITTALS

A. Shop Drawings:

- 1. See applicable parts of Division 01 and Section 26 05 00 for requirements for the submittal process.
- 2. Provide an electronic copy of submittals in PDF format.
- 3. Group submittal data for each system and subsystem. That is to say, the SI's submittal may be submitted under a single cover but then shall include subsections (or tabs) for individual instruments and control panels that are separate components of the control system.
- 4. Product technical data including:

- a. Equipment catalog cut sheets.
 - b. Instrument data sheets:
 - c. ISA S20 or approved equal.
 - d. Separate data sheet for each instrument.
 - e. Materials of construction.
 - f. Minimum and maximum ranges, calibration information (in engineering units or as otherwise noted).
 - g. Physical limits of components including temperature and pressure limits.
 - h. Size and weight.
 - i. Electrical power requirements and wiring diagrams.
 - j. NEMA rating of housings.
 - k. Submittals shall be marked with arrows, boxes, and/or underlines to show exact features to be provided. Features and options not being provided shall be crossed out.
- 5. Comprehensive set of wiring diagrams for each control panel / system.
 - a. Control drawings shall include succinct dedicated field connections sheet(s), for the convenience and efficiency of the field installer.
 - 6. Panel fabrication drawings.
 - 7. Nameplate layout drawings.
 - 8. Engraving and escutcheon lettering legends.
 - 9. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3:
 - 10. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed throughout submittals.

1.06 CLOSEOUT SUBMITTALS

A. Shop Drawings, additional requirements for closeout submittals.

- 1. All Shop Drawings shall be modified with as-built information/corrections.
- 2. All panel and wiring drawings shall be provided in both hardcopy and softcopy (PDF):
 - a. Drawings in AUTO CAD and PDF format.
- 3. Provide a parameter setting summary sheet for each field configurable device.
- 4. Certifications:
 - a. Documentation verifying that calibration equipment is certified with NIST traceability.
 - b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA:
 - I. Certification documentation is required for all equipment for which the specifications require independent agency approval.
- 5. Testing reports: Source quality control reports.

B. Operation and Maintenance Manuals (O&Ms):

- 1. O&Ms shall be neatly organized and clearly labeled.
- 2. A separate manual / cover shall be provided for each control system.
- 3. Cover shall include:

- a. Project Name.
 - b. Station Name.
 - c. Project Closeout Date.
 - d. Project Location.
4. Table of Contents shall include separate tabs for:
- a. Sequence of Operation.
 - b. Each drawing set.
 - c. Each PLC and / or HMI printed program copy.
 - d. Each bill of materials.
 - e. User Manual for each and every device which is programmable or configurable.
 - f. Product Documentation group for each control panel, system, and instrument.
 - g. Warranties.
 - h. Certificates.
 - i. Electrical Studies.

1.07 QUALITY ASSURANCE

A. System Integrator Qualifications:

- 1. Manufacturer of UL listed control panels.
- 2. Field Service personnel with 24/7 service availability.
- 3. Minimum of two full-time field service employees.
- 4. Service Center within 125-mile radius of jobsite.
- 5. Full-time on staff programmer with experience programming Rockwell programmable logic controllers and touchscreens.
- 6. Has been in business for a minimum of 25 years.
- 7. Has completed a minimum of 5 projects of equal or greater scope, size, nature, and complexity within the last 5 years.
- 8. Shall submit evidence of above listed qualifications upon Engineer request.
- 9. Shall submit 3 customer references upon Engineer request.
- 10. Shall submit example submittal and O&M from previous projects for review upon Engineer request.

B. Codes and Standards:

- 1. UL 508A
- 2. UL 698A (Where applicable)
- 3. NFPA 70 (NEC 2017 Edition)
- 4. Wisconsin Department of Natural Resources Administrative Codes (Where applicable)

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be stored in a clean and dry environment. It is the responsibility of the Contractor to maintain equipment in good and working condition for the duration of the project. The Contractor is responsible for any damage(s) occurring to the equipment until project final closeout.
- B. Each time equipment changes possession during the project, the party delivering the equipment and the party receiving the equipment shall both maintain a signed copy of a Product Release, to track and document equipment location and responsibility. Product Release, at a minimum, shall include the following information.

1. Date of release / transfer.
2. Party delivering / releasing equipment.
3. Party receiving equipment.
4. Location of equipment delivery.
5. Printed and signed names of individuals releasing and receiving equipment.
6. Bill of materials.
 - a. Quantities.
 - b. Part Numbers.
 - c. Manufacturers.

PART 2 - PRODUCTS

2.01 CONTROL PANELS

- A. Refer to drawings and below for control panels and requirements thereof as part of this project.
- B. Control Panels required as part of this project:

Schedule 26 90 00 – 2.1.1:

Tag	Name	Notes
100-PCP-001	Lift Station Pump Control Panel	#1

Notes:

1. Free-standing NEMA 3R Painted Steel Control Panel, furnished by SI. See Drawings and Section 26 90 05 for additional requirements.

C. PCP “Lift Station Pump Control Panel”

1. As much as possible, construct using same manufacturer models and methods as previous 2018 Pine Trails Crossing Lift Station Control Panel.
2. Shall be factory assembled and wired and installed as indicated on the drawings. Refer to manufacturer approved submittal and as-built drawings for installation details.
3. Shall bear UL698A serialized label.
4. New subplate shall be factory assembled and wired and installed as indicated on the drawings. Refer to manufacturer approved submittal and as-built drawings for installation details.
5. Components shall include, but not be limited to the following:
 - a. PLC:
 - I. Rockwell Micrologix 1400 Series (Primary)
 - II. Rockwell Micro810 Controller (Float Backup)
 - b. HMI: Integrator shall match size and type to Owner’s most recent previous installations.
 - I. IDEC #HG3G-8JT22MF-B 8.4” Color Touchscreen
 - c. AFD: Adjustable Frequency Drives shall be ABB ACQ580, or approved equal.

- I. Derate AFD(s) as recommended by the manufacturer for proper operation of 1PH to 3PH conversion with 208V 3PH 5hp motors.
 - II. Shall accept 240V 1PH (Utility) and 208V 3PH (Generator) input and output 208V 3PH (when connected to either source) to the pump motor.
 - III. Provide with full-voltage bypass, which can only operate when 3PH 208V is present (generator). Lockout bypass contactor coil call circuit via phase monitor relay alarm contact. Mechanically and electrically interlock AFD output contactor and bypass contactor.
 - IV. Provide NEMA 3R ventilation, heat-exchanger, or air conditioner of sufficient size / capacity to provide necessary heat dissipation / cooling for reliable operation of AFD(s) based on heat loss of drives and other components housed in the control panel.
- d. Surge Protection Device (SPD).
- I. SPD: Rockwell 4983-DS277-804, or approved equal.
 - II. See drawings for additional information.
- e. Network Equipment.
- I. MDS SD4 radio.
 - A) Yagi Antenna
 - B) Lightning Surge Arrestor
 - C) Radio Mounting Kit
 - D) Radio Pig-tail
 - E) LMR 400 Antenna Cable
 - II. Incorporate new Lift Station into Wonderware SCADA system.
 - III. Unmanaged Ethernet Switch.
 - A) N-Tron model 104TX-MDR, or approved equal.
- f. 24Vdc Power Supply.
- I. See Drawings and Section 26 90 06.
- g. Uninterruptible Power Supply.
- I. See Drawings and Section 26 90 06.
- h. All pilot devices, relays, signal conditioners, isolators, amplifiers, terminals, etc. required to provide the control sequences described herein and as indicated on the drawings.
- I. See Drawings and Section 26 90 06.
- i. Intrinsically Safe barriers & relays in quantities necessary for connections to applicable equipment installed in classified locations.
- I. See Drawings and Section 26 90 06.

2.02 INSTRUMENTS

- A. Refer to drawings and other sections for instruments and requirements thereof as part of this project.
- B. Instruments required as part of this project are listed in the 'CONTROL DEVICE SCHEDULE' on the drawings.
- C. Submersible Level Transducer "LT-100-1-1".
 - 1. See Drawings and Section 26 90 72.43.
- D. Level Switches "LSHH-, LSH-, LSL-100-2-1".
 - 1. See Drawings and Section 26 90 72.76.

2.03 SYSTEM INTEGRATION

- A. Firm for programming, integration, service, and support of controls. Contractor shall include allowance for I&C equipment and services from:
 - 1. PJ Kortens (Appleton WI)
- B. It is the responsibility of the System Integrator to ensure the final system is fully functional and capable of performing the intended operation(s). Any omissions of detail in the system description do not relieve the System Integrator from responsibility of providing a fully functionally operating system.

2.04 SEQUENCE OF OPERATIONS / CONTROL DESCRIPTION

- A. Wet Well
 - 1. Adjustable Frequency Drives (AFDs) w/ Full-Voltage Bypass
 - a. Pumps shall alternate in a first-on, first-off basis. If an alternation doesn't occur for 24 hours due to consistent flow, then an alternation will be forced.
 - b. Only the AFDs (not Bypass) shall be able to run the pumps when operating on the Utility 120/240V 1PH. AFDs or Bypass shall be able to run the pumps when operating on 120/208V 3PH as supplied by the Owner's portable generator.
 - 2. Pumps
 - a. AFD-BYPASS
 - I. AFD
 - A) Pumps are run with the Adjustable Frequency Drives and can operate on either Utility or Generator.
 - II. BYPASS
 - A) Pumps are run with the Full-Voltage Bypass Starters and can only operate on Generator. Bypass Starter coil call circuit shall be interlocked with a Phase Monitor Relay, which inhibits the call to the Bypass Starters if a loss of phase is detected.
 - b. HAND-OFF-AUTO
 - I. HAND
 - A) Pump STARTS and runs Manually.

- II. OFF
 - A) Disables starting of pump.
- III. AUTO
 - A) Grants control to automatic control system.
 - B) PLC controls pump(s).
 - 1) Operator adjustable setpoints for Low Level Alarm, Pump Off Levels, Lead and Lag Start, and High-level Alarm.
 - 2) When Wet Well level rises to reach Lead Start, Lead Pump STARTS and runs at full speed.
 - 3) When Wet Well level rises to reach Lag Start, and after operator adjustable time delay, Lag Pump STARTS and runs at full speed.
 - 4) If Wet Well level rises above the High-level Alarm setpoint, for an operator adjustable time delay, generate High Level Alarm.
 - 5) When Wet Well level falls to 1 Pump Off level, the pump which has been running the longest stops.
 - 6) When Wet Well level falls to Both Pumps Off level the remaining pump stops.
 - 7) If any pump is running for an operator adjustable time delay and Wet Well level is below pump operating range, generate Low Level Alarm. Low level alarm is suppressed if no pumps are running.
- c. Pump alternation selection on HMI.
 - I. AUTO
 - A) Pumps alternate lead/lag after expiration of operator adjustable totalized runtime.
 - B) Pumps alternate lead/lag after every run cycle.
 - II. MANUAL
 - A) Operator selects fixed lead/lag assignments.
 - III. If a pump is failed or disabled it is not included in the Auto alternation sequence.
- d. Pump automatic exercising.
 - I. HMI shall include operator adjustable frequency (time/days) and duration of pump exercising, to run the pumps when wet well level has not required pump operation for extended periods of time as long as the Low level Alarm is not active.
- e. FORCE-OFF/RESET-AUTO selector switch on front of PCP for Float Backup operation.
 - I. Float backup control shall be independent of (primary) transducer PLC control and shall have separate circuit breaker and DC supplies from primary controls.
 - II. When pumps are being operated by float backup control, the PLC shall be locked out from operating the pumps.
 - III. Float backup control shall include a pump alternator. Lead-Lag pump alternation shall be selectable as either AUTO or FIXED.
 - IV. System shall inhibit simultaneous pump starting.
 - V. FORCE
 - A) Pumps are operated by (3) float backup control.
 - VI. OFF/RESET
 - A) Float backup control is disabled and/or reset.

VII. AUTO

A) Entering float backup control:

- 1) Float backup control is initiated if the High-Level float is reached OR if the Low-Level float is reached and any pump is running.
- 2) Upon initiating float backup control, either a High-Level or Low-Level Alarm is generated.
- 3) If float backup is initiated due to High-Level float, Lead Pump shall START.
- 4) If after an adjustable time-delay the level remains above the Pump on float, Lag Pump shall START.
- 5) When Low-Level Float is reached, after an adjustable time-delay, both pumps shall STOP.
- 6) If float backup is initiated due to Low-Level Float, backup control shall lock out primary PLC control, and all pumps running in Auto shall be STOPPED.

B) Operating in float backup control:

- 1) When Wet Well level reaches the Pump On Float, Lead Pump shall START.
- 2) If/after adjustable time-delay the level remains above the Pump on Float, the Lag Pump shall START.
- 3) When Wet Well level reaches High-Level Float, High-Level Alarm shall be generated, and High-Level Float shall be used as a redundant START float for pumps.
- 4) When Wet Well level reaches Low-Level Float, after adjustable time-delay, all pumps running in Auto shall STOP.
- 5) If Wet Well level is below Low-Level Float and any pump is running after adjustable time-delay, Low-Level Alarm shall be generated.

f. LEVEL ALARM RESET pushbutton on front of PCP for Float Control level alarms.

I. Float Level Alarms shall be latched in until manually RESET.

B. Temperature Sensors

1. Temperatures shall be displayed on HMI in Fahrenheit and available as tagged values to SCADA.
2. PLC to generate low temperature alarms for HMI display and SCADA.

C. Other Control

1. The sequences above are intended to describe non-obvious control functions. All equipment indicated in specifications, shown on plans, or listed in schedules shall:
 - a. Be displayed on Touchscreens both graphically and textually
 - b. Trended if analog
 - c. Alarmed where appropriate
 - d. Allow for operator adjustment where required for specific use
 - e. Totalize Run time and Starts for each motor

PART 3 - EXECUTION

3.01 EXAMINATION

A. Factory Witness Testing.

1. Owner and Engineer shall have the opportunity to visit the Integrator's facility to witness proper operation of the control system and devices prior to shipment.

3.02 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes. Provide weep holes in conduits where necessary to prevent liquid buildup.

B. Install electrical components per Division 26.

C. Panel-Mounted Instruments:

1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

3.03 SITE QUALITY CONTROL

A. Maintain accurate log of startup activities, calibration functions, and final setpoint adjustments.

B. Instrumentation Calibration:

1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
2. Calibrate all field-mounted instruments after the device is mounted in place to assure proper installed operation.
3. Calibrate in accordance with the manufacturer's specifications.
4. Check the calibration of each transmitter and gage across its specified range at 0, 25, 50, 75, and 100 percent:
 - a. Check for both increasing and decreasing input signals to detect and document any hysteresis.
5. Replace any instrument which cannot be properly adjusted or calibrated.

C. Check control signal generation, transmission, reception, and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections:

1. Use actual signals where available.
2. Closely observe controllers, indicators, transmitters, displays, alarm and trip units, and other control components:
 - a. Verify that readings at all loop components are in agreement.
 - b. Make corrections as required:
 - I. Following any corrections, retest the loop as before.
3. Check all interlocks to the maximum extent possible.
4. In addition to any other as-recorded documents, record all calibration changes on all affected Contract Documents and turn over to the Owner.

- D. Provide verification of system assembly, power, ground, and I/O tests.
- E. Perform Start-up and Training as defined in this Section and other Sections:
- F. Manufacturer Services:
 - 1. Calibration shall be provided by qualified personnel, whether by manufacturer representative or manufacturer certified representative.

3.04 SYSTEM STARTUP

- A. System Integrator shall provide startup and training for all control equipment and instruments provided as part of this project.
- B. System Integrator shall include time as required for the following activities as part of this project:
 - 1. Site assistance and supervision for installing Contractor(s).
 - 2. Initial equipment Startup and Commissioning in the presence of Contractor and Engineer.

3.05 ADJUSTING

- A. Perform and document any calibration adjustments determined to be necessary during the startup, training, and closeout procedures.

3.06 CLOSEOUT ACTIVITIES

- A. System Integrator shall include Two (2) Man-days for training of Owner personnel in the presence of Contractor and Engineer.

- END OF SECTION -

SECTION 26 90 01

LIFT STATION INSTRUMENTATION & CONTROL

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

- A. Applicable provisions of Division 01 shall govern the work of this section.

1.02 APPLICABLE PUBLICATIONS

- A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
1. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, current edition:
 - a. ANSI/ISA-5.1-1984 - Instrumentation Symbols and Identification.
 2. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - a. NFPA 70 - National Electrical Code.
 3. Canadian Standards Association (CSA), Specifications and Standards, current edition:
 - a. CSA C22.2, Industrial Control Equipment.
 4. CUL - Underwriter's Laboratories of Canada.
 5. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
 - a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
 6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 7. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - a. UL508 - Industrial Control Equipment.
 - b. UL508A - Industrial Control Panels.
 - c. UL 698 - Industrial Control Equipment for Use in Hazardous (Classified) Locations
 - d. UL 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations
 - e. UL 913 - Intrinsically Safe Specification.
 - f. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DESCRIPTION OF WORK

- A. The work specified herein shall include the furnishing of all materials, equipment, labor, and supervision necessary to fabricate, install, start-up, and test a complete and operable Lift Station Instrumentation and Control System.
- B. The labor specified herein includes but is not limited to engineering, software development, panel fabrication, equipment calibration and adjustment, testing, training, and documentation.

- C. This section identifies the overall functional requirements for the Lift Station Instrumentation and Control System.
- D. This section includes modifications to the existing SCADA system and radio frequency communication network.
- E. This section includes coordination with the work of other sections. It shall be the responsibility of the system integrator specified under this section to execute this coordination during the shop drawing submittal phase of the work. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.
- F. This section includes coordination with electrical contractor to ensure that the proper number of raceways and conductors are installed. It shall be the responsibility of the system integrator to coordinate this work with the installing electrician. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.
- G. The Work specified under this section shall be included as an allowance per Division 1 requirements. Contractor handling charges, overhead, and mark-up shall be included in the base bid and are not included under this allowance.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Division 01.
- B. Submit the following information specifically for Lift Station Instrumentation and Control:
 - 1. General requirements specific to this section include:
 - a. Submit complete and integrated document containing all equipment included under the scope of this section.
 - b. Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
 - c. Include a complete list of proposed exceptions to and deviations from these specifications.
 - d. Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
 - 2. Submit the following information:
 - a. Bill of Materials:
 - 1) Complete listing of all components identifying exact make and model, quantity, and description.
 - b. Component Data Sheets:
 - 1) Detailed listing for each type of device, identifying Engineer's tag number, manufacturer, model, options, ranges, and other information necessary to supplement component catalog cut sheets and clearly show compliance with these specifications.
 - c. Component Catalog Cut sheets:
 - 1) Manufacturer's standard catalog information.
 - d. Control Panel Construction Drawings:
 - 1) Scaled drawings of all control panels and enclosures.
 - 2) Front panel elevation complete with nameplate legend.
 - 3) Back panel elevation complete with schedule of devices.
 - e. Control Panel Schematic Wiring Diagrams:
 - 1) Ladder type schematic diagrams.

- 2) Show all devices requiring electrical connections.
- 3) Identify all wire and terminal numbers.
- 4) Identify PLC I/O addresses.
- 5) Reference Engineer's tag number where assigned.
- 6) Cross-reference all relay contacts and coils.
- 7) Identify switching action on all switching devices.
- 8) Common diagrams will not be accepted.
- f. Analog Loop Diagrams:
 - 1) Show all devices requiring electrical connections.
 - 2) Identify all wire and terminal numbers.
 - 3) Identify PLC I/O addresses.
 - 4) Identify location of loop power supply.
 - 5) Identify field devices, back-of-panel devices, and front-of panel devices.
 - 6) Show tabular summary of transmitter output capability, input impedance of each receiver, total loop impedance, and reserve output capacity.
 - 7) Reference Engineer's tag number where assigned.
 - 8) Common diagrams will not be accepted.
- g. Control Panel Power and Environmental Requirements:
 - 1) Identify voltage and ampacity requirements.
 - 2) Show sizing calculations for environmental controls (ventilation, heat, air conditioning).
- h. Interconnecting Wiring Diagrams:
 - 1) Show all interconnections between control panels and field devices.
 - 2) Identify all wire and terminal numbers, including field terminal junction box terminals.
- i. Control Device Installation Details:
 - 1) Supplement contract documents with additional details necessary for proper installation of control devices.
- j. Configuration Documentation:
 - 1) Submit complete, documented configuration data for all configurable controllers.

1.05 FACTORY TESTING

- A. The entire Lift Station Control System shall be assembled at the manufacturer's facility and tested to the greatest extent possible. This test shall include demonstration of proper system operation. Document the results of this test in writing and submit to the Engineer.
- B. The Engineer and Owner may witness the factory acceptance test. Schedule test date a minimum of two weeks in advance to allow attendance by the Engineer and the Owner.
- C. Correct any deficiencies identified during the test prior to shipping the control system to the job site.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

- A. Submit operation & maintenance manuals and instructions in accordance with Division 01.
- B. Submit the following information specifically for Lift Station Instrumentation and Control:
 1. Submit final revised shop drawings incorporating any modifications made as a result of factory test, installation, start-up, operational testing, or for any other cause. Submit

- results of all field-testing and corrective actions taken for all discrete control devices and for all analog control devices. Submit analog device calibration data sheets.
2. Submit manufacturers' standard operation & maintenance information including installation manuals and safety instructions.
 3. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Process Instrumentation and Control System.
 4. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and trouble-shooting guide.
 5. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with costs.

1.07 QUALITY ASSURANCE

- A. All materials, equipment, and parts shall be new and unused of current manufacture.
- B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- E. Control panels shall be constructed in accordance with UL 508 and UL698A standards and shall bear the UL listing.
- F. Control panel shall be marked in accordance with NEC requirements to identify it as being suitable for use as service equipment.

1.08 WARRANTY

- A. See Division 01 for additional requirements.

PART 2 PRODUCTS

2.01 SYSTEM INTEGRATOR

- A. The system integrator shall be a firm specializing in the integration of control systems with documented experience in the detailed design, construction, configuration, and maintenance of PLC based control systems and motor control centers for the water/wastewater utility market. System Integration firms that are able to document compliance with the following requirements will be considered an equal to the named system integrators.
 1. The system integration firm has completed projects for at least five municipal customers, two of which must be similar in scope and approach to this project.
 2. To demonstrate financial stability, the system integration firm has completed a minimum of four past projects, each with an individual contract cost in excess of \$500,000.
 3. To demonstrate technical capability, the system integration firm shall employ an on-staff, full-time employee that is a State of Wisconsin Licensed Professional Engineer and also employs an engineering staff of not less than five engineers with no less than a

combined experience of no less than 100 years designing, constructing, and configuring process control systems.

4. The system integration firm shall have an active \$1,000,000 Professional Liability Insurance Policy.
5. The system integrator shall be factory authorized to commission Drives, PLC's and MCC's, and to be an authorized Rockwell Strategic Provider with full development software to modify and create new applications in the specified HMI software.

B. Acceptable system integrators include

1. P.J. Kortens and Company, Inc., contact Mark Hoff, telephone number 920-730-9023.

2.02 ENVIRONMENTAL REQUIREMENTS

A. Enclosure:

1. NEMA 3R insulated enclosure constructed of 12 or 14 gauge 304SS and suitable for mounting as shown on the drawings.
2. 12 gauge enclosures have 10 gauge backs
Floor stands are welded to enclosure
3. Seams continuously welded and ground smooth, no holes or knockouts
4. Strong, rigid construction with body stiffeners
5. Gasketed overlapping doors eliminate need for center post
6. Painted steel back-panel for equipment mounting.
7. Dead front, three-point latch, gasketed exterior door, with padlocking attachment and full-length piano type hinge.
8. Aluminum or stainless steel inner door for mounting of all pilot devices.
9. Self-grounding latch system with double seal provides maximum protection against leakage.
10. Latch rods have rollers for easier door closing.
11. Heavy duty lifting eyes are Type 316 stainless steel
12. Data pocket, provided on door with 3-point latches, is high-impact thermoplastic
13. Collar studs for mounting optional panel
14. Ground studs in body of enclosure
15. Bonding provision on doors
16. Drip shield kit
17. Finish:
 - a. Enclosures are unpainted. Front, sides, top, and back have smooth No.4 brushed finish
 - b. Steel sub-panels are painted white

B. Temperature Control:

1. Thermostatically controlled, fan-forced heater, sized to maintain equipment-operating temperature inside panel.
2. Thermostatically controlled condensation heater sized to prevent condensation inside panel or any panel components.
3. Filtered ventilation fan(s) where needed and sized to dissipate heat generated by components located within control panel.

C. Corrosion Protection:

1. Vapor phase protective corrosion inhibitor selected based upon interior volume of enclosure.

2.03 ELECTRICAL REQUIREMENTS

A. Service Entrance:

1. Suitable for electric service as shown on the drawings.
2. Main circuit breaker and short circuit current rating, suitable for the ampacity and available fault current identified on the drawings.

B. Lightning/Surge Protection

1. A 100kA lightning arrestor shall be supplied and connected to each line of the incoming side of the power input terminals. The arrestor shall protect the panel components from damage due to lightning strikes on the incoming power line.
2. A three phase surge capacitor shall be supplied and connected to each line of the incoming side of the power input terminals. The capacitor shall provide supplemental protection of the panel components from damage due to surges on the incoming power line.

C. Phase Failure Relay

1. Relay voltage sensing for under voltage, phase reversal, phase unbalance and phase loss.

D. Uninterruptible Power Supply:

1. Control Panel and control system shall incorporate an Uninterruptible Power Supply (UPS) capable of sustaining control system, telemetry system and alarm system operation for a minimum of thirty minutes.

2.04 CONTROL POWER:

A. 208/120V, 3-Phase, 4-Wire System (refer to contract drawings).

1. Grounded 208-120V control power transformer with two primary fuses and one secondary fuse.
2. Size transformer to accommodate control panel loads and other station loads as identified on the drawings.
3. Single-pole circuit breakers as needed for control panel loads.
4. Single and multi-pole circuit breakers for other station loads as identified on the drawings.

2.05 MISCELLANEOUS:

- A. Interior-mounted, individually protected, GFCI duplex outlet, Hubbell #GFR8300HILU, or equal.
- B. Exterior-mounted, individually protected, GFCI duplex outlet, Hubbell #GFR8300HILU, or equal.
- C. Interior mounted light with control panel door switch.

2.06 CONTROL SYSTEM FUNCTIONAL REQUIREMENTS

A. General:

1. Float switches and hardwired control shall provide backup wet well level control.

B. Power Monitoring

1. Power fail relay provided under this section shall detect CONTROL POWER FAIL condition when 120VAC control power circuit fails.
2. Uninterruptible Power Supply is provided under this section. Provide relay logic as necessary to generate common UPS FAULT signal.
3. Phase failure relay provided under this section shall detect abnormal conditions and generate PHASE FAIL signal to prevent motor operation under any abnormal condition. Motors shall restart upon restoration of proper voltage and phase. Normal motor starting voltage dip shall not cause phase failure relay to trip motor.

C. Raw Wastewater Pump Motor Control:

1. Each pump shall be equipped with the following pilot control devices:
 - a. Hand-Off-Auto selector switch.
 - b. Required Pilot Light (Amber).
 - c. Run Pilot Light (Green).
 - d. Fail Pilot Light (Red).
 - e. High Temperature Pilot Light (Red).
 - f. Seal Fail Pilot Light (Amber).
 - g. Reset Pushbutton.
 - h. Runtime Totalizer (Seven digit, accurate to 0.01 hours).
2. In Hand position pump shall run continuously. In Auto position pump shall run in response to signals from wet well level control system. Auxiliary contact shall monitor IN AUTO position.
3. Required light shall be energized when wet well level control system calls pump to run.
4. Run light shall be energized by run signal.
5. Motor overload shall provide motor protection. Auxiliary contacts shall monitor the following motor data functions: RUN and MOTOR OVERLOAD.
6. Fail light shall be energized by a discrepancy between required and run conditions after an adjustable time delay. Fail condition shall prevent pump from running and shall require local reset.
7. High temperature light shall be energized by pump high temperature sensor. Provide adjustable time delay to prevent nuisance alarms after power outage. Provide interface relay compatible with pump requirements. High temperature condition shall prevent pump from running and shall require local reset.
8. Seal fail light shall be energized by pump seal fail sensor. Provide interface relay compatible with pump requirements. Seal fail light shall provide indication only.
9. Display the following status conditions: IN AUTO, REQUIRED, RUN, and MOTOR OVERLOAD.

D. Local Control Functions:

1. Three intrinsically safe float switches provided under this section shall detect the following Lift Station WET WELL LEVEL conditions:
 - a. High Level/LAG pump ON.
 - b. Lead Pump ON.
 - c. Low Level/pumps OFF.
2. Provide intrinsically safe relay for each discrete float switch.
3. Submersible level transmitter shall detect wet well level.
4. Provide intrinsically safe barrier for level sensor.
5. Provide surge protection in panel for each analog signal circuit.

E. Provide selector switch on deadfront door for wet well control: Normal/Back-up.

F. Normal Wet Well Level Control:

1. Programmable Logic controller and submersible level transducer shall be the primary level control in the wet well. This system shall have a minimum of the following setpoints accessible via the operator interface terminal:
 - a. High Level Alarm Setpoint.
 - b. Lag Pump On Setpoint.
 - c. Lead Pump On Setpoint.
 - d. Lag Pump Off Setpoint.
 - e. Lead Pump Off Setpoint.
 - f. Low Level Alarm Setpoint. (redundant pumps off)

G. Backup Wet Well Level Control:

1. The following pilot devices shall be incorporated into the backup wet well level control system:
 - a. High Float Level Alarm Pilot Light (Red).
 - b. Low Float Level Alarm Pilot Light (Red).
 - c. Back-up Control Active Pilot Light (Red).
 - d. Back-up Control Reset Pushbutton.
2. High Float Level alarm pilot light shall be energized by high level float. High level float shall be a normally closed contact float switch.
3. If the normal level control fails and the wetwell level drops to the low alarm float, the operating pump(s) shall be deactivated.
4. Low Float Level alarm pilot light shall be energized by low level float.
5. HIGH FLOAT LEVEL and LOW FLOAT LEVEL conditions shall generate BACKUP CONTROL ACTIVE signal after adjustable time delay (0 to 30 seconds) and shall illuminate the Back-up Control Active Pilot Light.
6. Normal wet well level control shall be disabled when back-up level control is activated.
7. In backup control, the Lead pump ON float shall start Pump No.1 after the delay as long as the low level float condition is not active.
8. In backup control the High Level float shall activate adjustable Pump No.2 ON delay timer (0 to 60 seconds). Pump No.2 REQUIRED signal shall be generated after the delay time has expired only if the High Level Float remains active (rising wetwell level).
9. Operating pump(s) shall be deactivated when the wetwell level falls to the low float.
10. Back-up Wet Well Level Control shall require manual reset. Normal wet well level control shall be restored by depressing the Backup Control Reset pushbutton when both the HIGH FLOAT LEVEL and LOW FLOAT LEVEL conditions are not active.

H. Human Machine Interface

1. Display available parameters, including pump run times, alarm status, setpoints, and calculated daily, yesterday's and cumulative flow totals.
2. Provide operator adjustability of all set-points as described above.
3. Display alarm history, including time and date stamp, in reverse chronological order.
4. Display instantaneous flow and totalized flow.
 - a. Display totalized flow for each pump and combination of pumps.
 - b. Display totalized flow for all pumps.
5. Provide data logging for future Compact Flash Card or USB download in.CSV format of pump run times, alarm status, setpoints, and calculated daily, yesterday's and cumulative flow totals.

I. Alarming:

1. Weatherproof alarm light with LED lamp, weatherproof alarm horn, and weatherproof silence pushbutton shall be mounted on panel exterior.

2. The following conditions shall activate the alarm system:
 - a. Pump No.1 Call-to-Run Fail.
 - b. Pump No.1 Motor High Temperature.
 - c. Pump No.1 Seal Fail.
 - d. Pump No.2 Call-to-Run Fail.
 - e. Pump No.2 Motor High Temperature.
 - f. Pump No.2 Seal Fail.
 - g. Wetwell High Level Alarm (float switch).
 - h. Wetwell Low Level Alarm (float switch).
 - i. Backup Level Control System Active.
 - j. Power Phase Fail.
 - k. Control Power Fail.
 - l. UPS Fault.

J. Remote Monitoring, SCADA system:

1. SCADA system programmable logic controller system shall provide remote monitoring of the following status and alarms for future communication with the SCADA radio:
 - a. Pump No.1 In Auto.
 - b. Pump No.1 Run.
 - c. Pump No.1 Call-to-Run Fail.
 - e. Pump No.1 Motor High Temperature.
 - f. Pump No.1 Seal Fail.
 - g. Pump No.1 Motor Overload
 - h. Pump No.2 In Auto.
 - i. Pump No.2 Run.
 - j. Pump No.2 Call-to-Run Fail.
 - l. Pump No.2 Motor High Temperature.
 - m. Pump No.2 Seal Fail.
 - n. Pump No.2 Motor Overload
 - o. Wet Well Level.
 - p. Wetwell High Level Alarm (float switch).
 - q. Wetwell Low Level Alarm (float switch).
 - r. Backup Level Control System Active.
 - s. Power Phase Fail.
 - t. Control Power Fail.
 - u. UPS Fault.

2.07 SCADA SYSTEM AND RADIO COMMUNICATIONS

A. Summary of System Improvements:

1. Radio communications will be provided under a separate contract.
 - a. Maintain space in panel, minimum 18" x 12" for future SCADA radio, surge suppressor, and antenna cable. Panel to have access on side of panel to accommodate antenna cable exit. See plans.

2.08 MAJOR COMPONENTS

- A. Enclosure shall be Hoffman, or equal.
- B. Lightning arrestor shall be Square D SDSA Series, or equal.
- C. Surge capacitor shall be Delta CA Series, or equal.

- D. Motor Controllers:
1. Magnetic starters through NEMA Size 9 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring. Each starter shall have one (1) NO auxiliary contact
 2. Coils shall be permanently marked with voltage, frequency and part number
 3. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed
 4. Motor starter units shall have a 3-pole manual reset solid-state overload relays with alarm contacts and providing Class 20 operation with the following protection features:
 - a. Over current.
 - b. Phase loss.
 - c. Ground fault.
 - d. Jam protection.
 5. Where under-current protection is indicated for motors, provide second solid-state relay with adjustable trip current setting (40-100% of rated) to detect under current condition and alarm as shown.
- E. Circuit breakers shall be Square D, Cutler-Hammer, or equal.
- F. Programmable logic controller system shall be Allen-Bradley Micrologix 1400.
- G. Operator Interface shall be a minimum 5" high brightness touch screen, Beijer T7BR, Pro-face AGP3300-U1-D24, IDEC HG High Performance Series, or equal. Display shall be easily viewable in full daylight.
- H. Ethernet switch shall be industrial 5-port switch designed for control panel installation, Hirschmann, Phoenix Contact, or equal.
- I. Pilot devices shall be Allen Bradley Bulletin 800T/800H, or equal.
1. 30mm, oil tight
 2. Indicating Lights: push-to-test.
- J. Phase failure relay shall be Symcom Motor Saver, or equal.
- K. Relays shall be Allen Bradley, or equal.
1. General Purpose: Bulletin 700-HB
 2. Solid State: Bulletin 700-SH
- L. Timing relays shall be Allen Bradley Bulletin 700-HS, or equal.
- M. Uninterruptible Power Supply shall be PULS Dimension DC-UPS, or equal.
1. Internal Battery type: Sealed, lead-acid; maintenance free
 2. Provide dry contacts for monitoring Ready, Buffering (in use), and Replace Battery status.
 3. Warranty: 3 year comprehensive, including battery.
- N. Intrinsically safe relays shall be Diversified Electronics, Inc. Model ISO-120-xx, or equal.
- O. Intrinsically safe barriers shall be non-zener type, PR Electronics, or equal.

- P. Submersible Level Element and Transmitter shall be manufactured by Sigma Controls, Model 6100, Or equal.
- Q. Float switches shall be Anchor Scientific, Non-mercury Rotofloat-SST, or equal, complete with 15-pound anchor, nylon coated stainless steel rope, and clamps. Float Switches shall be provided with adequate cable length to reach the Lift Station Control Panel without splices and to provide slack cable as shown on drawings.
- R. Alarm strobe shall be weatherproof, red in color, and constructed of shatter- proof polycarbonate material. The strobe shall utilize a Xenon flash tube and shall contain internal timing and trigger circuits. Unit shall be U.L. Listed and manufactured by Edwards Signal, 94 Series, or equal.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

- A. The Contractor shall have overall system responsibility and shall provide all materials and labor necessary to provide a complete and operable system and comply with all requirements of this section.
- B. It shall be the responsibility of the Contractor and the Lift Station Control System supplier to coordinate various installation aspects including but not limited to the following:
 - 1. Proper type, size, and number of raceways and signal wiring.
 - 2. Proper type, size, and number of raceways and power wiring,
 - 3. Proper installation including working clearances based on actual as-built physical dimensions of electrical panels and enclosures.
 - 4. Shipping schedules for timely installation of equipment.
 - 5. Conduit entrance requirements.
 - 6. Proper special cable lengths required for field instruments.
 - 7. Wire numbering methodology for all field wiring.
- C. The Lift Station Instrumentation and Control System supplier shall be responsible for certifying the correctness of installation for all work related to the lift station instrumentation and control system regardless of who performs the installation work.
- D. The contract drawings are diagrammatic in nature; it shall be the responsibility of the supplier to supplement the contract drawings and complete the final design of the instrumentation and control system and to coordinate exact requirements with the installing contractors.

3.02 CONTROL PANEL CONSTRUCTION

- A. General requirements
 - 1. Fabricate, install instruments, plumb and wire in factory.
 - 2. Test wiring and plumbing prior to shipment.
 - 3. Make external connections by way of numbered terminal blocks.
 - 4. Separate electrical components from pneumatic components by metal barriers.
 - 5. Conform to ISA standards.
- B. Fabrication
 - 1. 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. 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 purposes and panel bracing. Internal framework shall permit lifting of panel without racking or distortion.
- C. Control circuit wiring:
1. No more than 20 devices on any single circuit.
 2. Where multiple units perform parallel operations, do not group all devices on the same branch circuit; the purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.
 3. Do not exceed the ampacity of the branch circuit.
 4. Panel service outlet shall be fed from a separate branch circuit.
 5. Provide 120-volt ac plugmold and 3-wire plug-in line cords for all panel components powered by 120-volt ac power.
- D. Instrument Location:
1. Locate instruments designated for back-of-panel mounting in manner to allow for maintenance and adjustment.
 2. Instrument mounting height shall not exceed 6 ft-6 in. Minimum height shall be 4 ft-0 in.
- E. Nameplates:
1. All front of panel pilot devices shall be equipped with manufacturer provided service legend indicating function of device.
 2. All other front of panel devices shall have laminated plastic nameplates with 3/16-inch high characters. Unless otherwise noted, color shall be white with black letters.
 3. Each panel shall be provided with a face mounted laminated nameplate. Unless otherwise noted, color shall be white with black letters 1/2-inch high.
- F. Output Signal Fusing:
1. Provide appropriately sized fuses for all output signals to devices located external to the panel in accordance with the following requirements:
 - a. Maximum fuse size: 5A
 - b. Separate fuse for each device
 - c. Fuses shall be installed in indicating type fuse holder terminal blocks.
- G. Wiring:
1. Wiring within panels, consoles, racks, and cabinets shall meet the following requirements:
 - a. Wires for ac circuits shall be 300-volt, Type MTW stranded copper and shall be sized for the current to be carried but not smaller than No. 16 AWG.
 - b. Wires for analog signal circuits shall be 300-volt stranded copper and shall be twisted shielded pairs not smaller than No. 18 AWG.
 - c. Wires for other dc circuits shall be 300-volt, Type MTW stranded copper not smaller than No. 18 AWG.
 - d. Wiring shall be numbered and tagged at each termination. Wire tags shall be snap-on or slip on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.
 - e. Wiring for special signals such as communications, digital data, and multiplexed signals shall use manufacturer's standard cables.
 2. Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:

- a. Wire all spare or unused panel mounted elements to their panels terminal blocks.
- b. Provide open construction terminal blocks for wiring that is entirely internal to the panel.
- c. Provide isolation switch terminal blocks for all wiring that is not entirely internal to the panel.
- d. Rail mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.
- e. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags.
- f. Provide power distribution blocks for distribution of control panel power at voltages exceeding 120VAC.
- g. Provide CSA certified and UL approved terminal blocks manufactured by Allen Bradley, or equal.

H. Grounding

1. Panels, consoles, racks, and cabinets shall be provided with an isolated copper grounding bus for all signal and shield ground connections. This ground bus shall be grounded at a common single ground point. The signal grounding system shall meet National Electrical Code requirements.

I. Power Supplies:

1. Provide dc power supplies as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Power supplies shall be suitable for intrinsically safe circuits where two-wire transmitters are located in a hazardous area.

J. Intrinsically safe circuits

1. Conductors of intrinsically safe circuits shall be separated from conductors of non-intrinsically safe by a minimum distance of two inches. Provide separate wiring compartments for intrinsically safe and non-intrinsically safe terminals. Physical barriers shall be grounded metal or insulating partitions and all wiring shall be secured.
2. Provide intrinsically safe relays and barriers in accordance with Class I, Division 1 requirements of the National Electric Code where shown or specified.

K. Electrical transient protection

1. All electrical and electronic elements of the Control System shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.

3.03 FIELD MEASUREMENTS

- A. Field verify with exact measurements, the available mounting space for control system equipment. Identify deficiencies prior to beginning installation.
- B. Where ranges are indicated on the contract documents, they are to be considered preliminary. Field-verify the exact ranges required based on field conditions.

3.04 DELIVERY STORAGE AND HANDLING

- A. It shall be the responsibility of the installing contractor to receive lift station control system equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.
- B. Exercise due diligence in storing, protecting, and moving lift station control system equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Owner.

3.05 INSTALLATION

- A. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.
- B. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.

3.06 TESTING AND START-UP SERVICES

- A. Lift station control system manufacturer shall provide installation and start-up services required to place the complete system into operation.
- B. Each signal and function shall be fully tested. These tests shall be based on actual operation of primary elements and verification of proper control system response. Submit test results as part of Operations and Maintenance Manual.
- C. Record calibrations of all analog devices.
- D. Demonstrate proper operation of the lift station control system to the Owner and in the presence of the Engineer.

3.07 TRAINING

- A. Training shall be suitable for operations personnel with limited knowledge of electrical components.
- B. Provide one instructor day of operator training at the job site. Training shall consist of operations instruction and maintenance/trouble-shooting instruction.
 - 1. Operations instruction shall identify all control loops with description of all interlocks, interface with other loops, and operational input requirements. Describe procedures for re-starting the system.
 - 2. Maintenance instruction shall identify periodic maintenance that can be performed by the operator. Provide description of procedures and locations for replacement of consumable devices such as fuses and for checking the calibration or operation of devices.
 - 3. Trouble-shooting instruction shall identify simple procedures and methods for identifying potential causes in the event of failures.

END OF SECTION

SECTION 26 90 05
CONTROL PANEL CONSTRUCTION

PART 1 - GENERAL

1.01 SCOPE

- A. Control Panels shall meet the performance, protection, safety and certification criteria of this specification.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 RELATED SECTIONS

- A. Section 26 05 00 – Common Work Results
- B. Section 26 05 19 – Line-voltage Power Conductors and Cables
- C. Section 26 05 23 – Control-voltage Electrical Cables
- D. Section 26 05 53 – Identification
- E. Section 26 28 13 – Fuses
- F. Section 26 29 00 – Low-voltage Controllers
- G. Section 26 90 00 – Process Instrumentation and Control

1.04 REFERENCES

- A. NFPA 70 – National Fire Protection Association - US National Electrical Code.
- B. UL 508 – Underwriters Laboratory Inc.
- C. UL 698A – Underwriters Laboratory Inc.

1.05 SUBMITTALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.07 QUALITY ASSURANCE

- A. All control panels shall be constructed by a UL panel shop, bear UL label, and bear label of panel manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of -40 °C to 70 °C (-40 °F to 158 °F).
- C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.09 WARRANTY

- A. The manufacturer shall warranty for (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first. Warranty shall cover all parts and labor for corrections and replacing of failed components (not normally consumed under normal operation).

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Enclosure Manufacturer

- 1. Hoffman / nVent
- 2. Saginaw Control & Engineering (SCE)
- 3. Motor Control Center manufacturer if control panel is integral to an MCC.
- 4. Or Engineer approved equal.

B. Design Criteria

- 1. All control panels shall conform to UL 508A requirements.
- 2. All control panels which house programmable logic controllers (PLC), network devices, or other critical components for alarm monitoring and logging shall include an uninterruptible power supply (UPS).
 - a. PLC shall monitor UPS status contacts and line power to avoid nuisance alarming during generator exercising.
 - b. See Section 26 90 06 for additional UPS requirements.
- 3. Provide all accessories and ancillary equipment necessary to meet component manufacturer recommendations for factors including but not necessarily limited to:
 - a. Overcurrent protection
 - b. Surge protection
 - c. Heat dissipation
 - d. Environmental protection
 - e. Noise immunity
 - f. Circuit isolation
 - g. Power supplies.

4. Control panel overcurrent devices shall be provided, sized, adjusted, and coordinated to meet the requirements and recommendations determined by the electrical studies (Refer to Section 26 05 73).
5. Control panels be designed for and labeled with a short-circuit current (SCCR) kA rating equal to or greater than the available fault current.
6. See drawings, other sections, and below for additional requirements.
7. Control Panels shall be suitable for the environment for which they are to be installed.
8. Control panels shall be provided with a minimum ten percent of the total or quantity ten installed spare terminals, whichever is greater.
9. Minimum spacing and clearances shall be maintained for all equipment per manufacturer recommendations and requirements (e.g. space around heaters, AFDs, transformers, etc.).
10. Sufficient wire bending space shall be provided for all termination points for external connections, per NEC and UL 508 requirements.
11. Clearances or barriers shall be maintained or provided for proper separation of circuits, per NEC and UL 698A requirements.

C. Fabrication

1. All control panels shall be constructed in accordance with UL 508 requirements.
2. Control Panel construction shall be done in a workmanlike manner.
3. Wires shall be supported from strain and protected from abrasion.
 - a. Utilize split wire loom tubing or spiral cable wrap wherever wires extend to the enclosure door and for neatness with large wire bundles.
 - b. Utilize cable tie mounts to reduce cable strain.
4. All enclosure cutout openings shall be ground smooth and painted.
5. Enclosures shall be provided with mounting kit.
 - a. Mounting foot kit for wall-mounted panels.
 - b. Floor stand kit for free-standing panels.
6. Two-door enclosures shall have the following additional requirements:
 - a. Removable center post, for non-overlapping doors.
 - b. 3-point latching mechanisms.
7. When rain hood, heat exchanger, air conditioner, grille kit, louvers, drip shields, or other enclosure accessories visible from enclosure exterior and subject to environmental conditions, they shall be of the same material, finish, and color as the enclosure exterior to which they are mounted.
8. Each control panel shall be labeled and identified with a laminated phenolic nameplate.
9. All door-mount components shall be labeled with a laminated phenolic nameplate, which identifies their use or function.
10. All terminals and wires shall be numbered and marked to reference the control panel manufacturer schematics.
11. Door-mounted devices (e.g. switches, circuit breaker operators, etc.) mounting heights to center of the grip of the operating handle above the finished floor or working platform shall be:
 - a. Minimum 3'
 - b. Maximum 6'-6"
12. Shall include a 15-amp 120Vac convenience receptacle powered from a dedicated circuit breaker.

13. When a PLC and/or Ethernet network is provided, control panels shall include a door-mounted RJ-45 programming port with a type 4X closure cap & lanyard.
14. Free-standing enclosures shall be provided with heavy-duty lifting eyes.
15. All equipment and components shall be properly secured and supported to avoid fall and/or damage.

D. Manufacturer Services

1. Control panel manufacturer shall perform calculations to determine heating and ventilation/cooling requirements for proper operation and protection of components. Costs associated with necessary heaters, ventilation fans, heat exchangers, and/or air conditioners shall be included in bid price.
 - a. Upon Engineer request, calculations shall be submitted for review.
 - b. Calculation considerations shall include but not necessarily be limited to:
 - I. Enclosure size
 - II. Installation location/environment
 - III. Enclosure material
 - IV. Housed equipment heat dissipation / watts loss.
 - V. Housed equipment operating temperature ranges. Use the below guidelines for calculations.
 - A) For cooling/ventilation:
 - 1) 40°C (104°F) for maximum ambient temperature external to control panel.
 - 2) 50°C (122°F) for maximum control panel internal temperature or lowest maximum operating temperature of any component installed within control panel, whichever is lower.
 - B) For heating:
 - 1) 0°C (32°F) for minimum ambient temperature external to control panels installed in heated locations.
 - 2) -30°C (-22°F) for minimum ambient temperature external to control panels installed in non-heated/outdoor locations.
 - 3) 0°C (32°F) for minimum control panel internal temperature or highest minimum operating temperature for any component installed within control panel, whichever is higher.
2. Control panel manufacturer shall energize, test, and inspect all control panels prior to shipment. I/O shall be tested.
 - a. Inputs shall be simulated by way of switches, current/volt sources, or other means as necessary to prove functionality.
 - b. Outputs shall be tested for proper operation.

E. Materials

1. Control Panels not integral to an MCC shall conform to the following requirements:
2. All control panels shall include:
 - a. Collar studs for mounting of subpanel.
 - b. Ground stud on door and body.
 - c. Subpanel, power coated white.
 - d. Industrial corrosion inhibitors, Hoffman/nVent ACHI series, or equal.

- e. Removable print pocket.
- f. Doors stop kit(s).
- g. Concealed hinges.
- h. Door secured with easily removable and replaceable stainless steel hinge pins with clip retainer that allow door removal.
- i. Flange trough collar around all sides of door opening.
- j. Easily removable and interchangeable doors.
- k. Seams continuously welded and ground smooth.
- l. Padlocking/key-locking door handle(s).
- m. Condensation heaters.
 - I. Saginaw Control & Engineering SCE-TSH series, or equal.

F. Construction

- 1. Front swing-out or dead front panel.
- 2. Be approved by UL for type 3R rating
- 3. Drip shield kit.
- 4. Rain hoods for any ventilation or other non-sealed cutouts through enclosure body.
- 5. LED enclosure interior light fixtures with door-activated light switches.
- 6. Heating and Cooling provisions and equipment to maintain operable internal temperature.
- 7. Enclosure Insulation
 - a. Manufacturer
 - I. ESP type LOW-E Insulation
 - II. Or equal
 - b. Thickness: 1/4" minimum
 - c. Material: Polyethylene Foam
 - d. Enclosure interior shall be insulated on all surfaces.

- G. When circuits from panel extend to classified locations and their raceways stub-up beneath the control panel, provide 18-inch high legs & vented louver kit.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.
- B. The supplier shall verify all settings have been properly adjusted prior to energizing.

3.02 SYSTEM STARTUP

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

3.03 TRAINING

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

- END OF SECTION -

SECTION 26 90 06
ELECTRICAL CONTROL COMPONENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Electrical Control Components shall meet the performance, protection, safety and certification criteria of this specification.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 RELATED SECTIONS

- A. Section 26 05 00 – Common Work Results
- B. Section 26 90 00 – Process Instrumentation and Control

1.04 REFERENCES

- A. NFPA 70 – National Fire Protection Association - US National Electrical Code.
- B. UL 508 – Underwriters Laboratory Inc.
- C. UL 698A – Underwriters Laboratory Inc. (Where applicable)
- D. IEC 146 – International Electrical Code

1.05 SUBMITTALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of -40 °C to 70 °C (-40 °F to 158 °F).
- C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.08 WARRANTY

- A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

PART 2 - PRODUCTS

2.01 ELECTRICAL CONTROL COMPONENTS

- A. The electrical control components shall include:
1. Pilot Devices & Control Stations
 2. Relays and Timers
 3. Miniature Circuit Breakers
 4. Terminal Blocks and Fuse Blocks
 5. Power Supplies
 6. Intrinsic Barriers
 7. Signal Conditioners/Isolators
 8. Sensing Devices
 9. Control Stations
- B. The electrical control components shall be interoperable with standard electrical equipment.
- C. Electrical control components shall be suitable for the environment which they are installed.

2.02 PILOT DEVICES AND CONTROL STATIONS

- A. Manufacturer
1. Rockwell 800T/H Series
 2. Eaton 10250T Series
 3. Or Engineer approved equal
- B. 30.5mm Pushbuttons, Selector Switches, and Pilot Lights
1. Construction
 - a. Type 4/13 watertight/oil-tight or type 4/4X/13 corrosion-resistant/watertight/oil-tight.
 - b. 30.5 mm push buttons, selector switches and pilot lights shall provide EN/IEC 60529 IP66/65 degree of protection.
 - c. Electrical design life cycles: 10,000,000 at max. rated load.
 - d. Operating range: -40 to 131°F (-40 to 55°C).
 - e. Illuminated devices: Press-to-test LED type.
 - f. Push buttons shall have a diaphragm seal for protection from liquids, particles, and corrosive agents.
 - g. Selector switches shall incorporate a positive detent to prevent the switch from hanging up between positions.
- C. Potentiometer Devices
1. Type 4/13 watertight/oil-tight or type 4/4X/13 corrosion-resistant/watertight/oil-tight.
 2. Shall be rated for 300 VAC/VDC, 2 W maximum (6 VDC minimum):
 - a. Mechanical design life: Min. 25,000 cycles
 - b. Rotational torque: 3 to 12 in-oz

- c. Stopping torque: Min. 12 in-lb
- 3. Shall have single-turn operation, 312-degree rotation.

D. Control Stations

- 1. Control stations shall provide heavy industrial 30.5 mm push button(s) or selector switch with appropriate contact action, button/lever type and color/legend marking. Devices shall be type 4/13 watertight/oil-tight or type 4/4X/13 corrosion-resistant/watertight/oil-tight.
- 2. Control stations shall be suitable for the environment which they are installed.
- 3. Emergency Stop Switches
 - a. Rockwell Model 800H-TFRXT6A, or Engineer approved equal.
 - b. 800H Non-Illuminated Trigger Action.
 - c. Two-position maintained.
 - d. Twist release.
 - e. Red 45mm plastic head.
 - f. 1-NO and 1-NC standard contacts.

2.03 ELAPSED TIME METERS (ETM)

A. Manufacturer

- 1. Eaton / Durant E42DIR Series
- 2. Or Engineer approved equal

B. Round solid-state hour meter

C. Performance

- 1. Record and display up to 99,999.9 hours, rollover and continue timing.
- 2. EEPROM memory, data retention for up to 25 years.
- 3. Visual indication for time accumulation
- 4. Frequency range: 48 – 440 Hz
- 5. Display: 6-digit LCD, 0.20"
- 6. Accuracy: +/- 0.1%
- 7. Resolution: 0.1 hour

2.04 RELAYS AND TIMERS

A. Manufacturer

- 1. Rockwell / Allen-Bradley
- 2. Eaton
- 3. Or Engineer approved equal

B. Relays – Time Delay

- 1. Time delay relays shall have 10A (minimum), DPDT contact ratings and coil voltages appropriate for the power source.
- 2. Function: User-selectable timing functions and timing ranges.
- 3. Terminals: Screw-type

4. Indication: LED

C. Relays – General Purpose

1. Allen-Bradley general purpose relays Bulletin 700-HB, or Engineer approved equal.
2. Shall have tube-base/Octal 8-pin or 11-pin terminals and ON/OFF flag indicators.
3. General purpose relay contacts shall be silver nickel, have 10A, DPDT or 3PDT ratings, and coil voltages appropriate for the power source.
4. General purpose relays shall have an electrical schematic on the faceplate and a clear cover for visual inspection.
5. General purpose relays shall have LED status indicators, push-to-test and manual override.

D. Relays – Miniature

1. Rockwell 700-HL series pluggable terminal block, or Engineer approved equal.
2. For control logic circuit connections to programmable logic controllers.
3. Miniature relay contacts shall be silver or gold-plated, have 6A, DPDT ratings, and coil voltages appropriate for the power source.
4. Miniature relays shall have an electrical schematic on the faceplate and a clear cover for visual inspection.
5. Miniature relays shall have LED status indicators.

E. Relays – Industrial-type

1. Allen-Bradley industrial-type relays Bulletin 700-P, or Engineer approved equal.
2. Shall be ruggedly constructed (10 million operation mechanical life), 2-pole, 4-pole, 8-pole, or 12-pole, configured N.O./N.C., and DIN-rail mounted.
3. Industrial-type relays shall be finger-safe.
4. Industrial-type relay contacts shall be silver nickel with a double-break and bifurcated design and 10A rating for AC or 5A rating for DC.
5. Accessories shall include adder decks, time delay, latching, surge suppressors and/or mounting strip.

F. Timers – Pneumatic

1. Allen-Bradley pneumatic timers Bulletin 700-PT, or Engineer approved equal, shall be open-type and mounted on Allen-Bradley industrial-type relays Bulletin 700-P, or equal.
2. Pneumatic timer contacts shall be 1 N.O. and 1 N.C., rated 10A.
3. Timing modes shall be On-Delay and Off-Delay with ranges of 0.1 to 60 seconds as shown on drawings.

G. Timers – Solid-State

1. Allen-Bradley solid-state timers Bulletin 700-FS, or Engineer approved equal.
2. Shall be DIN rail-mounted.
3. The solid-state timer contacts shall be available as SPDT or DPDT, 8A.
4. Solid-state timers shall be available with On-Delay, Off-Delay, On- and Off-Delay, One-Shot and Flasher operating modes as required on the drawings.
5. Solid-state timers shall have coil surge protection and adjustable timing ranges of 0.05 seconds to 60 hours as shown on drawings.

H. Timers – Programmable

1. Allen-Bradley programmable timers Bulletin 700-HX, or Engineer approved equal.
2. Shall be digital timing relays with LCD display and shall be socket-mounted.
3. Programmable timer contacts shall be SPDT, rated 5A.
4. Programmable timer panel surface shall offer Type 4X/IP66 protection.
5. Programmable timers shall be configurable for Signal On-Delay, Power On-Delay, Off-Delay, Repeat Cycle, One-Shot and Cumulative operating modes as required.
6. Programmable timers shall have timing ranges of 0.000 seconds to 9999 hours, depending on selected mode.

2.05 MINIATURE CIRCUIT BREAKERS

- A. Miniature circuit breakers shall be Allen-Bradley Circuit Breakers Bulletin 1489-M, or Engineer approved equal.
- B. Miniature circuit breakers shall be thermal-magnetic, current-limiting type:
1. 0.5A to 63A current rating
 2. 1-, 2- or 3-pole
 3. Type C or Type D tripping characteristic
- C. Miniature circuit breakers shall be UL Listed (E197878), CSA Certified (259391), CE Marked, and RoHS Compliant. Standards compliances shall include:
1. UL 489
 2. CSA C22.2, No. 5.1
- D. Miniature circuit breakers shall be rated for:
1. Voltage: Max. 480Y/277 VAC
 2. Interrupting capacity: 10 kA
- E. Housing shall satisfy Insulation Group II/RAL 7035, shall have IP20 finger-safe design, shall be suitable for DIN rail mounting and shall include status indicator window and scratch- and solvent-resistant printing.
- F. Miniature circuit breakers shall support reversible line and load connections and shall have dual terminals that:
1. Connect up to 4 wires, or 2 wires and a bus bar.
 2. Clamp from both sides.
- G. Miniature circuit breakers shall be compatible with UL 508 Listed bus bars, auxiliary contacts, signal contacts, shunt trips and toggle-mount lockout attachments.

2.06 TERMINAL BLOCKS AND FUSE BLOCKS

- A. Terminal Blocks – Control, #22 to #8 AWG
1. Manufacturer
 - a. Rockwell / Allen-Bradley Bulletin 1492
 - b. Or Engineer approved equal

2. Control terminal blocks shall be screw-type, feed-through.
3. Control terminal blocks shall be certified:
 - a. UR/CSA – #22 to #8 AWG wire range, 50A maximum current, 600 VAC/VDC voltage rating
 - b. IEC – 6 mm² wire range, 41A maximum current, 800 VAC/VDC voltage rating
4. Color: Gray (Green for grounding terminals)
5. Control terminal blocks shall have a snap-in card marking system.
6. Accessories
 - a. End anchors
 - b. Partitions

B. Terminal Blocks – Power

1. Power terminal blocks shall be Allen-Bradley Bulletin 1492-PD, or Engineer approved equal:
 - a. Mini-block – 3-pole, rated at 600 VAC/VDC, 115A
 - b. Open-style power distribution block with aluminum or copper connectors – 3-pole or 1-pole, rated at 600 VAC/VDC, 175 to 760A
 - c. Open-style feed-through/splicer terminal block with aluminum or copper connectors – 3-pole or 1-pole, rated at 600 VAC/VDC, 175 to 760A
2. Power terminal blocks shall be certified by UR, CSA and CE.
3. Wire ranges and tightening torques shall be labeled on the block.

C. Fuse Blocks

1. Allen-Bradley fuse block kits Bulletin 1491, or equal.
2. Shall be used for protection of transformers and control circuits capable of delivering no more than 200,000 RMS symmetrical amps, 600V maximum.
3. Fuse block kits shall be 1-pole, 2-pole or 3-pole.
4. Each pole shall have a fuse cover.

2.07 ALARMS AND SIGNALS

A. Alarm Horn

1. The alarm horn shall be an Allen-Bradley High Performance Electronic Horn Bulletin 855H, or Engineer approved equal.
2. The alarm horn shall have a UV-stable plastic housing and non-moving parts.

B. Alarm Beacon

1. The alarm beacon shall be an Allen-Bradley Bulletin 855B, or Engineer approved equal.
2. LED illumination.
3. The alarm beacon shall have polycarbonate housing and lens and Type 4/4X/13, IP65/IP66 ingress rating as required for the installation location.
4. Flashing frequency shall be 1 Hz.
5. Alarm beacon lens colors shall be red.

C. Signal Alarm (Panel Mount)

1. The signal alarm shall be an Allen-Bradley Panel Mount Signaling Alarm Bulletin 855P, or Engineer approved equal.
2. The signal alarm shall have polycarbonate base and lens.
3. The signal alarm shall be:
 - a. Sounder
4. The signal alarm shall be rear-securing and finger-safe.

2.08 POWER SUPPLIES

A. Control Power Transformer

1. Manufacturer
 - a. Allen-Bradley Bulletin 1497
 - b. Or Engineer approved equal
2. Construction
 - a. Single-phase.
 - I. 240x480 volt Primary
 - II. 120 or 24 volt Secondary, as required for by the secondary load.
 - b. The control power transformer shall be epoxy encapsulated.
 - c. The control transformer shall have a dual primary and single secondary fuse block, pre-wired and top-mounted.
 - d. Provide with primary and secondary fuses sized based on transformer VA.
3. Size Transformers sufficiently to operate at no more than 50% of rated capacity. Size for a rated capacity of 200% that of the load served.
 - a. Upon Engineer's request, submit load/sizing calculations to engineer for review.

B. 24 VDC Power Supplies

1. Manufacturer
 - a. Allen-Bradley Bulletin 1606
 - b. Idec PS5R-V Series
 - c. Or engineer approved equal
2. Perform load calculations and size Power Supplies sufficiently to operate at no more than 50% of rated capacity. Size power supplies for a rated capacity of 200% that of the load to which they supply power.
 - a. Upon Engineer's request, submit load/sizing calculations to engineer for review.
3. 24 VDC power supplies shall have low inrush current, and power supplies with greater than 100-Watt output shall incorporate a minimum 120% Power Burst design.
4. 24 VDC power supplies shall have NEC Class 2 "Limited Power" output.

C. Uninterruptible Power Supplies (UPS)

1. Manufacturer
 - a. Allen-Bradley Bulletin 1609-B/D Series (for AC loads)
 - b. PULS UB10.241 (for DC loads)

- c. Or engineer approved equal
- 2. Perform load calculations and size UPS to be of sufficient capacity to operate for a minimum of 15 minutes during loss of supply power.
 - a. Upon Engineer's request, submit load/sizing calculations to engineer for review.
- 3. Supply with all necessary batteries and other accessories for an operable and complete system.
- 4. 120 VAC input voltage and 24 VDC or 120VAC output, as required for the installation.
- 5. Shall be DIN-rail mounted.
- 6. Shall provide:
 - a. Surge protection to 380 Joules
 - b. Overload protection, resulting in delayed shutdown at 110 to 130% and immediate shutdown at 130%
 - c. Protection against output short on line – over-current protection from premises branch circuit
 - d. Protection against output short on battery, resulting in shutdown
 - e. Thermal protection
- 7. The UPS shall have dry status contacts.
 - a. UPS Ready
 - b. UPS Buffering
 - c. UPS Change Battery
- 8. The UPS shall perform to 50°C, which may require hi-temperature rated batteries depending on the unit.

2.09 INTRINSIC BARRIERS

A. Intrinsic Safe Relays

- 1. Manufacturer
 - a. Allen-Bradley Bulletin 937
 - b. Turck IM1-22EX-R
 - c. Or engineer approved equal
- 2. Used to limit energy to field devices in hazardous locations.
- 3. Performance
 - a. Signal Type: Discrete I/O
 - b. Approvals: UL Listed
 - c. Functional Safety: SIL2
 - d. Protection Class: IP20
 - e. The interface device shall contain a fuse for fault protection and zener diodes to limit voltage and shall provide resistance to excessive current.
 - f. The interface device shall provide signal break and short-circuit monitoring.

B. Intrinsic Safe Barriers

- 1. Manufacturer
 - a. Allen-Bradley Bulletin 937
 - b. Turck IM33-11EX-HI/24VDC
 - c. Or engineer approved equal

2. Used to limit energy to field devices in hazardous locations.
3. Performance
 - a. Signal Type: Analog (HART transparent)
 - b. Device Type: Isolating transducer
 - c. Approvals: UL Listed
 - d. Functional Safety: SIL2
 - e. Protection Class: IP20
 - f. The device shall include a built-in zener barrier and transformer-based isolation.
 - g. The interface device shall provide signal break and short-circuit monitoring.

2.10 SIGNAL CONDITIONERS/ISOLATORS

A. Manufacturer

1. Allen-Bradley Bulletin 931
2. Or engineer approved equal

B. For isolating, repeating, or converting of analog signals/circuits.

1. High-density device – 6 mm wide, current/voltage isolator, current/voltage converter, RTD converter, thermocouple, HART isolator.
2. Standard device – 12.5 to 22.5 mm wide, current/voltage isolator, current/voltage converter, RTD converter, thermocouple, line monitoring isolator, line monitoring converter, bridge converter, frequency converter.
3. Universal device – 12.5 mm wide, programmable converter for current, voltage, RTD, thermocouple, potentiometer, resistance and frequency signals

C. The signal conditioner/isolator shall mount on DIN rail and provide local status indications

2.11 SENSING DEVICES

A. Systems Integrator / Control Panel provider shall provide field connection terminals for separate monitoring of each circuit/device.

B. Intrinsically Safe Relays/Barriers shall be provided for any circuits where required when switches or other devices are installed in classified / hazardous locations.

C. Door and Hatch Switches

1. Door Switch - Non-hazardous and unclassified locations

- a. Manufacturers
 - I. Edwards Model 2507A-L.
 - II. Engineer approved equal.
- b. Construction
 - I. Includes 28" Stainless Armored Cable
 - II. IP67 Rated
 - III. UL Listed
 - IV. 30V Rated SPDT Contacts
- c. Accessories
 - I. Provide custom aluminum angle brackets for mounting, and to separate from door and frame.
 - II. Provide flush box adjacent and connect cable to stainless cover plate.

2. Hatch Switch – Non-hazardous and unclassified locations
 - a. Manufacturers
 - I. Rockwell Series 802T.
 - II. Engineer approved equal.
 - b. Construction
 - I. Type 4/13 oil-tight with synthetic rubber seals
 - II. UL Listed
 - III. Spring return Level Type
3. Door and Hatch Switch – Classified and corrosive locations
 - a. Manufacturers
 - I. Rockwell Series 802MC-A.
 - II. Engineer approved equal.
 - b. Construction
 - I. Corrosion Resistant
 - II. Type 316 stainless steel for exposed metal parts
 - III. NEMA 4X
 - IV. UL Listed
 - V. Spring return Level Type

D. Temperature Transmitters

1. Non-classified locations (Panel/wall-mount)
 - a. Manufacturers
 - I. Siemens QAC3171.
 - II. Engineer approved equal.
 - b. Performance
 - I. Output: 4-20mA (loop powered)
 - II. Display: None
 - III. Housing: IP65
 - IV. Cable Entry: Cable Gland
 - V. Sensor Range: 4...20 mA –50...+50 °C
 - c. Accessories
 - I. Wall mount. Provide flush box adjacent with Gland in stainless cover plate.
2. Manufacturer
 - a. Dayton Model 1UHH2
 - b. Or equal
3. Line-voltage heating/cooling mechanical thermostat
4. Performance
 - a. Switch Type: SPDT
 - b. Control Range: 30 to 110 °F
 - c. Voltage: 24 to 600 VAC
 - d. Full Load Amps: 16A @ 120 VAC
 - e. Differential: 3.5 °F

E. Thermostats for Control Panels

1. Manufacturer
 - a. Saginaw Control & Engineering Model SCE-TEMNC, -TEMNO

- b. Or equal
- 2. UL recognized component.
- 3. Normally Open type for cooling.
- 4. Normally Closed type for heating.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.
- B. The supplier shall verify all settings have been properly adjusted prior to energizing.
- C. The supplier shall ensure accessibility to electrical control devices.

3.02 SPARE MATERIALS

- A. The supplier shall provide one (1) spare electrical control device of each type utilized.

3.03 SYSTEM STARTUP

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

3.04 TRAINING

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

- END OF SECTION -

SECTION 26 90 72.43
SUBMERSIBLE PRESSURE TRANSDUCERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Submersible pressure transducers shall contain all components required to meet the performance, protection, safety, and certification criteria of this specification.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 RELATED SECTIONS

- A. Section 26 05 00 – Common Work Results
- B. Section 26 90 00 – Process Instrumentation and Control

1.04 REFERENCES

- A. NFPA 70 – National Fire Protection Association - US National Electrical Code.
- B. UL 698A – Underwriters Laboratory Inc.

1.05 SUBMITTALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.07 QUALITY ASSURANCE

- A. Section 26 90 00 System Integrator shall provide this equipment to contractor and shall include all interconnection and installation details in SI submittal.
- B. Startup and training shall be by System Integrator.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of 0 °C to 40 °C (32 °F to 104 °F).

C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.09 WARRANTY

A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE PRESSURE TRANSDUCERS

A. Manufacturers

1. Endress & Hauser Waterpilot FMX21.
2. KPSI 750.
3. Engineer approved equal.

B. Construction

1. Material: 316L stainless steel
2. Process Connection: Mounting clamp
3. Seal: FKM Gland
4. Provide with cable length sufficient to reach junction box without splicing, and with sufficient extra length for adjustment and maintenance.

C. Mounting Hardware

1. Transducers shall be provided with manufacturer recommended mounting and suspension hardware or as shown on the drawings or as specified.

D. Approval(s): Class 1 Division 1, Hazardous Location

E. Certifications:

1. UL Listed
2. CE compliant
3. FM compliant

F. Output: 4-20mA

G. Accuracy: +/- 0.25 % of the set span

2.02 ADDITIONAL REQUIREMENTS

A. Intrinsically Safe Barriers shall be provided for any circuits where transducers are installed in classified / hazardous locations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All equipment shall be installed, configured, interconnected, and commissioned by qualified persons, in accordance with the manufacturer's instructions and guidelines, and in compliance with all governing regulations and accepted engineering practices.
- B. Wire per System Integrator Interconnection drawings.
- C. Observe noted mounting heights.

3.02 SYSTEM STARTUP

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

3.03 TRAINING

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

- END OF SECTION -

SECTION 26 90 72.76 LEVEL SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Level Switches shall contain all components required to meet the performance, protection, safety, and certification criteria of this specification.

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.

1.03 RELATED SECTIONS

- A. Section 26 05 00 – Common Work Results
- B. Section 26 90 00 – Process Instrumentation and Control

1.04 REFERENCES

- A. NFPA 70 – National Fire Protection Association - US National Electrical Code.
- B. UL 698A – Underwriters Laboratory Inc.

1.05 SUBMITTALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Submit under provisions of Division 1
- B. Refer to Section 26 90 00 – Process Instrumentation and Control for additional requirements.

1.07 QUALITY ASSURANCE

- A. Section 26 90 00 System Integrator shall provide this equipment to contractor and shall include all interconnection and installation details in SI submittal.
- B. Startup and training shall be by System Integrator.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of 0 °C to 40 °C (32 °F to 104 °F).

- C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.09 WARRANTY

- A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

PART 2 - PRODUCTS

2.01 FLOAT SWITCHES

- A. Manufacturers

1. Contegra Model FS-90.
2. Evoqua / Siemens Model 9G-EF.
3. Anchor Scientific Model Roto-Float-SSTNM.
4. Engineer approved equal.

- B. Construction

1. Non-mercury.
2. Stainless Steel with non-stick coating.
3. 5-inch or 5-1/2-inch diameter.
4. Contact Rated 1-amp at 120 Vac.
5. Provide with cable length sufficient to reach junction box without splicing, and with sufficient extra length for adjustment and maintenance.

- C. Mounting Hardware

1. Float switches shall be provided with either cable mounting or pipe mounting hardware as shown on the drawings or as specified.
2. Cable Mounting
 - a. Provide with manufacturer recommended stainless steel cable and hardware for mounting the floats in the Wet Well.
 - b. Provide vinyl coated Float / Cable Anchor for each installation location.
3. Pipe Mounting
 - a. Contractor to provide pipe(s) and pipe mounting hardware where pipe mount installation type is shown or described.

2.02 FLOOD SWITCHES

- A. Manufacturers

1. Contegra Model FS-202.
2. Anchor Scientific Model 1500.
3. Engineer approved equal.

- B. Construction

1. Reed switch closes on rising float.
2. Submersible, corrosion resistant.
3. Contact Rated 0.5-amp at 24 Vdc.

C. Mounting Hardware

1. Flood switches shall be wall-mount type.
2. Install unit surface box over flush wall box.

2.03 ADDITIONAL REQUIREMENTS

- A. Intrinsically Safe Relays shall be provided for any circuits where switches are installed in classified / hazardous locations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All equipment shall be installed, configured, interconnected, and commissioned by qualified persons, in accordance with the manufacturer's instructions and guidelines, and in compliance with all governing regulations and accepted engineering practices.
- B. Wire per System Integrator Interconnection drawings.
- C. Observe noted mounting heights.

3.02 SYSTEM STARTUP

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

3.03 TRAINING

- A. Refer to Section 26 90 00 – Process Instrumentation and Control.

- END OF SECTION -

33

DIVISION 33

UTILITIES

SECTION 33 01 30.16

SEWER CLEANING & TELEVISIONING

PART 1 – GENERAL

1.01 SUMMARY

- A. Work included: This section includes cleaning and televising for sanitary sewer lines.
- B. Contractor shall submit three (3) copies of television inspection logs and DVD recordings (Flash Drive or DVD). One copy for Contractor and two copies for Engineer.

PART 2 – PRODUCTS - NOT APPLICABLE

PART 3 - INSTALLATION

3.01 SEWER LINE CLEANING

- A. High-Velocity Jet Equipment shall be used on this project. All high-velocity sewer cleaning equipment shall be constructed for ease and safety of operation. The equipment shall have a selection of two or more high-velocity nozzles. The nozzles shall be capable of producing a scouring action from 15 to 45 degrees in all size lines designated to be cleaned. The equipment shall carry its own water tank.
- B. The equipment shall be capable of removing dirt, grease, rocks, sand, and other materials and obstructions from the sewer lines and manholes. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning again attempted. If, again, successful cleaning cannot be performed or the equipment fails to traverse the entire manhole section, it will be assumed that a major blockage exists and the cleaning effort shall be abandoned.
- C. Roots shall be removed in the designated sections where root intrusion is a problem. Any work done to remove roots in a section shall be documented in the report. Documentation shall include the locations in the pipe segment where roots were removed and the procedure, which was used to remove the roots.
- D. All sludge, dirt, sand, rock, grease, and other solid or semisolid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from manhole section to manhole section, which could cause line stoppages, accumulations of sand in wet wells, or damage pumping equipment, shall not be permitted. A vacuum truck shall be used to remove accumulations of material.
- E. All solids or semi-solids resulting from the cleaning operations shall be removed from the site and disposed of at a site designated by the Owner. All materials shall be removed from the site no less often than at the end of each workday. Under no circumstances will the Contractor be allowed to accumulate debris, etc., on the site of work beyond the stated time, except in totally enclosed containers and as approved by the Owner.

- F. If the Contractor requires water for cleaning operations from hydrants, the Contractor shall make arrangements with the local water utility and shall use only fire hydrants designated by the responsible water utility. The Owner will pay all costs associated with use of this water. The Contractor shall provide backflow preventers at the hydrants to prevent contamination of the water system.
- G. Acceptance of sewer line cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the Owner. If TV inspection shows the cleaning to be unsatisfactory, the Contractor shall be required to re-clean and re-inspect the sewer line until the cleaning is shown to be satisfactory.

3.02 SEWER TELEVISION

- A. All designated sewer sections shall be visually inspected by means of closed-circuit color television.
- B. The television camera used for the inspection shall be one specifically designed and constructed for such inspection. The camera shall be capable of radial view for inspection of the top, bottom, and sides of pipe and for looking up lateral connections. The camera shall be mounted on adjustable skids, or self propelled, to keep it in the center of the pipe. Lighting of the camera shall be supplied by a lamp on the camera, capable of being dimmed or brightened remotely from the control panel. The lighting system shall be capable of lighting the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions and shall have a minimum of 650 lines of resolution and tested at 400 psi. The view seen by the televising camera shall be transmitted to a monitor of not less than 17 inches. The camera, television monitor, and other components of the DVD system shall be capable of producing a picture quality satisfactory to the Engineer; and if unsatisfactory, the equipment shall be removed and no payment will be made for an unsatisfactory inspection.
- C. The television camera shall be moved through the line in either direction at a uniform rate, stopping when necessary to insure proper documentation of the sewer's condition but in no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds (or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions) shall be used to move the camera through the sewer line. If, during the inspection operation the television camera will not pass through the entire sewer section, the Contractor shall re-setup his equipment in a manner so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire sewer section, the inspection shall be considered complete and no additional inspection work will be required. All costs for re-setup due to an obstruction in the sewer that will not allow the camera to pass shall be considered incidental. If the camera becomes submerged due to a sag in the pipe, a high velocity jet will be utilized to pull water away from the camera lens.
- D. The location meter, for accurately recording the location of the television camera with respect to the reference manhole, shall be a direct reading, above ground, friction clamp device or other suitable equipment. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be allowed. The meter shall be capable of reducing readings for reverse movement of the camera and shall be capable of being manually re-zeroed for each new setup. Footage shall be shown on the DVD data view and recorded at all times.

- E. The logs shall be typed or computer printed and acceptable to the Owner. Printed location records shall be kept by the contractor and will clearly show the location, in relation to adjacent manholes, of each infiltration point discovered by the television camera. An estimate of the flow rate of observed infiltration points shall be made and recorded. In addition, other points of significance such as locations of building sewer laterals, joints, unusual conditions, roots, storm sewer connections, collapsed sections, presence of scale and corrosion, and other discernible features will be recorded and two (2) copies of such records shall be supplied to the Owner.
- F. The purpose of tape recording shall be to supply a visual and audio record of the condition of the lines that may be replayed both daily and at future presentations. DVD recording playback shall be at the same speed that it was recorded. Upon completion of the work, all discs recorded during the television inspection shall become the property of the Owner. Cost of DVDs/Flash drives shall be included in the unit price bid. A complete recording shall be made of each line televised. A voice recording on DVDs shall make brief and informative comments on the sewer conditions.
1. DVDs/Flash drives shall include the following information:
 - a. Visual (on screen in corner):
 - 1) Report number.
 - 2) Date of television inspection.
 - 3) Sewer section and number.
 - 4) Current distance along reach (tape counter footage).
 - 5) Printed labels on DVD containers and DVD discs or Flash Drives with location information, date, format information, and other descriptive information.
 - 6) Three (3) sets of DVD or Flash Drive with Report shall be submitted. (1 copy for Contractor and 2 copies for Engineer).
 - b. Audio:
 - 1) Date and time of television inspection, operator name, name of overlying or adjacent street, and manhole numbers.
 - 2) Verbal confirmation of sewer section and television direction in relation to direction of flow.
 - 3) Verbal description of pipe size, type, and pipe joint length.
 - 4) Verbal description and location of each service connection and pipe defect.
 - 5) Type of weather during inspection.
 2. Television inspection logs shall include, but are not limited to, the following:
 - a. Date, time, city, street, basin, sewer section, reference manhole number, name of operator, inspector, and weather conditions.
 - b. Pipe diameter, pipe material, section length, depth of pipe, length between joints, and corresponding DVD/Flash Drive identification.
 - c. Location of each point of leakage.
 - d. Location of each service connection.
 - e. Location of any damaged sections, nature of damage, and location with respect to pipe axis.
 - f. Deflection in alignment of grade of pipe.
- G. Acceptance of televising shall be made upon the successful completion of the project and shall be to the satisfaction of the Owner. If the recordings show the inspection to be unsatisfactory, the Contractor shall be required to re-inspect the sewer line.

SECTION 4 – PAYMENT

- A. Payment shall be based on following: Line cleaning and television inspection of the sewer lines shall be incidental to the appropriate bid item.

- END OF SECTION -

SECTION 33 32 19

SUBMERSIBLE PUMP LIFT STATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: This section includes providing integral valve vault lift station in accordance with the drawings and specifications.
- B. Section includes the following to provide a complete submersible pump lift station:
1. Pre-cast wet well.
 2. Pre-cast valve manhole.
 3. Non-clog submersible centrifugal wastewater pumps.
 4. Pump mounting and guide systems.
 5. Piping, fittings and valves.
 6. Electrical switchgear and electrical service.
 7. System instrumentation and controls.
 8. Control panels.
 9. Telemetry system.
 10. Installation and start-up.
- C. Related sections and divisions:
1. Applicable provisions of the General Conditions shall govern the work in this section.
 2. Section 01 75 00, Start-up, Testing and Operator Training.
 3. Section 01 78 23, Operation and Maintenance Data.
 4. Section 40 05 13.53, Ductile Iron Pipe.
 5. Section 05 50 50, Metal Fabrications.
 6. Section 09 90 00, Painting and Special Coatings.
 7. Section 10 14 00, Signage.
 8. Section 01 78 43, Equipment, Installation, Training, and Receipt for Spare Parts Checklists.
 9. Section 46 42 56.19, Submersible Centrifugal Pumps.
 10. Section 40 05 15, Methods & Materials for Pipe Installation
 11. Section 40 05 16.61, Valves – Lift Stations.
 12. Section 40 05 13.10, Buried Piping and Appurtenances.
 13. Division 26, Electrical.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
1. ASTM A48 Standard Specification for Gray Iron Castings
 2. ASTM A615 Standard Specification for Deformed and Plain –Carbon- Steel Bars for Concrete Reinforcement
 3. ASTM C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 4. ASTM C478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
 5. ASTM C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes, and Laterals

6. ASTM D41 01 Standard Specification for Polypropylene Injection and Extrusion Materials

B. American National Standards Institute (ANSI):

1. ANSI A21.10 Ductile-Iron and Gray Iron Fittings, 3 inch through 48 inch for Water and Other Liquids.

C. National Electric Code (NEC)

D. NEMA Electrical Standards

E. Underwriter's Laboratory

1.03 SUBMITTALS

A. Submit the following:

1. Shop drawings including complete assembly and installation drawings.
2. Integral wet well/valve manhole with all openings shown and located.
3. Manufacturers certification that manholes were manufactured in accordance with designated reference standards with test results and date of tests.
4. Descriptive information on material and equipment.
5. Assembled electrical and control equipment drawings for all components.
6. Pump information including:
 - a. Name of manufacturer.
 - b. Type and model.
 - c. Design rotative speed.
 - d. Weight of pump and motor assembly.
 - e. Complete performance curves showing:
 - 1.) Flow
 - 2.) Total Design Head
 - 3.) Efficiency
 - 4.) Brake Horsepower
 - f. Materials of construction and cross-sectional drawing.
 - g. Pump mounting and guide system.
7. Submit two (2) copies of a report documenting the field testing results to the Engineer

C. Operation and maintenance manuals shall be provided in accordance with Section 01 78 23, Operation and Maintenance Data.

PART 2 - PRODUCTS

2.01 PRECAST REINFORCED CONCRETE WET WELL AND VALVE MANHOLE

A. Pre-cast reinforced concrete components in accordance with ASTM C478.

B. The integral valve vault area shall be fabricated of pre-cast concrete with minimum inside dimensions as shown on the contract drawings. The lift station shall be designed for installation in a ground water table 3 feet below the top of lift station slab. Watertight joint wall sleeves shall be provided where the joints are made to the inlet and discharge lines. The joint shall also be so designed to absorb any vibration, distortion, and normal settling and maintain a leak-proof seal. The rubber gasket element shall be constructed of poly-isoprene or natural rubber to the

requirements of ASTM C923. The gasket shall have a minimum tensile strength of 1600 psi and a minimum thickness of 0.275 inches.

- C. The valve chamber shall be furnished as an integral part of the pump chamber. The top of the chamber shall include an aluminum hatch. The valve vault shall provide complete isolation from the wastewater wet well. Concrete supplier shall determine the thickness of the base, transition, and cover sections and supply structural calculations stamped by a registered professional engineer. A factory representative shall be on site to witness station installation and offer on-site technical assistance. The concrete supplier shall have a minimum of three years experience in the manufacturing of pre-cast integral valve vault structures.
- D. Each piece of the station shall be cast from a one piece mold. The use of connecting form ties which may result in corrosion or leakage points is not acceptable. The rectangular box transition piece shall each be a single pour section. All lift station joints shall have bell and spigot connections in conformance with ASTM C478. Station to be supplied with all necessary bitumastic joint sealant.
- E. The concrete supplier's manufacturing facility shall be certified by the National Precast Concrete Association and a copy of certification shall be included with the submittal documents.
- F. Joints shall be in accordance with ASTM C443 with 1-1/4-inch thick butyl gasket.
- G. Tops shall withstand AASHTO H-20 loadings.
- H. Plastic cement sealant shall be in accordance with Federal Specification SS-C-153C.
- I. Connectors between manhole structure and pipes shall be in accordance with ASTM C923.
- J. Access hatches shall be provided as specified in Section 05 06 50, Metal Fabrications.
- K. Entrance Danger Signs
 - 1. Signage shall be as specified in Section 10 14 00, Signage.

2.02 SURFACE COATINGS

- A. The exterior concrete surfaces of valve vault shall be coated per coated per C-6 System Type and all piping, which is not stainless steel or PVC, shall be coated per P-1 or P-2 System Type in accordance with Specification Section, 09 90 00, Painting and Special Coatings.
- B. Pumps shall receive a standard factory applied coating suitable for submerged condition in raw municipal wastewater as specified in Section 09 90 00, Painting & Special Coatings.

2.03 PUMPING EQUIPMENT

- A. Pump shall be as specified in Section 46 42 56.19, Submersible Centrifugal Pumps.

2.04 PORTABLE DAVIT CRANE

- A. Provide a davit crane top of slab mounting base assembly as shown on the plans for removing the submersible pumps. The mounting base shall be fabricated out of 304 stainless steel.

2.05 PRESSURE GAUGES

- A. Acceptable manufacturers shall be Terrice, Ashcroft or equal.
- B. Furnish and install gauges where shown on the drawings or where required to perform start-up testing.
- C. All gauges shall have pressure ranges as shown on the drawings.
- D. All gauges for lift station applications shall be a minimum 2½-inch diameter stainless steel, liquid filled, and equipped with factory installed diaphragm seals.
- E. Provide each gauge with a 316 stainless steel bourdon tube and a ¼-inch NPT bottom connection.

2.06 PIPING INSTALLATION

- A. Piping installation shall be as specified in Section 40 05 15, Methods & Materials for Piping Installations.

2.07 ELECTRICAL AND CONTROL SYSTEMS

- A. Control panel shall be provided by P. J. Kortens and Company, Inc., through an allowance item.
- B. Refer to Division 26 for electrical/control description.

PART 3 - EXECUTION

3.01 Installation

- A. Install in accordance with the shop drawings and manufacturer's recommendations. After installation, demonstrate trouble free operation in presence of the Engineer.
- B. Install the wet well, valve manhole and piping at alignment and grades shown on the drawings in accordance with the specification backfilling and compacting requirements.
- C. Piping, fittings and valves shall be installed per alignment shown on the drawings with proper support and restraint on all pipe, valves, joints and fittings.
- D. The pump and pump guides shall be installed and anchored with stainless steel anchors per manufacturer's recommendations.
- E. Each motor power cable and control cable shall be in a separate conduit with sealed junction boxes below the control panel.

3.02 Field Testing

- A. All necessary precautions recommended by the Manufacturer and as specified herein shall be followed to ensure that the wet well and piping connected thereto is completely clean and free of any debris, dirt, or other foreign materials which could clog the pumps, piping and interfere with operation.

- B. Field testing shall be conducted on the equipment provided. Each pump shall be subjected to an operational test before acceptance as follows:
1. The pump shall be properly installed in the wet well, firmly upon its discharge connection. After determination (a) proper service voltage is being supplied, and (b) proper rotation of the impeller. No cooling by forced or circulated air shall be allowed.
 2. Pump shall be demonstrated to operate without excessive noise, vibration, and without overheating at its rated condition.
 3. All components and operation sequences of the lift station, as specified herein, shall be tested in the field to verify proper operation in accordance with this specification. Each operation and alarm condition shall be satisfactorily performed and documented on the lift station alarm test form.
- C. All testing shall be performed under the supervision of the Manufacturer's representative in the presence of the Engineer.
- D. Engineer shall be notified in advance of any field tests.
- E. The field test must meet the performance requirements as described in this specification. Tests shall be extended or repeated if, in the opinion of the Engineer, additional time is needed to make observations.
- F. All defects noted during the field test shall be corrected promptly at the expense of the Manufacturer.
1. When necessary, the field test shall be repeated until the requirements of the specification have been met.
 2. All testing and modifications required to meet the specification shall be at the expense of the Manufacturer.
- G. If the Manufacturer is unable to demonstrate by the field test results that the equipment conforms to the requirements of the specification, the equipment shall be rejected and replaced with acceptable equipment at the Manufacturer's expense.
- H. Minimum start-up time for operator training and final adjustment by the Manufacturer shall be one (2) days with one (2) trips.
- I. Qualifications of Start-Up Personnel
1. Personnel shall be authorized by the Manufacturer to start-up and initiate the warranty of the equipment being provided.
 2. Personnel shall come to the site with the required tools to complete start-up.
 3. Personnel shall have full working knowledge of the equipment being provided.
 4. Failure to provide personnel with full qualifications shall be cause for service trip to be disqualified as part of the requirements and shall be cause for reimbursement costs incurred by the Owner due to services required for start-up inspections.

– END OF SECTION –

Lift Station Alarm Test Form Date:

Location: _____

Rim Elevation: _____

Contractor: _____

Alarm/Status Signals	Activated at local panel	Signal telemetered	Dialer Activated	Depth	Elevation
High-water alarm tested w/float					
Pump No. 1 fail					
Pump No. 2 fail					
Power fail					
L.S. Level					
L.S. High Level					
L.S. Low Level					
Pump No. 1 Run					
Pump No. 1 Fail					
Pump No. 1 Seal Fail					
Pump No. 1 High Temp.					
Pump No. 2 Run					
Pump No. 2 Fail					
Pump No. 2 Seal Fail					
Pump No. 2 High Temp.					
Back-Up Mode On					

Signed by the Contractor: _____

Date: _____

LIFT STATION START-UP CHECKLIST

Project No. _____ Contractor: _____ Date: _____
Lift Station Location: _____ By: _____

LIFT STATION PERFORMANCE

	Pump No. 1	Pump No. 2
TDH (discharge gauge reading)	_____	_____
Amp	_____	_____
Tach (rpm)	_____	_____
Drawdown Time (secs)	_____	_____
Flow Calculation from drawdown (gpm) ($3.1416 \times r^2 \times \text{drawdown in feet} \times 7.48 \div \text{time}$)	_____	_____
Flow meter reading (gpm)	_____	_____
Hour meter reading at end of start-up	_____	_____

Note: Check results with efficiency curve on the pump performance chart

Pump No. 1 _____ Pump No. 2 _____

LIFT STATION CYCLING TEST

- ☐ High-level alarm functions when flooded.
- ☐ Both pumps start up in flooded condition.
- ☐ All pumps off functions under pumping condition.
- ☐ Low-level alarm functions.
- ☐ Lead pump starts automatically.
- ☐ Lead pump stops automatically.
- ☐ Lead pump starts, alternating pumps automatically.
- ☐ Lead pumps stops automatically.
- ☐ Lead pumps starts automatically.
- ☐ Lag pumps starts automatically.

- ☐ All pumps off automatically.

GENERAL CHECKLIST

- ☐ Bolts tightened.
- ☐ Conduit secure.
- ☐ Check valves free.
- ☐ Pump rotation.
- ☐ Touch-up paint.
- ☐ Valves operational.
- ☐ Valves in working position.
- ☐ Wetwell & pipe coating.
- ☐ Telemetry operational.
- ☐ Emergency equipment operational.
- Type _____
- ☐ Phase convertor balanced.

SECTION 33 34 00

FORCE MAIN

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section includes furnishing and installing all pipe and fittings for the forcemain as shown on the contract drawings, as specified, and as directed by the Engineer.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 01 32 19, Submittals.
 - 3. Section 01 57 14, Erosion Control.
 - 4. Section 01 45 24, Testing and Inspection of Pipeline Construction.
 - 5. Section 31 23 33, Trenching, Backfill and Compaction.
 - 6. Section 40 05 13.10, Buried Piping and Appurtenances.
 - 7. Section 40 05 13.53, Ductile Iron Pipe.
 - 8. Section 40 05 13.73, PVC Plastic Pipe.
 - 9. Section 40 05 13.74, Polyethylene Pipe.
 - 10. Section 32 90 00, Landscaping.

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
- B. American Water Works Association (AWWA).
- C. American National Standards Institute (ANSI).

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 001 32 19, Submittals including:
 - 1. Product literature and catalog cuts of materials to be supplied to relate these materials to the specifications.
 - 2. One copy of test reports.

PART 2 - PRODUCTS

2.01 PIPE MATERIAL

- A. Ductile Iron Pipe shall conform to Section 40 05 13.53, Ductile Iron Pipe.
- B. PVC Pipe shall conform to Section 40 05 13.73, PVC Plastic Pipe.
- C. Polyethylene pipe shall conform to Section 40 05 13.74, Polyethylene Pipe.

2.02 POLYETHYLENE ENCASEMENT

- A. Polyethylene encasement shall conform with AWWA C105.
- B. Polyethylene encasement shall be Class C Black, Type 1, and Grade E-1.
- C. Thickness shall be 8 mils minimum.

2.03 TRACER WIRE

- A. Provide the following:
 - 1. For direct burial service for all directional borings:
 - a. Tracer wire shall be No. 10 AWG, stranded stainless steel, with HMWPE insulation rated for direct burial service for all borings. No splices are permitted.**
 - OR**
 - a. Tracer wire may be No. 10 AWG, solid copper, or No. 12 AWG, stranded stainless steel with HMWPE insulation rated for direct burial service, if installed in a separate conduit. Conduit shall be Polyethylene Tubing, SDR-9, PE-3608, min. 1-inch diameter, conforming to AWWA C901 and NSF No. 14.**
 - OR**
 - 2. For direct burial service, for all open cut:
 - a. Tracer wire shall be No. 10 AWG, solid copper, or No. 12 AWG stranded stainless steel, with HMWPE insulation rated for direct burial service.
- B. Tracer wire splices stainless steel and copper wire shall be Dryconn waterproof connectors by King Innovation or Snakebite Connectors by Copperhead Industries. In lieu of connectors, connections for copper wire may be soldered. Soldered connection shall be coated with 3M Scotchkote electricians coating and then securely taped.
- C. Tracer wire signal connection box shall be three-piece, 5¼-inch cast iron valve box with top marked, "Sewer" as manufactured by Clow, Tyler, or equal.

2.04 PIPE BEDDING AND BACKFILLING

- A. Trenching, backfilling and compaction shall be in accordance with Section 31 23 33, Trenching, Backfilling and Compaction and standard details on the drawings.

2.05 THRUST BLOCKING

- A. Thrust blocks shall be constructed of concrete having a minimum 28-day compressive strength of 2,000 psi. Hardwood blocking may be used if approved by the Engineer.
- B. The minimum cement content shall be 4½ bags of cement per cubic yard of concrete. The allowable slump shall be 4 to 5 inches
- C. Blocking shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground shall be as shown or required by the Engineer.
- D. Thrust blocks shall, unless otherwise specified or required, be placed so that the pipe and fitting joints will be accessible for repair.

- E. A piece of 15-pound building paper or other approved material shall be placed between the cap or plug and the concrete.

2.06 JOINT RESTRAINT MATERIAL

- A. Rods shall be $\frac{3}{4}$ -inch diameter, Type 304, or 316 Stainless Steel.
- B. Underground clamps shall conform to the following:
 - 1. $\frac{1}{2}$ -inch x 2 inches flat bar stock clamps, Astral Corp., or equal.
 - 2. Clamps shall include retainer washer.
- C. Bolts shall be $\frac{5}{8}$ -inch diameter, stainless steel.
- D. Megalugs, by EBAA iron may be used for joint restraint.

2.07 PIPE COUPLINGS

- A. Mechanical pipe couplings shall be Dessler Style 162, or equal.

2.08 BUILT UP MASTIC COATINGS

- A. Coating shall be Tape coat, TC Mastic, or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Before excavation of trenches is begun, the Contractor shall uncover the end of the existing main to which the new main is to be connected. This will permit adjustments in line and grade and avoid the use of extra fittings. The exposed end of an existing main must be protected and blocked by the Contractor to prevent the blowing out of the plug or cap at the end of the main.
- B. The Contractor shall have sufficient and adequate equipment on the site of the work for unloading and lowering pipe and fittings into the trench. Extreme care shall be exercised by the Contractor in handling all pipe, fittings, and special castings to prevent breakage and coating damage. Any significant damage to coating shall be repaired before installation. Under no circumstances shall pipe or fittings be dropped into the trench or so handled as to receive hard blows or jolts. All mud or concentration of dirt shall be removed prior to installation.
- C. Every precaution shall be taken to prevent foreign materials from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During the laying operations, no debris, tools, clothing, or other material shall be placed in the pipe.
- D. At all times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means accepted by the Engineer. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the

trench is pumped completely dry. No pipe shall be laid in water or when trench conditions are unsuitable.

3.02 PIPE INSTALLATION

- A. Pipe installation shall conform with Section 31 23 33, Trenching, Backfilling and Compaction and bedding details shown on the drawings.
 - 1. Lay pipe to line and depth shown on plans. Unless otherwise stated, pipe shall be laid with the bell ends facing the direction of laying. When grade exceeds two feet per hundred feet, the bells shall face upgrade.
 - 2. When the depth is not shown on the plans, bury the pipe with 6.5 feet of cover as determined from the top of pipe to finished ground elevation.
 - 3. Keep pipe and fittings free of debris and foreign matter. The interior of all pipes shall be clean before being installed. The Contractor shall provide the necessary means to wipe, brush, swab, or air blast to remove foreign matter.
 - 4. Assemble all joints in accordance with manufacturer's recommendations.
 - 5. Utilize full lengths of pipe, except at fittings.
 - 6. Provide thrust blocking and restraints at the following locations:
 - a. Bend deflecting 11½ degrees or more.
 - b. Valves and tees.
 - c. Plugs and caps.
- H. When it is necessary to interrupt an existing system to complete construction, adhere to the following:
 - 1. No controls or appurtenances shall be operated without the Owner's consent or direction.
 - 2. Work requiring interruption of existing service shall be done at the Owner's convenience and normal working schedule.

3.03 POLYETHYLENE ENCASEMENT

- A. Wrap all below ground metal in accordance with AWWA C105, including:
 - 1. Ductile iron pipe.
 - 2. Fittings, valves, and valve boxes.
 - 3. All metal restraining devices.

3.04 TRACER WIRE

- A. Run tracer wire along pipe when PVC or polyethylene pipe is used.
- B. Tape wire to each length of pipe at a minimum of two points.
- C. Tracer wire shall be tested prior to acceptance of project.
- D. Maximum distance for tracer wire between tracer wire signal boxes shall be 2,000 feet.
- E. For directionally bored pipe, the tracer wire shall be taped to the pipe at a min. 10' spacing. No splices are permitted.

- F. For directionally bored pipe that includes a separate conduit for the tracer wire, the conduit shall be installed concurrently with the carrier pipe; tracer wire shall then be installed inside the conduit. No splices are permitted.

3.05 PROTECTION OF BURIED METAL SURFACES

- A. All steel clamps, rods, bolts, and other metal accessories using reaction anchorage or joint harness and all mechanical pipe couplings, flanges, and sleeves installed underground shall be protected.
- B. Surfaces shall be cleaned by wire brushing immediately prior to application of the mastic.
- C. The mastic shall be molded firmly to encase all bolts, nuts, clamps, straps and flanges, and built-up to a uniform surface over the entire fitting.
- D. The built-up surface shall be applied in full accordance with manufacturer's recommendations.
- E. All buried metal surfaces with built up mastic protection shall be wrapped with polyethylene encasement.

3.06 JOINING PIPE OF DIFFERENT MATERIAL OR OUTSIDE DIAMETER

- A. Where specified or required, pipes of different material or outside diameter shall be joined with mechanical pipe couplings.
- B. Couplings shall be suitable for the intended service and shall be installed in accordance with the manufacturer's instructions.
- C. The Contractor shall submit details of proposed coupling for Engineer's review.

3.07 CONTRACTOR RECORD KEEPING

- A. Measure and record the following:
 - 1. Service locations: Point of origin and terminus.
 - 2. Valve and fitting locations.

3.08 PIPE TESTING

- A. Perform pipe testing in accordance with Section 01 45 24, Testing and Inspection of Pipeline Construction.

3.09 CUTTING OF PIPE

- A. Pipe shall be cut at right angles to the centerline of the pipe. Cutting shall be done in a neat workmanlike manner without damage to the pipe and to leave a smooth end. All pipes shall be cut for use with rubber gasket joints shall be tapered by grinding or filing about 1/8 inch back at an angle of approximately 30 degrees with the centerline of the pipe, and any sharp or rough edges shall be removed.

3.10 OBSTRUCTION IN LINE OR GRADE

- A. Whenever it becomes necessary to lay a main over, under or around a known obstruction, the Contractor shall furnish and install the required fittings. The laying of such fittings will be paid for at the unit price bid for each size of main. No additional compensation will be paid to the Contractor for any expenses incurred because of such obstruction.
- B. When an unknown underground structure interferes with the work and an alteration of the plan is required, the Engineer will issue a written order for such altered work, specifying the basis of payment or credit for such altered work.

DELETE PART 4 IF LUMP SUM BID

PART 4 - MEASUREMENT AND PAYMENT

- A. Force Main
1. Measure forcemain along the centerline as installed, with no deductions for fittings and valves.
 2. The unit price per linear foot shall include:
 - a. Labor, material, and equipment.
 - b. Clearing and grubbing.
 - c. Removal, hauling, and disposal of all street surfacing and curb and gutter in the trench area.
 - d. Excavation and dewatering.
 - e. Traffic control.
 - f. Erosion control.
 - g. Installation of pipe materials, fittings, including pipe bedding and cover material.
 - h. Poly-wrap fittings, valves, and valve boxes.
 - i. Reaction blocking.
 - j. Joint restraints.
 - k. Backfilling and compacting.
 - l. Loading, hauling and disposal of surplus excavated material.
 - m. Dust control.
 - n. Restore all facilities damaged or destroyed during construction.
 - o. Landscaping.
 - p. Maintenance and repair of all disturbed street surfacing.
 - q. Leakage and pressure testing.
 - r. Tracer wire testing.
 - s. Tracer wire.
 - t. Tracer wire box.
- B. Boring and jacking casing pipe.

1. Measurement for the casing pipe shall be made along the centerline of the casing pipe as installed.
2. Payment shall be made by the unit price per linear foot installed and include:
 - a. Labor, equipment, and material necessary to install the casing pipe.
 - b. Blocking and supports necessary to anchor the sewer pipe inside the casing pipe.
 - c. Placing a sand slurry, pea gravel, or fly ash slurry to completely fill the annular space between the casing and sewer pipe.
 - d. The sewer pipe placed inside of the casing.

- END OF SECTION -

40

DIVISION 40

PROCESS INTEGRATION

SECTION 40 05 13.19

STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section covers the work necessary to furnish and install, complete, the stainless steel pipe and fittings.
- B. Related sections and divisions.
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 01 32 19, Submittals.
 - 3. Section 01 45 24, Testing and Inspection of Pipeline Construction.
 - 4. Section 40 05 15, Methods and Material for Process Piping Installation: Exposed.

1.02 REFERENCE STANDARDS

- A. American Society Testing and Materials (ASTM)
- B. AISI 316L

PART 2 – PRODUCTS

2.01 GENERAL SERVICE

- A. Pipe: Stainless steel, pickled and passivated, ASTM A 778F TP304L, “as welded” grade, unless otherwise specified thereafter.
 - 1. 3-inch and Smaller: ASTM A312, TP304, Schedule 40S, seamless.
 - 2. 3½-inch and Larger: Schedule 10S.
 - 3. After fabrication, all stainless steel assemblies and parts shall be passivated by immersion in a pickling solution of from 5% to 25% of nitric acid (65% strength) and 1% to 3% hydrofluoric acid (60% strength), both by volume, in water at a bath temperature of 120°F to 140°F for a minimum of 10 to 15 minutes, as determined by test. Scrubbing shall be completed as required. Immediate final thorough rinsing shall be completed in clean hot water followed by drying. Parts shall be free of iron particles or other foreign material.
- B. Joints:
 - 1. 3-inch and Smaller: Screwed or Welded.
 - 2. 3½-inch and Larger: Butt welded or flanged.
- C. Fittings:
 - 1. Screwed, stainless steel, rated 1,000 pound CWP, forgings conforming to ASTM A182, Grade F316 or barstock to ASTM A276, Type 304, dimensions conforming to ANSI B16.3 for 150-pound SWP malleable iron screwed fittings.
 - 2. Butt welding type, stainless steel, pickled and passivated schedule to match piping, ASTM A774, Type 304L, conforming to MSS SP-43; “as welded” grade; all ells LR, unless otherwise designated.

- D. Flanges:
1. Forged stainless steel, ASTM A182, Grade F304L, slip-on type, faced and drilled 150-pound, 1 1/16-inch raised face, ANSI 316.5 standard.
- E. Stub Ends: Stainless steel, ASTM A240, Type 304L, as welded grade, conforming to MSS-SP43, or flared nipples, schedule to match pipe.
- F. Bolting:
1. Type 304 stainless, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts.
 2. When mating flange on valves or equipment is cast iron, use stainless bolts.
- G. Gaskets: Gaskets shall be 1/8-inch thick neoprene rubber, durometer hardness No. 80, 1500 psi minimum tensile strength, 125 percent minimum elongation, flat ring type with RF flanges and full-face type with FF flanges, Garlock Style 7797, or equal.
- H. Thread Lubricant: Teflon tape.
- I. Covered Welding Electrodes;
1. For Shielded Metal Arc Process:
 - a. For Type 304L Pipe: AWS 5.4, E309 CB
- J. Welding Rod and Bare Electrodes:
1. For Gas Tungsten Arc or Gas Metal Arc Processes:
 - a. For Type 304L Pipe: AWS 5.9, ER 309 C3.

PART 3 - EXECUTION

3.01 WELDING

- A. In accordance with latest editions of Section IX, ASME Boiler and Pressure Vessel Code and the American National Standard Code for Pressure Piping, ANSI and B31.3, as applicable.
- B. Flanges shall be shop welded to the pipe. All welding shall be by the shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a cross section of weld metal equal to, or greater than, the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding shall be provided to the interior and exterior of the joint.
- C. Interior weld beads shall be smooth, evenly distributed when an interior projection not exceeding 1/16-inch beyond the pipe I.D. The outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel. All discoloration and deposits left by welding shall be removed by pickling.
- D. All field welding of stainless steel pipe shall be minimized and subject to the approval of Engineer. Field welding shall be shielded metal arc (SMAW). All field welding shall be accomplished by certified welders and using procedures in accordance with ASME Section 9. All field welds shall be wire brushed after completion and grinding shall be provided as required. All field welds shall be passivated with Bradford Derustit, or equal solution.

3.02 WELDING PROCEDURE QUALIFICATIONS

- A. Furnish Engineer for prior review, procedure specifications, and qualification records of welding procedures for all pipe welding to be performed under this section, in accordance with Section IX, Article II of the ASME Boiler and Pressure Vessel Code.

3.03 WELDING PERFORMANCE QUALIFICATIONS

- A. All welders and welding operators shall be qualified at the Contractor's sole expense by an ASME-approved testing laboratory before performing any welding under this section. Qualification tests shall be in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code. Welders and welding operators shall be qualified for making groove welds in Type 304 and 304L stainless steel pipe in position 5g for each welding process to be used.
- B. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified.
- C. Qualification tests may be waived if evidence of prior qualification is deemed suitable by the Engineer. Contractor shall retest any welders at any time Engineer considers the quality of the welder's work substandard. When Engineer request the retest of a previously qualified welder, the labor costs for the retest will be at the owner's expense if the welder successfully passes the test. If the welder fails the retest, all cost shall be at the contractor's expense.

3.04 IDENTIFICATION OF WELDS

- A. Each weld shall be marked with a symbol, which identifies the person who made the weld.

3.05 FABRICATION

- A. End Preparation: Pipe edges shall be prepared by machine shaping or cutting with an aluminum oxide blade. Oxygen or arc cutting are acceptable only if the cut is reasonably smooth and true and all slag is removed either by chipping or grinding. Beveled ends for butt welding shall conform to ANSI B16.25.
- B. Cleaning: Surfaces shall be clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding. Prior to welding, wire brush joints to be welded with stainless steel wire brushes or stainless steel wool.
- C. Alignment and Spacing: Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness. Root opening of the joint shall be as stated in the procedure specification.
- D. Procedure:
 - 1. The direct current, reverse polarity, shielded metal arc or gas metal arc processes or direct current, straight polarity, gas tungsten-arc process shall be used for all field welding. Shop fabrication shall be in accordance with the submitted welding procedure qualifications.
 - 2. No welding shall be performed if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F. If the ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.
 - 3. Tack welds shall be thoroughly cleaned to avoid porosity or pinholing in the cover pass and shall be small enough to be readily fused into the succeeding bead.

4. Tack welds, if not made by a qualified welder using the same procedure as for the completed weld, must be completely removed. Tack welds, which are removed, shall be made with an electrode that is the same as, or equivalent to, the electrode to be used for the first weld pass. Tack welds, which have cracked, shall be removed.
5. Each layer of deposited weld metal shall be thoroughly cleaned prior to the deposition of each additional layer of weld metal, including the final pass, with a power-driven stainless steel wire brush. Surface defects, which will affect the soundness of weld, shall be chipped out or ground out.
6. Welds shall be free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity, slag inclusions and other defects in excess of the limits prescribed in Chapter V of ANSI B31.3, as applicable.
7. Branch connections shall be fitted and groove-welded in accordance with the details described and shown in Chapter V of ANSI B31.3, as applicable.
8. Screwed joints shall be made with fitting threads and pipe threads accurately conforming to the requirements of ANSI 32.1 for standard taper pipe threads. The Contractor shall use clean and sharp dies to provide an accurate thread profile, free of ridges and burrs. Back-welding of joints will not be permitted to remedy joints failing pressure tests. Joints failing the pressure test shall be replaced with a crewed joint, which passes the test, or the Contractor may replace the materials with low carbon stainless steel conforming to the requirements of welding pipe and welding fittings, at the Contractor's option. Welding shall be as specified herein.

E. Supports and Hangers:

1. All hanger-pipe contact surfaces shall have a dielectric barrier consisting of neoprene rubber wrapping or plastic coated hangers. Hangers shall be as specified in Section 40 05 15, Methods and Material for Process Piping Installation: Exposed, except spacing shall be as follows:

Pipe Size	Maximum Support/Hanger Span	Minimum Rod Size Single Rod Hanger
1-inch and Smaller	6 feet	¼-inch
1½-inch thru 4-inch	8 feet	¼-inch
6-inch	8 feet	3/8-inch
8-inch and 10-inch	10 feet	3/8-inch
12-inch	10 feet	½-inch
14-inch	12 feet	½-inch
16-inch	12 feet	5/8-inch
18-inch and 20-inch	14 feet	¾-inch
24-inch	14 feet	7/8-inch

2. The load rating of universal concrete inserts shall not be less than that of the hanger rods they support.

3.06 ACCEPTANCE TEST

A. General

All pipelines and sewers shall be tested. Test pressure, duration, and media shall be as specified in the piping system specification sheets. Care should be exercised to isolate equipment not rated for the specified test pressure to avoid damage to the equipment.

- B. All pipe shall be tested in accordance with Section 01 45 24, Testing and Inspection of Pipeline Construction.

- END OF SECTION -

SECTION 40 05 13.53

DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: This section includes material and performance requirements for ductile iron pipe and fittings.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 01 32 19, Submittals.
 - 3. Section 01 45 24, Testing and Inspection of Pipeline Construction.
 - 4. Section 31 23 33, Trenching, Backfilling and Compaction.
 - 5. Section 33 34 00, Forcemain.
 - 6. Section 40 05 13.10, Buried Piping and Appurtenances.
 - 7. Section 33 11 13, Watermain.
 - 8. Section 33 33 13, Sanitary Sewer

1.02 REFERENCE STANDARDS

- A. American Water Works Association (AWWA):
 - 1. AWWA C104 Cement-Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings for Water
 - 2. AWWA C110 Gray Iron and Ductile Iron Fittings, 3-in. through 48-in. for Water and Other Liquids
 - 3. AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - 4. AWWA C115 Flanged Ductile-Iron Pipe with Threaded Flanges
 - 5. AWWA C150 Thickness Design of Ductile-Iron Pipe
 - 6. AWWA C151 Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids
 - 7. AWWA C153 Ductile-Iron Compact Fittings 30-in. through 16-in., for Water and Other Liquids
 - 8. AWWA C600 Installation of Ductile-Iron Watermains and their Appurtenances

1.03 MARKING, HANDLING AND STORAGE

- A. Marking
 - 1. Conform with AWWA C151.
 - 2. Markings shall include:
 - a. Weight.
 - b. Class or thickness.
 - c. Manufacturer's mark.
 - d. Where casted.
 - e. Year produced.
- B. Handling and Storage
 - 1. Conform with AWWA C600.
 - a. Pad lifting equipment to prevent damage to exterior coatings.
 - b. Do not drop, skid, or roll pipe.

- c. Store so pipe remains free of dirt and foreign material.
- d. Any significant damage to coatings shall be repaired before installation.
- e. Under no circumstances shall pipe or fittings be dropped into the trench or so handled to receive hard blows or jolts.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 32 19, Submittals:
 - 1. Submit manufacturer's certification that materials delivered comply with the requirements of this section.

PART 2-PRODUCTS

2.01 PIPE

- A. Conform with AWWA C150 and C151.
 - 1. All pipe shall be the product of one manufacturer.
- B. Coating and Lining:
 - 1. Exterior Coating: Asphaltic coating, minimum of 1 mil thick for buried pipe; epoxy coating per Specification 09 90 00, Painting and Special Coatings, for all exposed pipe.
 - 2. Interior Lining:
 - a) Cement Lining:
 - 1) Standard thickness of cement-mortar conforming with AWWA C104.
 - b) Glass Lining:
 - 1) Completely fused above 1,400 degrees F, 6 mils to 10 mils thick, defects which expose base metal not greater than 0.01 percent of total lined surface, hardness greater than 5 on the Mohs scale, lining bonded sufficiently to withstand a metal strain of 0.001 inch/inch without damage to the glass lining, finished lined pipe not to deviate more than 0.0125 inch per foot of length from the centerline perpendicular to the flange face or square end of the pipe.
- C. Pipe Class and Rating for Push-on, Push-on Lock Joint, and Mechanical Joint:
 - 1. 3-inch through 24-inch:
 - a. Class 52.
 - b. Rated pressure 350 psi.
- D. Pipe Class and Rating for Flanged Joint Pipe:
 - 1. Class 53 minimum.
 - 2. Rated pressure 250 psi.

2.02 PIPE JOINTS

- A. Push-on:
 - 1. Conform with AWWA C111.
 - 2. Gaskets
 - a. Plain rubber for sewer and water to temperatures not exceeding 150°F.
 - b. For air piping, gaskets shall be rated for a minimum of 248°F.
- B. Push-on Lock Joint:

1. Conform with AWWA C111.
2. Joints shall be held in place with a boltless locking ring.
3. Gaskets: Plain
 - a. Plain rubber for sewer and water to temperatures not exceeding 150°F.
 - b. For air piping, gaskets shall be rated for a minimum of 240°F.

C. Mechanical Joint:

1. Conform with AWWA C111.
2. Joints shall include:
 - a. Ductile or gray iron follower gland.
 - b. T-bolts shall be Type 304 or 316 stainless steel. All stainless steel threads shall be coated with anti-seize compound prior to assembly. In lieu of anti-seize compound, a green fluoropolymer coated stainless steel nut may be substituted.
 - c. Plain rubber gasket for sewer and water to temperatures not exceeding 150°F.
 - d. Joint restraints shall be MEG-A-LUG by EBBA Iron, Uni-Flange Series 1400 by Ford Meter Box Company, Sigma One-Lok by Sigma Corporation.

D. Flange Joint:

1. Conform with AWWA C110.
2. Joints shall include:
 - a. Ductile iron flanges.
 - b. Bolts with nuts shall be 316 stainless steel. All stainless steel threads shall be coated with anti-seize compound prior to assembly.
 - c. Sheet rubber gaskets, full face, minimum 1/8 inch thick.
 - d. For air piping, gaskets shall be rated for a minimum of 240°F.

E. Grooved Joint:

1. Conform with AWWA C-606.
2. Joints shall include:
 - a. Couplings.
 - b. Transition couplings when needed.
 - c. Gaskets & bolts.
 - d. For air piping, gaskets shall be rated for a minimum of 240°F.
 - e. Transition couplings when needed.

2.03 PIPE JOINT RESTRICTIONS

- A. The use of lead or asbestos in the gasket material is prohibited.

2.04 FITTINGS

- A. All fittings shall be the product of one manufacturer.
- B. For use below grade:
 1. Compact ductile iron mechanical joint conforming to AWWA C153.
- C. For use within manholes, structures or above grade:
 1. Standard gray iron or ductile iron flanged joint conforming to AWWA C110.
- D. For use within structures:
 1. Ductile iron grooved joint conform with AWWA C-606.

- E. Coatings and Linings
 - 1. Exterior Coating: Asphaltic coating, minimum of 1 mil thick for all buried fittings; epoxy coating per Specification 00 90 00, Painting and Special Coatings, for all exposed fittings.
 - 2. Interior Lining: Lined same as pipe.
- F. Gaskets: Conform with AWWA C111.

2.05 POLYETHYLENE ENCASEMENT

- A. General Requirements
 - 1. Meet AWWA C105.
 - 2. Type: 1
 - 3. Class: "C" (black).
 - 4. Grade: "E-1"
 - 5. Thickness: 8 mils

PART 3 - EXECUTION

3.01 POLYETHYLENE ENCASEMENT

- A. All underground ductile iron pipe, valves, valve boxes and fittings shall be polyethylene encased.

3.02 APPLICATION

- A. Install piping in accordance with the plans and appropriate specification sections for the type of work being performed.

3.03 CLEANING AND PROTECTION OF PIPE

- A. The interior and exterior of all pipe shall be clean and free from all foreign material before being installed. The Contractor shall provide the necessary means to wipe, brush, swab, or air blast to remove any foreign material from the interior of the pipe as required by the Engineer.
- B. Every precaution shall be taken to prevent foreign materials from entering the pipe while it is being placed in the line. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During the laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe.
- C. At all times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means accepted by the Engineer. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry. No pipe shall be laid in water or when trench conditions are unsuitable.

3.04 ACCEPTANCE TEST

- A. General

All pipelines and sewers shall be tested. Test pressure, duration, and media shall be as specified in the piping system specification sheets. Care should be exercised to isolate equipment not rated for the specified test pressure to avoid damage to the equipment.

- B. All pipe shall be tested in accordance with Section 01 45 24, Testing and Inspection of Pipeline Construction.

- END OF SECTION -

SECTION 40 05 15

METHODS AND MATERIALS FOR PIPING INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section defines the methods and materials for process piping installation. Provide all labor, materials, tools, and equipment to install the process plant piping.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern the work in this section.
 - 2. Section 01 32 19, Submittals.
 - 3. Section 01 45 24, Testing & Inspection of Pipeline Construction.
 - 4. Section 40 05 13.53, Ductile Iron Pipe.
 - 5. Section 40 05 13.13, Steel Pipe.
 - 6. Section 40 05 13.19, Stainless Steel Pipe.
 - 7. Section 40 05 13.73, PVC Plastic Pipe.
 - 8. Section 05 06 50, Metal Fabrications.
 - 9. Section 09 90 00, Painting & Special Coatings.

1.02 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 32 19, Submittals including:
 - 1. Product data for couplings, expansion joints, and wall seals.
 - 2. Drawings for all types of hangers, joints, supports, and materials used in the piping system.
 - 3. Piping drawings that show piping layout, couplers, adaptors, wall pipe, sleeves, etc.

1.03 DESIGN REQUIREMENTS

- A. Pipe supports and hangers.
 - 1. Design, size, and locate piping support systems throughout facility, whether shown or not.
 - 2. Piping supports are shown only where specific types and locations are required; additional pipe supports may be required.
 - 3. Meet requirements of MSS SP 58, MSS SP 89, and ASME B31.1 or as specified.
 - 4. Pipe support systems shall be designed for gravity and thrust loads imposed by weight of pipes or internal pressures, including weight of fluid in pipes and insulation.
 - 5. Seismic loads and wind loads in accordance with governing codes and as shown on drawings.
 - 6. Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
 - 7. Use existing supports and/or hangers to support new piping only if contractor can prove supports and/or are adequate for additional load, if strengthened to support additional load, or as stated on drawings.
 - 8. Special supports and hangers may be required for cases where standard catalog supports are inapplicable.

9. Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
10. Protect insulation at all support and hanger locations.

PART 2 - PRODUCTS

2.01 PIPING MATERIAL SCHEDULE

- A. All pipe and fittings for process piping shall be in accordance with the schedules at the end of this section.

2.02 VALVES

- A. All valves shall be as shown on the drawings and shall conform to section: "Valves."

2.03 PIPING MATERIAL SPECIFICATIONS

- A. Refer to Section 40 05 13.53 for ductile iron pipe.
- B. Refer to Section 40 05 13.13 for steel pipe.
- C. Refer to Section 40 05 13.19 for stainless steel pipe.
- D. Refer to Section 40 05 13.73 for PVC plastic pipe.
- E. Refer to Section 40 05 13.74, Polyethylene Pipe.
- F. Refer to CPVC pipe section.

2.04 PIPING RELATED MATERIALS

- A. Bolts and Nuts
 1. Carbon steel standard treated bolts and studs conforming to ASTM A307, Grade B, and nuts conforming to ASTM A563, Grade B. Stainless steel bolts & nuts grade 316 shall be used where specified and indicated on the drawings.
- B. Gaskets
 1. Blended natural/SBR red rubber, 1/8-inch thick sheet packing 70-85 shore durometer.

2.05 COUPLINGS AND ADAPTORS

- A. Mechanical couplings used for joining plain end of pipe of the same diameter shall be Dresser style 38, or equal.
- B. Mechanical couplings for joining steel, plastic, or ductile iron pipe of different outside diameters up to 1/4 inch difference shall be Dresser style 162, or equal.
- C. Mechanical couplings for joining steel, plastic, or ductile iron pipe of different outside diameters larger than 3/4 inch difference shall be reducing coupling Dresser style 62, Rockwell style 415, or equal. Compression coupling for joining small diameter pipe shall be Dresser style 68, or equal.

- D. Expansion joint couplings used in absorbing concentrated pipe movement for steel and cast iron pipe shall be Dresser style 63, or equal.
- E. Flanged coupling adaptors used for joining plain end pipe to flanged valves and fittings for steel or cast iron pipe shall be Dresser style 128, or equal.
- F. Restrained flanged coupling adaptors used for joining plain end pipe to flanged valves and fittings for ductile iron pipe shall be EBAA Iron Series 2100, or equal.

2.06 EXPANSION JOINTS

- A. Acceptable manufacturer shall be General Rubber Series 1100, or equal.
- B. Flexible connections shall be provided as shown on the plans for all pumps, blowers, and other items of equipment, which may induce vibration to the piping system.
- C. Flexible connector shall be neoprene, except for aeration blowers shall be EPDM.
- D. Joints shall allow a minimum of 0.625 inches pipe expansion, 0.25 inches pipe compression.
- E. Flexible connectors shall be constructed with a filled arch to eliminate sedimentation of solids in the arch area.
- F. Tie rods shall be provided at all flexible connectors and expansion joints on pump discharge. These tie rods shall be of sufficient number and strength to restrain the connection at test pressure as required. Use a minimum of two 5/8-inch diameter tie rods at all connections.
- G. Reducing flanged expansion joints (eccentric and concentric) used shall be General Rubber, Series 1100 GR/ER, or equal.

2.07 WALL SLEEVES AND SEALS

- A. All process piping passing through below ground or water bearing concrete walls shall be installed utilizing wall pipe. Wall pipe castings shall have mechanical joints on the building exterior & flange joint on the building interior.
- B. All process piping passing through above ground concrete or masonry walls shall be installed utilizing wall sleeves or stainless steel sleeves as shown on the drawings. When sleeves are used the gap between the sleeve and the pipe shall be large enough to accommodate the specified insulation or at a minimum two inches larger than the pipe.
- C. Where pipes pass through interior walls or floors use stainless steel sleeves two inches larger than outside diameter of the pipe. A gap between the sleeve and the pipe shall be sealed using the specified sealant.
- D. Rotary drilled holes can be used for pipe penetrations through existing walls. For exterior of water bearing walls, the annular space between outside surfaces of the pipes passing through the drilled hole and the interior surfaces of the wall sleeves shall have a watertight seal.
 - 1. The annular space shall be sealed by a modular mechanical type unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between

the pipe and wall opening. The modular unit shall form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. Compression of the unit shall cause the rubber sealing elements to expand and provide a watertight seal. All hardware shall be 316 stainless steel.

2.08 MECHANICAL PIPE SUPPORT DEVICES

- A. Manufacturers shall be Grinnell, Cooper B-Line, or equal. All pipe support devices used on this project shall conform to the details in this section. Each pipe support shall consist of a pipe attachment (PA-1 through PA-16) or pipe guide (PG-1 through PG-3) and the appropriate structural attachment (SA-1 through SA-15). All pipe supports, hangers, and anchors shall be type 304 stainless steel. Upon approval by the Engineer, hot dipped galvanized pipe supports and hangers may be acceptable if stainless steel is not available. Pipe supports & hangers for pipe larger than 12-inches are as detailed on the drawings.
- B. Concrete Inserts
1. Concrete inserts shall be provided at locations to support piping where structural steel supports are not readily available. Inserts shall be located so that total load on any insert does not exceed the manufacturer's recommended maximum load. The location of all inserts shall be approved by the Engineer.
 2. Where it is necessary to anchor supports to hardened concrete or completed masonry, expansion anchors shall be used. All expansion anchors shall type 316 stainless steel and be sized as required for the service with a minimum safety factor of five.
 3. Continuous slot inserts shall be Grinnell figure SG200, or equal.
 4. Individual inserts shall be Grinnell figure 282, hot dipped galvanized, or approved equal.
- C. Precast Prestressed Concrete
1. Where it is necessary to anchor supports to precast prestressed concrete, a steel plate of sufficient size shall be anchored to the upper surface. A hole of proper size shall be provided in the center of the plate for the support rod. The plate shall be placed over a field drilled hole through the precast prestressed concrete. The hole shall be drilled and the plate anchored as approved by the precast manufacturer and Engineer.
- D. Pipe Hangers
1. All piping shall be so installed so that it will be free to expand and contract without creating undue stresses in the piping system. All supports and hangers shall be so constructed and adjusted to allow for proper pitch of pipes. Where grooved and shouldered type joints and couplings are used, a hanger shall be placed within 2' of each side of the fittings to keep the pipes in alignment.
 2. All hangers shall be stainless steel. In all cases, the contractor shall provide enough supports of the proper type to insure a functional and safe piping system. If the contractor proposes to use different pipe material or different joint fittings, he shall provide any additional hangers or supports necessary at no additional cost to the Owner.
 3. Hangers used on copper pipe placed directly on the pipe shall be copper or stainless steel.
 4. All hanger rods 24 inches or shorter shall be continuous thread type. All rods shall be stainless steel.
 5. All structural steel, angles, rods, channels, etc. used for pipe hangers shall be hot dipped galvanized after fabrication or shall be stainless steel.
 6. Hangers for fiberglass reinforced plastic (FRP) pipe shall be saddle type.
 7. Trapeze hangers shall be constructed of angle, channel or other structural shapes type 304 stainless steel or hot dipped galvanized with flat surfaces for point of support. The

support member shall be of sufficient weight to avoid deflections which may cause undue stresses on the pipes being supported. The hangers shall be constructed to permit vertical adjustment of at least 1½ inches after installation.

8. Pipe hangers shall be as detailed at the end of this section or as shown on the drawings.

E. Vertical Pipe Supports

1. Vertical pipe supports shall be constructed of 316 stainless steel equipped with pipe saddle supports at the top and flanged at the floor.
2. The pipe saddle support shall be adjustable to approximately 2½ inches.
3. Vertical pipe supports shall be as detailed at the end of this section or as shown on the drawings.

F. Anchors

1. For suspended piping, anchors shall be centered, as closely as possible, between expansion joints and between elbows and expansion joints. Anchors shall hold the pipe securely and shall be sufficiently rigid to force expansion and contraction movement to take place at expansion joints and elbows.
2. Anchorage shall be provided as required to resist thrusts due to changes in diameter or direction or dead ending of pipe line. Anchorage shall be required wherever bending stresses exceed the allowable for the pipe.

2.09 FIBERGLASS/COMPOSITE PIPE AND EQUIPMENT SUPPORT SYSTEMS

A. General

1. The fiberglass/composite pipe and equipment support systems includes but is not limited to: channel framing (strut) and accessories, fasteners and hanging systems, pipe clamps, clevis hangers and attachments.
2. All composite materials shall have a maximum flame spread of 25 or less, per ASTM E84 (Class I flame spread) and shall have UV additive.
3. All composite materials shall be FRP vinyl ester.

B. Design

1. All pipe support shall be designed based on the manufacturer's recommendations.

C. Clamps and Hangers

1. All pipe clamps and hangers shall be designed for rigid PVC coated steel, schedule 40 or schedule 80 PVC or CPVC and filament wound fiberglass pipe or conduit.

D. Fasteners

1. All fasteners shall be pultruded vinyl ester rod with ground threads and compression molded vinyl ester nuts. If bolts are not available from the manufacturer, they can be field fabricated from FRP threaded rod and nuts.

E. Channel

1. All channel shall be manufactured by the pultrusion process and contain a minimum of 50% glass by weight.

F. Field cutting

1. All field cutting shall be sealed by manufacturer's sealing products.

G. Manufacturer's

1. Enduro or equal.

2.10 PIPE INSULATION

A. General

1. Insulation products shall be manufactured by Armstrong, CertainTeed, Knauf, Manville, Owens-Coming, Partek, Pittsburgh Coming, Rubatex, Spoule or Engineer approved equal.
2. Insulation materials shall be compatible with stainless steel equipment, tanks and piping and shall be guaranteed not to cause stress corrosion cracking of stainless steel or copper tubing.
3. Asbestos and asbestos bearing materials shall not be used.
4. All products including vapor barriers and adhesives shall conform to NFPA 90A and 255 and shall have a flame spread rating less than 25, fuel contributed rating less than 50 and a smoke developed rating less than 50.
5. All material shall be fire retardant, moisture resistant, mildew resistance, vermin proof and suitable for the temperatures to which they are applied.
6. All material shall be delivered in good condition, and the packages and insulation shall be plainly marked with manufacturer's identification label.

B. Pipe Insulation Materials

1. Piping insulation includes insulating material, protective jackets, flashing, and other materials as required for a complete and waterproof system. Insulation shall be provided as shown on the drawings and as specified in the Piping System Specification Sheets. Surfaces to be insulated include piping and related vessels and appurtenances.
 - a) Low Temperature Insulation
Insulation for low temperature applications (-30°F to 75°F) shall be flexible unicellular type conforming to Fed. Spec. HH-I-573, Class 1. Adhesive and accessories shall be as recommended by the manufacturer.
 - b) Medium Temperature Insulation
Insulation for medium temperature applications (76°F to 370°F) shall be fiberglass conforming to the requirements of ASTM 1393 & ASTM C1136 Type I All Service Jacket (ASJ). Adhesive and accessories shall be as recommended by the manufacturer.
 - c) High Temperature Insulation
Insulation for high temperature applications (1200°F) shall be calcium silicate type conforming to the requirements of Fed. Spec. HH-I-523, Type II. Adhesives and accessories shall be as recommended by the manufacturer.
 - d) Protective Jacket
A protective jacket shall be provided for all heated surface insulation. Protective jackets shall be fabricated from aluminum, stainless steel, or laminated polyvinyl materials as specified.
SYSTEM 1) Aluminum Jacket
Aluminum jacket shall be provided for heated surfaces and piping larger than 8 inches in diameter. The jacket shall be constructed of plain finish aluminum sheet conforming to ASTM B209, alloy 5005, with a minimum temper of H16. The jacket shall be 36 inches minimum width and shall be 0.020-inch thick on surfaces 14 inches in diameter or larger and 0.016-inch thick on smaller diameter surfaces. The jacket shall be provided with an impermeable water barrier on the inside. The jacket should be held in

place with aluminum rivets. The spacing and quantity of rivets shall be such that there are no gaps in the jacket and all seams are tight.

SYSTEM 2) Stainless Steel Jacket

Stainless steel jacket shall be provided for heated surfaces and piping larger than 8 inches in diameter. The jacket shall be constructed of embossed 304 stainless steel. The jacket shall be 36 inches minimum width and shall be 0.020-inch thick on surfaces 14 inches in diameter or larger and 0.016-inch thick on smaller diameter surfaces. The jacket shall be provided with an impermeable water barrier on the inside. The jacket should be held in place with stainless steel rivets. The spacing and quantity of the rivets shall be such that there are no gaps in the jacket and all seams are tight.

SYSTEM 3) Laminated Polyvinyl Jacket

Laminated polyvinyl Jacket shall be provided for heated piping 8 inches in diameter and smaller. The jacket shall be polyvinyl chloride. Jacket color shall be selected from the manufacturer's standard colors. Joint tape shall be vinyl, 10 mils thick. Fittings, valves, flanges, and other similar items shall be jacketed with 15 mils thick premold PVC. PVC jacketing and type shall be spray-coated to match PVC jacket color.

e) **Shields**

Shields for the protection of chilled surface insulation shall be 16-gauge galvanized steel sheet, 9 inches long and formed into a half cylinder.

f) **Flashing**

Flashing shall include aluminum caps, sealant and reinforcing as required. Aluminum cap shall be 0.020-inch thick and shall be cut to completely cover the insulation. Sealant for surfaces heated up to 370°F shall be constructed from silicone based material. Sealants for hotter surfaces shall be as recommended by the high temperature insulation manufacturer. Sealants for low temperature insulation shall consist of manufacturer's adhesive.

Reinforcement shall not be required for low temperature flashing. Reinforcement in flashing heated to 370°F shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the high temperature insulation manufacturer.

C. Jackets and Specialties

1. Provide matching smooth finish fitting covers or field fabricate from jacket material.

PART 3 - EXECUTION

3.01 GENERAL

- A. Pipe, fittings, specialties and material used are to be carefully inspected for defects and thoroughly cleaned before installation.
- B. It shall be the responsibility of the Contractor to coordinate the work with all other trades to insure proper scheduling of inter-related work so as not to cause unnecessary delays or upset the treatment plant process to the extent that they violate their permit.
- C. Contractor supplying pipe, fittings, and valves shall be responsible for coordinating the diameter, drilling, and pressure rating of flanges for all valve and equipment connections.

- D. Gauges, valves or any other equipment located in walls, above ceilings or in any other inaccessible location shall have access provided. In plaster or masonry, Contractor shall provide metal access doors. Acoustical ceilings shall be provided with removable panels and marker tabs on each panel.
- E. The drawings are diagrammatic as to what is required. The Contractor shall consult the architectural, structural, electrical and other mechanical drawings for true dimensions, details, obstructions, and conflicts.
- F. Dimensions given in figures shall take precedence over scaled dimensions. The architectural plans shall take precedence over mechanical and electrical plans.
- G. Piping drawings are drawn for maximum clarity and are not necessarily intended to indicate a dimensional location. Piping shall be grouped on walls and ceilings and shall be coordinated and run with other mechanical and electrical work to allow a neat and workmanlike finished appearance.
- H. Install pipe runs in straight lines parallel to or at right angles to the walls, floors, or other pipe runs.
- I. Do not run pipe through structural beams.
- J. Installed piping shall not interfere with the operation or accessibility of doors or windows, shall not encroach on aisles, passageways, and equipment, and shall not interfere with the servicing or maintenance of any equipment.
- K. All pipe passing through roof shall have flashing.

3.02 CONNECTIONS TO PUMPS, VESSELS AND EQUIPMENT

- A. Piping shall be erected and supported in a manner that shall not put undue strain on pumps, tanks or equipment.
- B. The procedure for connection of piping to equipment shall be as follows:
 - 1. After the equipment has been set and grouted, the pipe shall be run to the equipment without making any tight connections to flanges.
 - 2. Flat faced flanges and full-face gaskets shall be used on piping connecting to valves and equipment with flat flanges. Raised faces of standard flanges may be machined off flat to accomplish this.
 - 3. Flanges shall be checked by the Owner's representative to assure that no strain is placed on the equipment. If pipe is not in correct alignment, the piping shall be removed and corrected. The correction in alignment shall not be made while the pipe is connected to the equipment.
 - 4. No piping shall be connected to equipment until sufficient permanent support has been installed.
- C. After alignment is found to be correct by the Owner's representative, the flanges shall be bolted up.
 - 1. The Owner's representative will observe the dial indicators on the coupling. If the piping has moved the equipment alignment in excess of the 0.005 inch T.I.R. allowable, the

piping will be reworked until no strain is exerted on the equipment by the pipe. If the piping has thrown the equipment out of alignment, the coupling shall be realigned to within the 0.005-inch maximum tolerance.

2. Any equipment realignment work due to excessive strain caused by piping shall be at the piping contractor's expense.

- D. After the equipment has been in service, tested at operating temperatures and with the lines and equipment still hot, flanged connections to pumps, tanks and equipment shall be loosened and checked for alignment, position, expansion and strain applied to the equipment and make any adjustments necessary, and secure approval of the Owner's representative before reconnecting.

3.03 DRAIN CONNECTIONS AND CLEANOUTS

- A. Drain connections and suitable valves shall be provided for all equipment and piping (pumps, tanks, etc.) and for all piping systems at low points in the system for draining for freeze protection and also for rapid draining of the system for maintenance work.
- B. Drain valves shall be located as close as possible to process lines to prevent dead legs.

3.04 VALVES

- A. Install valves to be accessible with valve operators at a convenient location for operation.
- B. Chain wheel operators shall be supplied and installed on valves which are higher than six feet above floors.

3.05 COUPLING AND ADAPTORS

- A. Pipe shall be cut clean with smooth ends such that a space is left between pipe ends of not less than 1/4-inch or more than 1 inch. Mechanical couplings shall be carefully installed in strict accordance with the manufacturer's recommendation and shall be suitably restrained to prevent movement. The pipe shall be furnished with plain ends which are smooth and round for a distance of at least 10 inch from each end.

3.06 EXPANSION JOINTS

- A. Expansion joints shall be adequately supported to prevent stress on joint.
- B. Vertical supports shall be located within 3 pipe diameters of the connection and shall be provided on each side of the connection.

3.07 WALL PIPES AND SLEEVES

- A. Wall pipe shall be furnished and installed true to grade, line, position and plumb or level and shall be maintained during construction by the Contract. Wall pipe shall be placed in position before concrete is poured to insure a watertight anchored connection between the concrete and wall pipe. The wall pipe shall be placed so that the intermediate collar is centered in the wall and shall be carefully aligned.
- B. Wall pipe shall be set in the form with the bolt holes and ranges straddling the centerlines horizontally and vertically.

- C. Pipe sleeves shall be installed flush with finished surfaces.
- D. The annular space on all interior sleeves shall be stuffed and caulked.

3.08 PIPE SUPPORTS

- A. Contractor shall design, furnish and install all pipe supports including auxiliary steel, structure attachments, pipe attachments, brackets, trapeze hangers, hanger rods and accessories such as turnbuckles, eye nuts, concrete anchors, inserts, etc. necessary to support the piping systems from the buildings, structures and utility bridges.
 - 1. The design and location of the pipe supports shall be in accordance with this specification and the drawings.
 - 2. Pipe supports shall not be attached to vessels or equipment without the prior written approval of the Owner's representative.
 - 3. Drilling, welding, cutting, and other operations required to attach the piping to such structures shall be a part of these specifications. No structural members shall be drilled or cut into without permission of the Owner's representative and the type contour, etc. of the hole or cut should be specified. No torch cutting will be permitted.
 - 4. Pipe hangers shall not be located closer than 6 inches from equipment or pipelines operated at temperatures greater than 450°F.
 - 5. Any detailed sketches or takeoffs required in connection with the work of pipe erection shall be submitted for approval.
 - 6. Pipe supports shall allow vertical adjustment for pitch and thermal expansion.
 - 7. Uninsulated piping such as stainless steel, copper, etc. shall be installed with isolation shields of like material to prevent galvanic action. Hangers of like material or PVC coated hangers (for piping less than 2½ inches) may also be used.
- B. All supports shall be designed to meet all static and operational conditions to which the piping system and connected equipment will be subjected. For supports specified to be designed in accordance with ANSI B31.1, the loads should not be based on increasing the allowable stress level in hanger components by 20%, as allowed by the code.
- C. Where supports are not designed and detailed on the drawings, contractor's supports designer shall analyze and determine the piping loads and movements that will exist at any time, including all applicable forces acting simultaneously, and shall design and detail the supports in accordance with the conditions.
- D. Hangers shall be designed for installation in the cold position such that the hanger rod is vertical when pipe moves to the hot operating position. The maximum vertical offset between pin-to-pin connections when cold shall be 4 degrees.
- E. Where it is necessary to weld to existing structural steel members to carry pipe supports, anchors, etc. the welds for securing the plates to the structural members shall in all cases be parallel to the length and located at web of the structural member. Welding across the flange of existing structural steel members is not permitted. All welding to building structural steel shall be performed by welders qualified in accordance with AWS D1.1, applicable Building Codes, and the welding section of these specifications.
- F. In addition to spacing schedule, support pipe as follows:

1. At each change in direction.
2. On each side of large valves.
3. Within 5 feet of each equipment connection.
4. At all branches or risers.
5. At all floor openings.
6. Minimum of one support for each length of cast iron or ductile iron pipe.

3.09 PIPE INSULATION

A. Piping Insulation Installation

1. Insulation shall be applied over clean, dry surfaces, with all joints butted firmly together. Double layer insulation, where required, shall be applied with section joints staggered. All equipment, tanks, valves, flanges, unions, expansion joints, rigid and flexible couplings and fittings shall be strengthened with reinforcing and insulating cement. Insulation for all of the above items except large equipment and vessels and welded fittings shall be attached to the insulation jacket halves to allow removal without causing damage to adjacent insulation.

Chilled surface insulation shall be provided with metal shields at each pipe support. Shield inside face shall be coated with insulation adhesive to prevent movement. No strapping will be required. The pipe insulation shall be provided with additional support at each shield. The use of rigid insulation sections will be acceptable. The use of wood or cork inserts is subject to approval.

2. Protective Jacket

Jacketing and insulation for heated surfaces shall be interrupted at hangers, anchors, pipe guides, and other support elements, and only that clearance between insulation system and support element which is required to permit a workmanlike installation of the required flashing shall be provided.

- a. Laminated Polyvinyl Jacket
Laminated polyvinyl jacket shall be applied with all joints taped in conformance with the manufacturer's instructions subject to acceptance by the Engineer.

b. Aluminum Jacketing

1) Pipe and Large Surface Jacketing

Pipe and large surface jacketing shall have longitudinal joints of either the interlocking type or lapping type. The exposed edge of the longitudinal lap shall be crimped tightly to form a stiffened ½-inch hem. Longitudinal joints shall be hidden from view if tightly to form a stiffened ½-inch hem. Longitudinal joints shall be hidden from view if practicable. Longitudinal joints shall be located in the lower half of the pipe and lapped 2 inches so as to shed water.

End Joints shall be lapped with adjacent jackets 2 inches and strapped. End joints on sloping or vertical runs shall be lapped so as to shed water.

All jackets shall be held in place by at least one strap at the end joints and one strap at midsection and by as many other straps as required to prevent initial or subsequent distortion of the lapped edge. On flat jacket surfaces where straps cannot be used to close joints, screws shall be used at a maximum spacing of 6 inches.

2) Fittings and Other Jacketing

Fittings and other jacketing shall be furnished in half sections and shall be fastened as required for pipe jacketing. Jackets shall not be applied until insulating cement has dried.

3. Flashing

Flashing shall be provided at all jacket penetrations and at all jacket terminations.

A heavy tack coat of sealant shall be troweled over the insulation, extending over jacket edge 1-inch and onto pipe or protrusion 2 inches. Reinforcement shall be smoothly stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall then be troweled over the reinforcement to a minimum thickness of 1/8-inch.

Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

On high temperature surfaces, fabricated aluminum caps cemented and tightly clamped to the pipe and strapped to the jacketing may be used following approval.

4. Insulation Thickness

Pipe Size	Low Temp	Med Temp	High Temp*
1/2" to 2"	1"	1"	1-1/2"
2-1/2" to 4"	1"	1-1/2"	2"
6" to 12"	--	2"	3"

*All engine generator exhaust piping and silencer shall be insulated with a minimum of 3 inches of high temperature insulation.

5. Miscellaneous:

- a. In cases where the insulation extends below grade to cover heat traced lines, the insulation shall be covered with 0.020 inch thick 316 stainless steel jacket. All joints on the jacket shall be sealed with waterproof mastic and then the jacket shall receive two coats of "Tape Coat" to make the underground portion of the insulation completely watertight.
- b. No drain plug or drain openings shall be insulated.
- c. Any protrusions through pipe insulation such as instrumentation connections, uninsulated pipe connections, supports or electrical tracing cables shall be carefully sealed for the appropriate service.
- d. Certain smaller piping systems (or smaller sized pipe runs) are only shown diagrammatically, or may be specified to terminate at a certain point not shown physically on the drawings. Contractor shall furnish and install insulation for such piping in order to complete the system whether physically shown or not.
- e. Insulation, three (3) inches and over in total thickness shall be applied in two layers with staggered joints unless otherwise specifically approved.
- f. All projecting hanger lugs on piping for working temperatures of 300°F and above shall be properly covered with insulation to maintain an outside surface temperature of not more than 175°F.
- g. The Contractor shall weld clip angles, studs, etc. to vertical runs of pipe as

may be required to properly support the insulation. Submit welding procedures to the Owner's representative for review prior to welding.

- h. The Contractor shall provide necessary flashings, sleeves, boots, clamps, sealants, etc. for roof, floor and wall penetrations requiring a watertight or weathertight seal. Submit details to the Owner's representative for review prior to installation.

3.10 PIPING IDENTIFICATION

- A. Identify piping and direction of flow so piping can be painted and labeled in accordance with Section 09 90 00, Painting and Special Coatings.

3.11 DIELECTRONICS

- A. Use dielectric unions at the junction of all dissimilar piping. Gasket material shall be No. 5, Steam.

3.12 CLEAN-UP

- A. All surfaces required to be painted shall be cleaned and degreased.
- B. Remove all debris, tools, scaffolding, trash and excess materials from the site.

3.13 TESTING

- A. All process plant piping shall be tested in accordance with Section 01 45 24, Testing & Inspection of Pipeline Construction.
- B. The Contractor shall notify the Owner's representative prior to all pipe testing.

- END OF SECTION –

TABLE 'A'						
PIPE SIZE	DESIGN WEIGHT	ROD SIZE BASED ON SINGLE ROD, SEE NOTE 1	MAXIMUM SPAN, IN FEET FOR PIPES NOT IN RACKS, SEE NOTE 2			
			STEEL	COPPER	PLASTIC SEE NOTE 3	CAST IRON SEE NOTE 4
3/8" - 3/4"	275 LBS	3/8"	5	5	CONTINUOUS	--
1"	275 LBS	3/8"	7	6	5	--
1-1/4"	300 LBS	3/8"	7	7	5	--
1-1/2"	300 LBS	3/8"	9	8	5	--
2"	325 LBS	3/8"	10	8	4	PRESSURE PIPE 12 FT
2-1/2"	375 LBS	1/2"	10	9	6	
3"	575 LBS	1/2"	10	10	7	SOIL PIPE 12 FT
4"	600 LBS	5/8"	10	10	7	
6"	750 LBS	3/4"	10	10	9	--
8"	950 LBS	7/8"	10	10	9	--
10"	1200 LBS	7/8"	10	--	--	--
12"	1450 LBS	7/8"	10	--	--	--

NOTES:

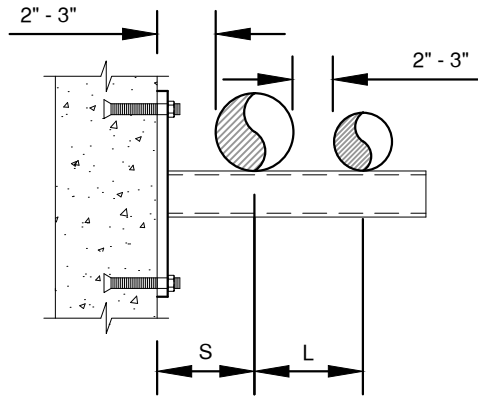
1. Rod size is based on carrying single pipe. When more than one pipe is to be supported, rods shall be sized using design weights to determine total load.
2. Where modularly spaced inserts are required. Pipes shall be supported at the insert module no special inserts shall be allowed for individual pipe supports unless specifically detailed or authorized by the engineer.
3. Spacing based on schedule 80 at 100°F. Schedule 40 or higher temperatures require shortened spans. See MFR's recommendations.
4. There shall be at least one hanger per pipe length located as close to the bell as possible.
5. See typical support rod, Attachment 'H', for pipes subject to horizontal movement (service temperatures 33°F - 55°F and 120°F - 450°F).
6. Use turnbuckle, WSS Type 13, for PA-3 and PA-7.
7. Design weights refer to the pipe size shown supported at the spacing listed and shall be used for design of all special hanger systems.

TABLE 'B'																			
SERVICE CONDITION			PIPE ATTACHMENTS																
			"X" INDICATES PIPE ATTACHMENTS SUITABLE FOR CONDITIONS LISTED IN SERVICE CONDITIONS COLUMN																
SERVICE TEMPERATURE			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
33°F - 55°F 120°F - 450°F 60°F - 115°F	}	INSULATED OR				X	X	X	X	X	X			X		X		X	
		UNINSULATED	X	X	X	X	X		X	X	X	X	X	X	X	X		X	
		UNINSULATED	X	X		X	X					X	X		X	X	X	X	
PIPING MATERIALS																			
STEEL			X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
COPPER				X					X	X	X	X	X	X	X				
PLASTIC			X	X								X	X		X			X	
CAST IRON			X	X	X					X	X	X	X	X	X		X	X	

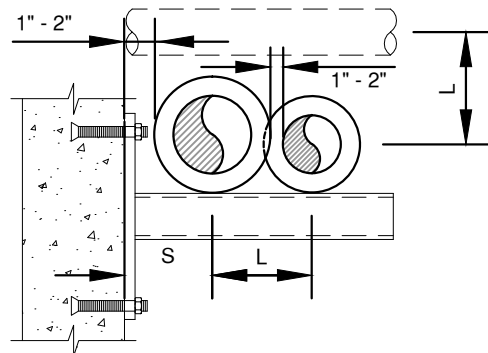
NOTES:

1. Asterisk indicates pipe attachments that require special treatment when used with copper pipe. Refer to individual details above.
2. For service other than those shown in Table 'B', pipe attachments shall be as selected by the engineer

PIPE SPACING SCHEDULE



PIPES WITHOUT FLANGES



PIPES WITH FLANGES

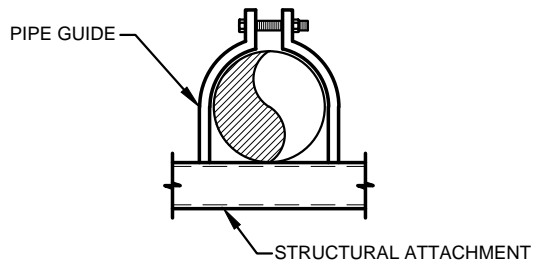
PIPE CENTER-TO-SURFACE DIMENSION 'S'		
CLEARANCE		
2 TO 3 INCHES		1 TO 2 INCHES
PIPE WITHOUT FLANGES		PIPE WITH FLANGE RATING (150 PSI)
NOMINAL PIPE SIZE (IN.)	2	4
	3	4
	4	5
	6	6
	8	7
	10	8
	12	9
	14	10
	16	11
	18	12
	20	13
	24	14

PIPE LINES WITHOUT FLANGES - DIMENSION 'L'												
NOMINAL PIPE SIZE (IN.)	NOMINAL PIPE SIZE (IN.)											
	2	3	4	6	8	10	12	14	16	18	20	24
	2	5	5	6	7	8	9	10	11	12	13	14
	3	5	6	6	8	9	10	11	11	12	13	14
	4	6	6	7	8	9	10	11	12	13	14	15
	6	7	8	8	9	10	11	12	13	14	15	16
	8	8	9	9	10	11	12	13	14	15	16	17
	10	9	10	10	11	12	13	14	15	16	17	18
	12	10	11	11	12	13	14	15	16	17	18	19
	14	11	11	12	13	14	15	16	16	17	18	19
	16	12	12	13	14	15	16	17	17	18	19	20
	18	13	13	14	15	16	17	18	18	19	20	21
	20	14	14	15	16	17	18	19	19	20	21	22
	24	16	16	17	18	19	20	21	21	22	23	24

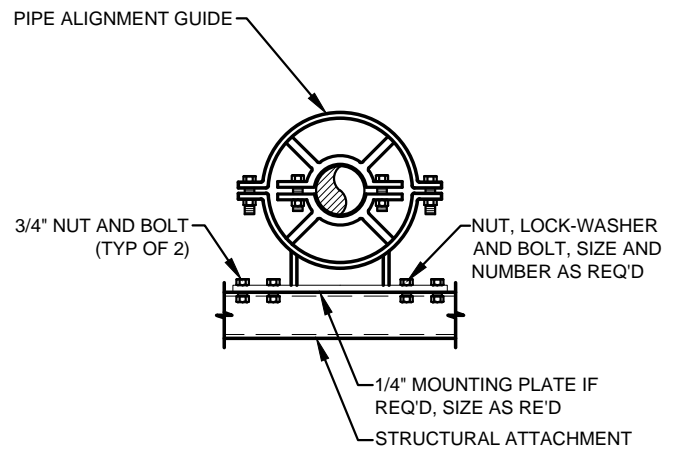
PIPE LINES WITH FLANGES - DIMENSION 'L'												
150 & 150 PSI, FLANGED												
NOMINAL PIPE SIZE (IN.)	NOMINAL PIPE SIZE (IN.)											
	2	3	4	6	8	10	12	14	16	18	20	24
	2	6										
	3	6	7									
	4	7	8	8								
	6	8	9	9	10							
	8	9	10	10	12	13						
	10	11	11	12	13	14	15					
	12	12	13	13	14	15	16	17				
	14	13	14	14	15	16	17	18	19			
	16	14	15	15	17	18	19	20	20	21		
	18	15	16	16	17	18	19	20	21	22	23	
	20	16	17	17	19	20	21	22	22	23	24	25
	24	19	19	20	21	22	23	24	24	25	26	27

NOTE:

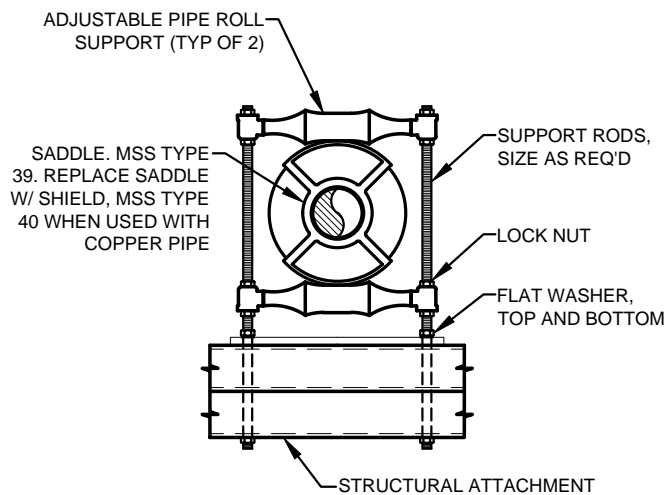
1. TABLES GIVE THE MINIMUM SPACING. INCREASE THESE DIMENSIONS FOR INSULATION AND IF THERMAL MOVEMENT WOULD REDUCE CLEARANCE.



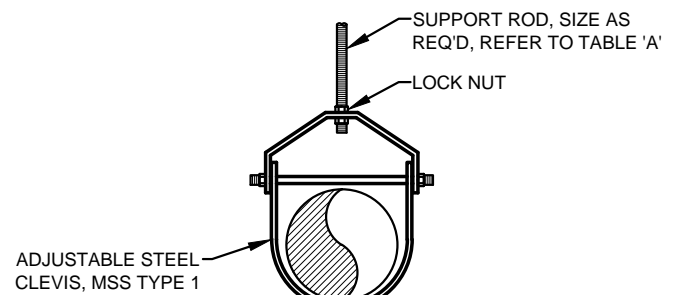
PG-1



PG-2



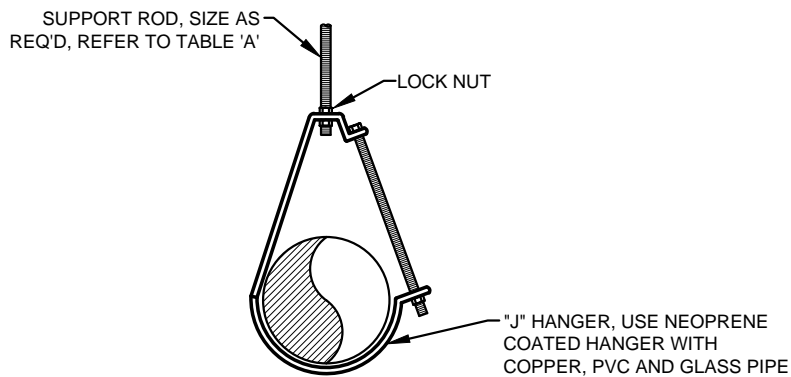
PG-3



REFER TO NOTE 5 ON TABLE 'A'

PA-1

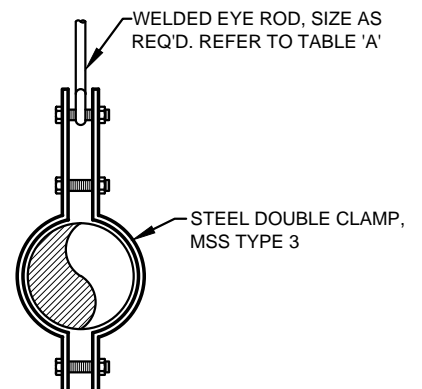
1/2" THROUGH 12" PIPE



REFER TO NOTE 5 ON TABLE 'A'

PA-2

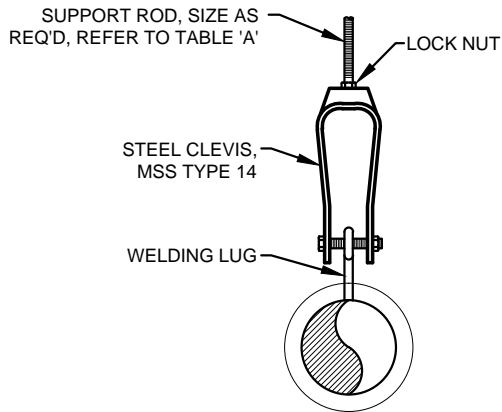
1/2" THROUGH 8" PIPE



REFER TO NOTE 5 ON TABLE 'A'

PA-3

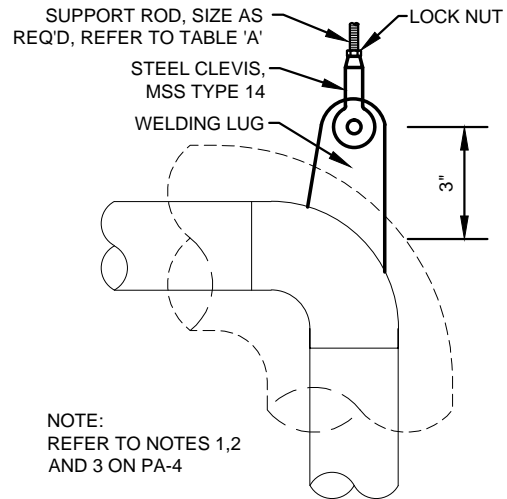
3/4" THROUGH 12" PIPE



NOTE:
 1. LUG SHALL BE WELDED TO PIPE BEFORE ANY LINING IS APPLIED TO PIPE.
 2. JACKET OF INSULATED PIPE SHALL BE MADE WATER TIGHT AT WELDING LUG.
 3. SEE TABLE 'A', NOTE 5.

PA-4

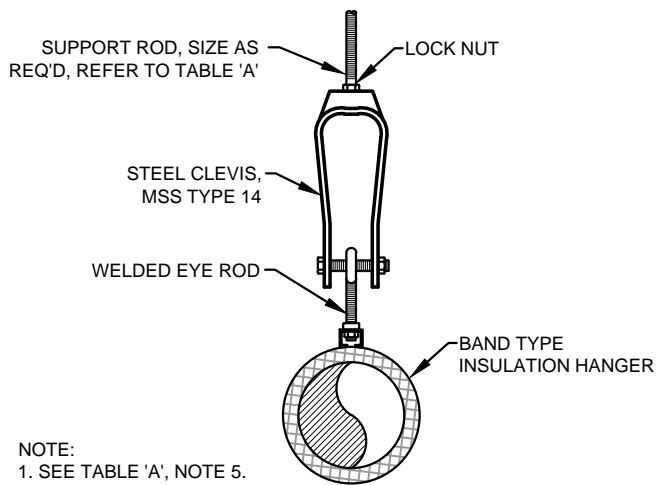
2-1/2" THROUGH 12" PIPE



NOTE:
 REFER TO NOTES 1,2 AND 3 ON PA-4

PA-5

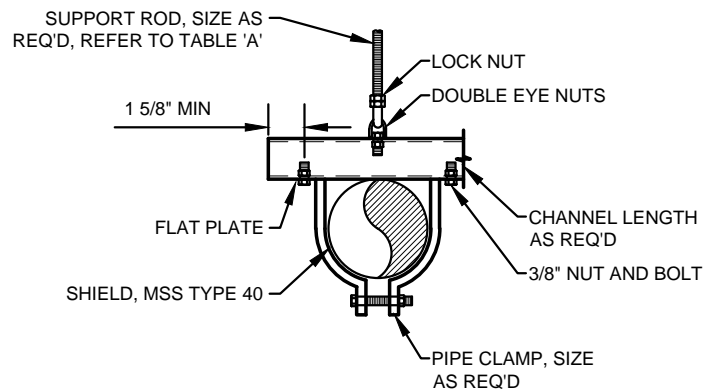
2-1/2" THROUGH 12" PIPE



NOTE:
 1. SEE TABLE 'A', NOTE 5.

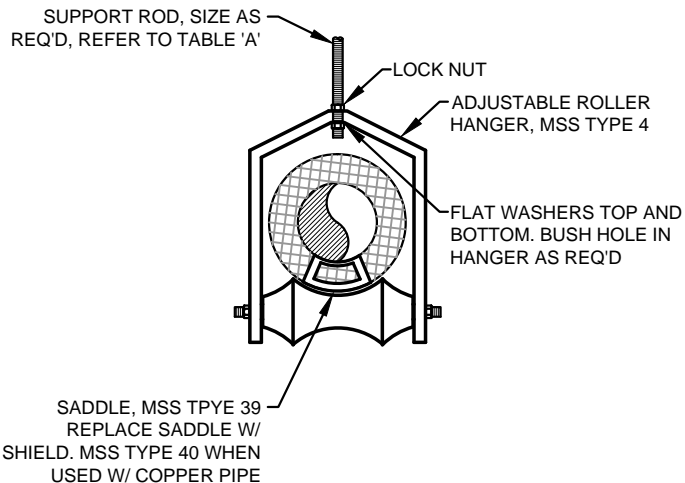
PA-6

1/2" THROUGH 12" PIPE



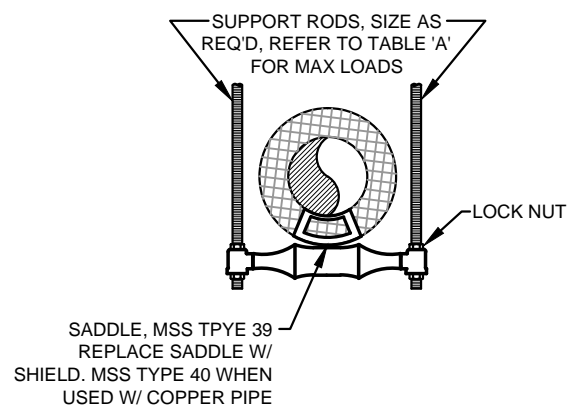
PA-7

3/8" THROUGH 3" PIPE



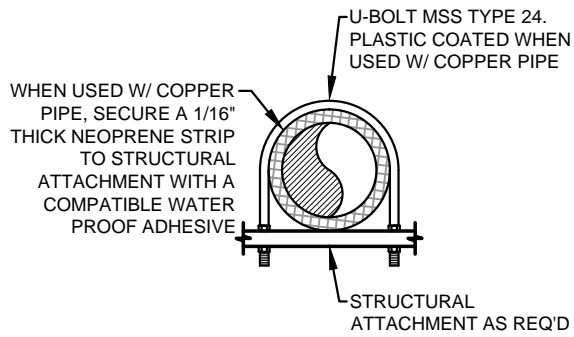
PA-8

3/8" THROUGH 12" PIPE

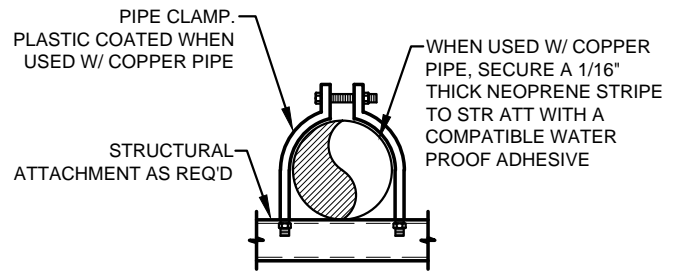


PA-9

3/8" THROUGH 12" PIPE

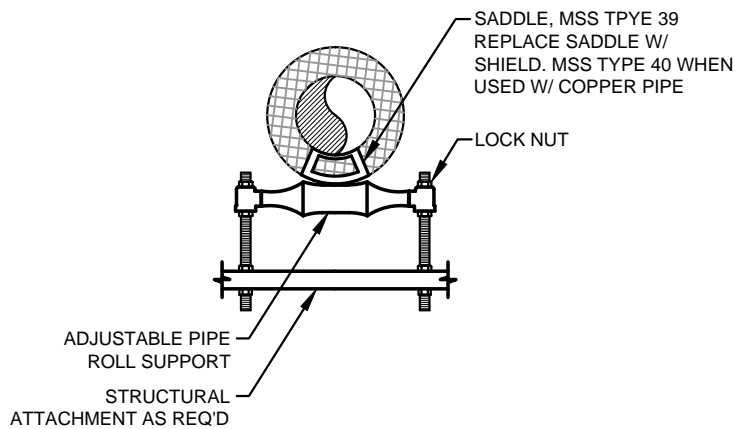


PA-10
1/2" THROUGH 12" PIPE

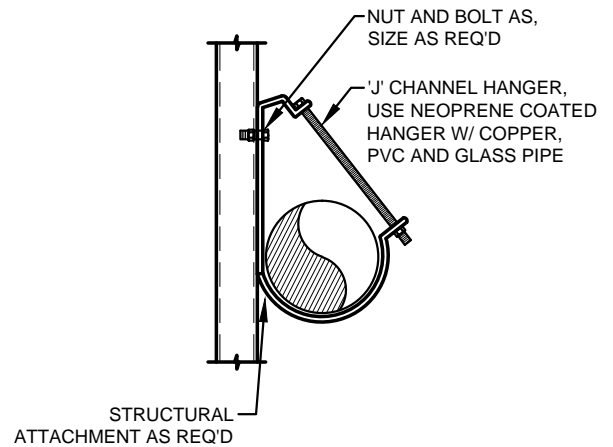


NOTE:
DO NO USE FOR HORZ. PIPES ABOVE 2" DIA. WHEN
STRUCTURAL ATTACHMENT IS MOUNTED VERTICALLY

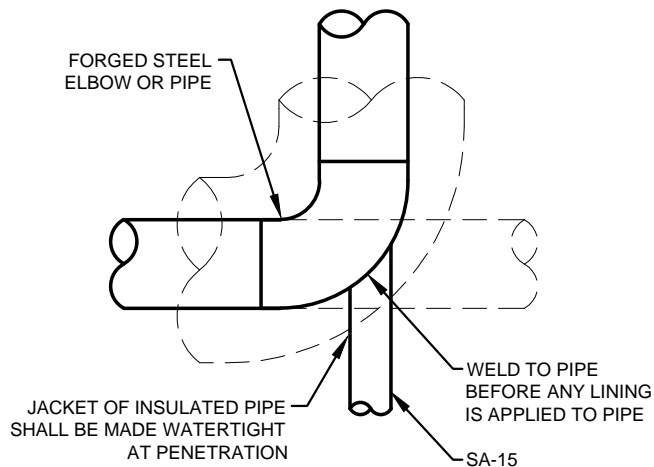
PA-11
3/8" THROUGH 8" PIPE



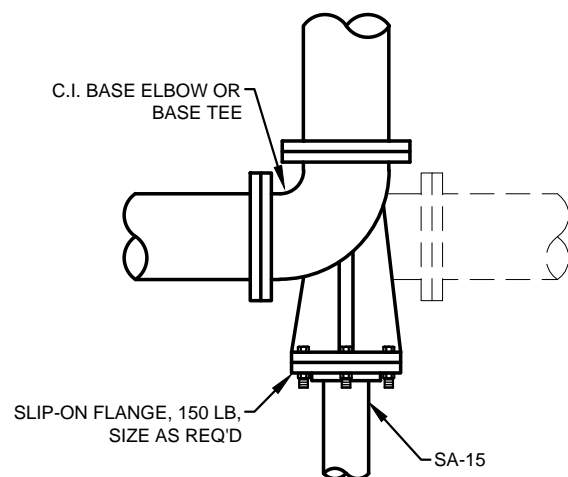
PA-12
3/8" THROUGH 12" PIPE



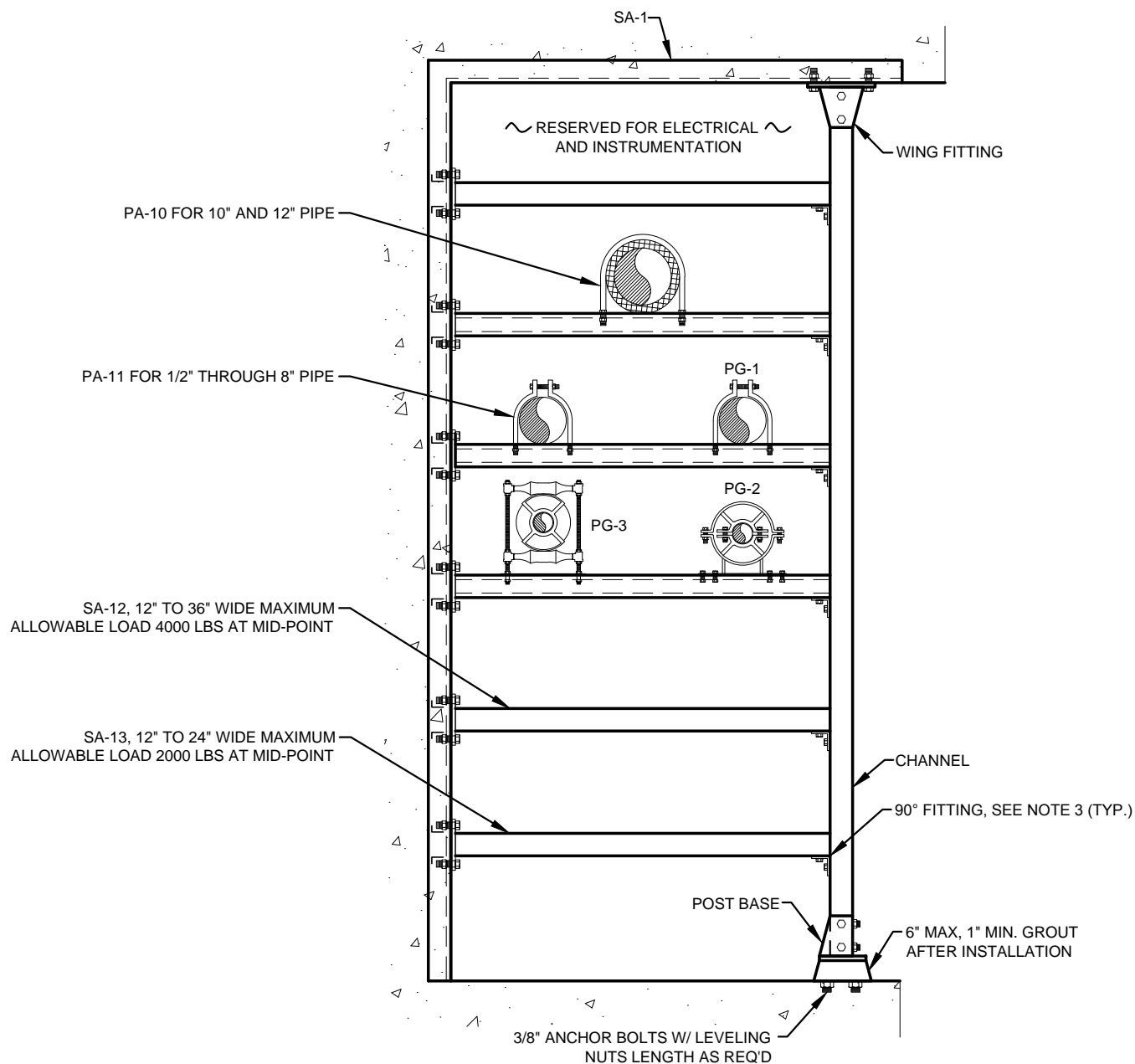
PA-13
1/2" THROUGH 8" PIPE



PA-14
2 1/2" THROUGH 12" PIPE



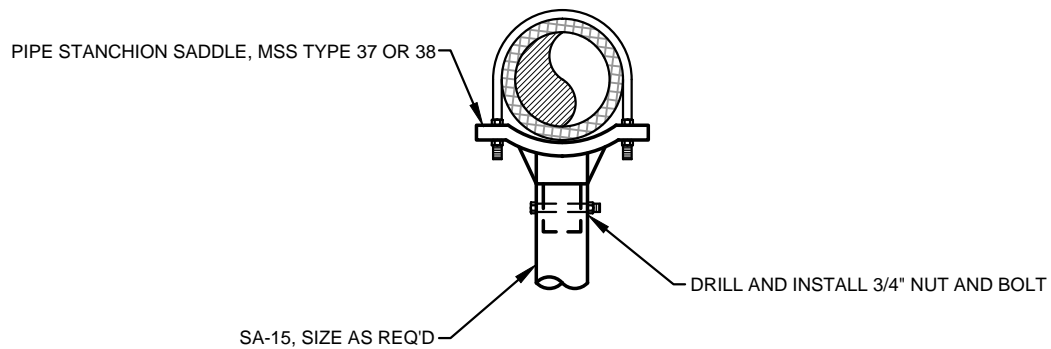
PA-15
2 1/2" THROUGH 12" PIPE



PIPE SUPPORT RACK AND TRAPEZE PIPING HANGER NOTES:

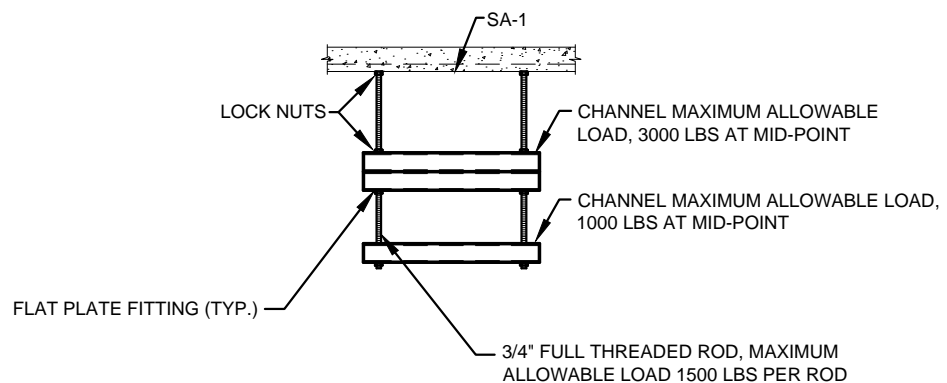
1. SPACING SHALL BE ON 5'-0" CENTERS. SEE TABLE 'A', NOTE 2.
2. MAXIMUM DESIGN WEIGHTS SHALL BE AS FOLLOWS:
 - 3/8" TO 1 1/4" PIPING = 100% OF DESIGN WEIGHT, REFER TO TABLE 'A'.
 - 1 1/2" TO 12" PIPE = 50% OF DESIGN WEIGHT, REFER TO TABLE 'A'.
3. TOTAL LOADS ON END CONNECTIONS SHALL NOT EXCEED HALF THE MAXIMUM ALLOWABLE LOAD AT THE MID-POINT.
4. VERTICAL SPACING SHALL BE AS REQ'D.
5. 6" MINIMUM, WHERE POSSIBLE.

TYPICAL PIPE SUPPORT RACK



PA-16

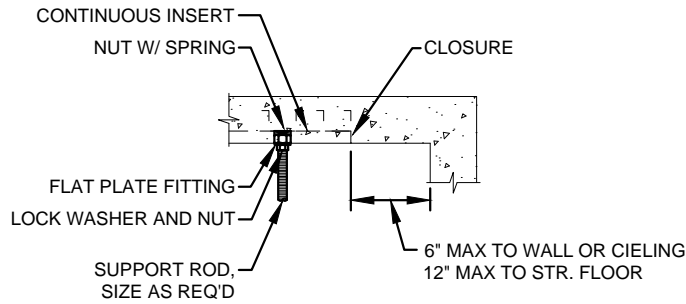
4" THROUGH 12" PIPE



TYPICAL TRAPEZE PIPE HANGER

NOTES:

1. MSS REFERS TO THE MFR'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY, STANDARD PRACTICE SP58 AND SP69.
2. FITTINGS SHALL NOT BE LESS THAN MSS CL 8
3. WHERE NO REFERENCE TO PIPE SUPPORT SYSTEMS IS GIVEN ON THE DRAWINGS, THE CONTRACTOR SHALL USE AN APPROPRIATE SYSTEM AS DIRECTED BY THE ENGINEER, REFER TO TABLE 'B'.



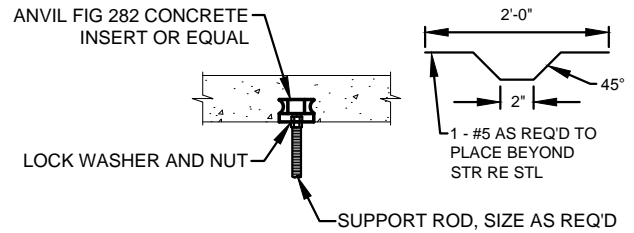
NOTE:
INSERT MAY BE USED WITH BOLTS AND SUPPORT RODS UP TO 3/4\".

CAPACITY: 3/8\" THROUGH 12\" PIPE (8\" THROUGH 12\" MUST BE SUPPORTED WITH 3/4\" RODS). LOAD SHALL NOT EXCEED 1500 LBS/FT OF INSERT LENGTH. USE DESIGN WEIGHTS SHOWN IN TABLE 'A' TO DETERMINE TOTAL LOAD.

SPACING: INSERTS SHALL BE INSTALLED ON 5'-0\" CENTERS IN WALLS AND CEILINGS OF TUNNELS, GALLERIES AND ROOMS BELOW GRADE WHERE INDICATED ON DETAIL DRAWINGS IF SPACING OTHER THAN 5'-0\" IS REQ'D. IT WILL BE INDICATED ON THE DRAWING

SA-1

SEE NOTE 5, TABLE 'A'

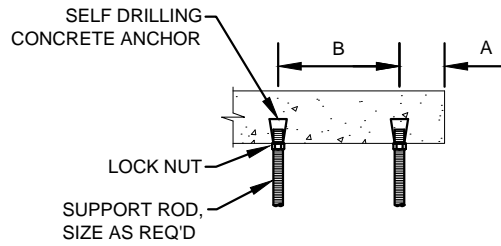


CAPACITY: 3/8\" THROUGH 12\" PIPE
MAXIMUM ALLOWABLE LOAD:
- 3/8\" ROD = 730 LBS
- 1/2\" ROD = 1130 LBS
- 5/8\" - 7/8\" RODS = 1140 LBS

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

SA-2

SEE NOTE 5, TABLE 'A'
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



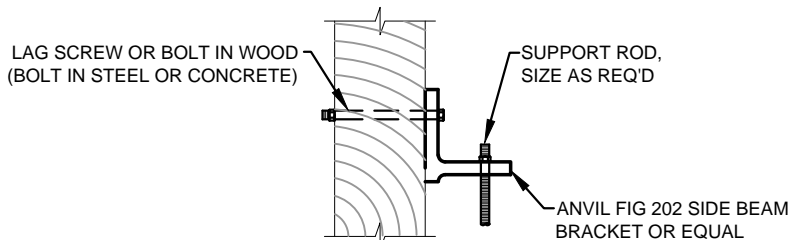
CAPACITY: 3/8\" THROUGH 12\" PIPE
MAXIMUM ALLOWABLE LOAD:
- 3/8\" ROD = 610 LBS
- 1/2\" ROD = 1130 LBS
- 5/8\" ROD = 1810 LBS
- 3/4\" ROD = 2350 LBS
- 7/8\" ROD = 2630 LBS

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

MINIMUM SPACING	'A' EDGE DISTANCE	'B' CENTER TO CENTER
3/8\" ROD	3"	4"
1/2\" ROD	4"	5"
5/8\" ROD	4"	6"
3/4\" ROD	5"	7"
7/8\" ROD	6"	8"

SA-3

SEE NOTE 5, TABLE 'A'
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



CAPACITY: WOOD 3/8\" THROUGH 6\" PIPE, STEEL OR CONCRETE 3/8\" THROUGH 12\" PIPE

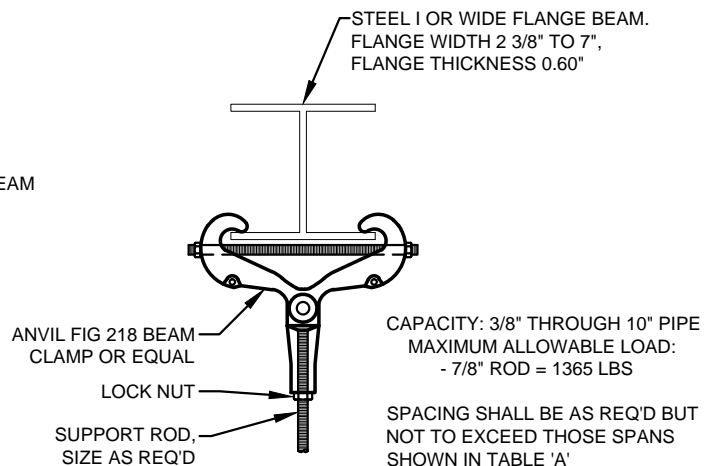
MAXIMUM ALLOWABLE LOAD

	WOOD	CONCRETE / STEEL
3/8\" ROD	390 LBS	730 LBS
1/2\" ROD	640 LBS	1350 LBS
5/8\" ROD	760 LBS	2160 LBS

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS IN TABLE 'A'

SA-4

SEE NOTE 5, TABLE 'A'
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.

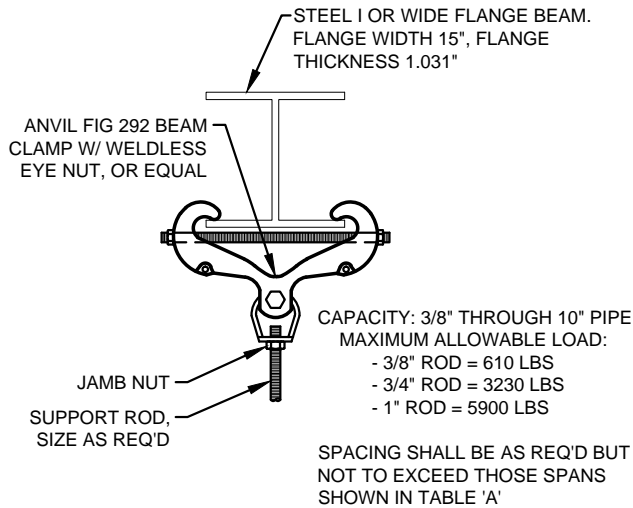


CAPACITY: 3/8\" THROUGH 10\" PIPE
MAXIMUM ALLOWABLE LOAD:
- 7/8\" ROD = 1365 LBS

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

SA-5

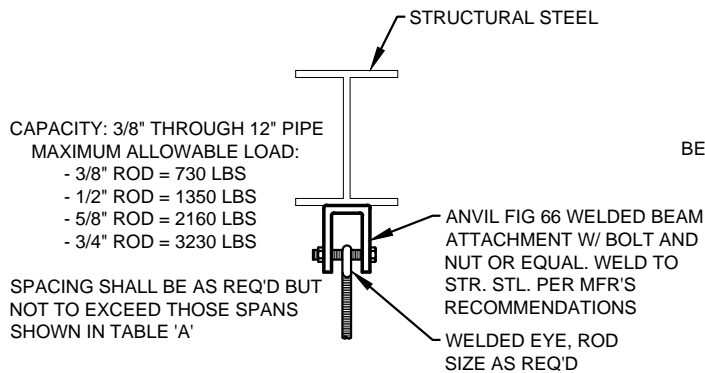
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



SA-6

SEE NOTE 2, TABLE 'A'

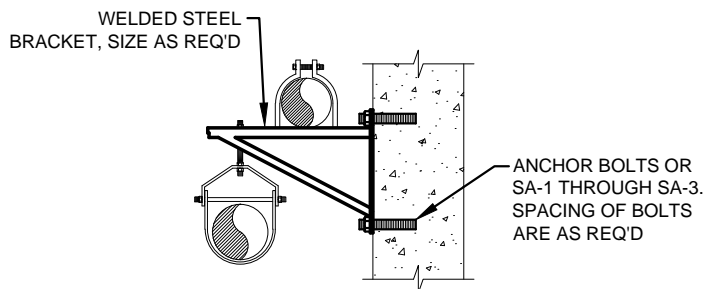
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



SA-8

SEE NOTE 2, TABLE 'A'

REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



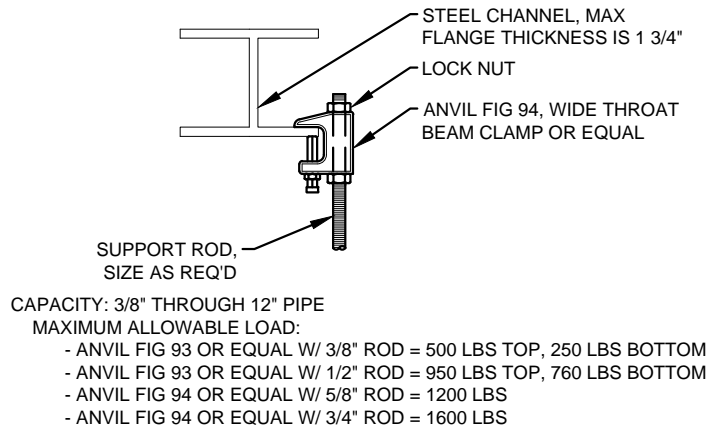
CAPACITY: 3/8" THROUGH 12" PIPE
- MAXIMUM ALLOWABLE LOAD
- ANVIL FIG 195 OR EQUAL = 1500 LBS
- ANVIL FIG 199 OR EQUAL = 3000 LBS
USE DESIGN WEIGHTS SHOWN IN TABLE 'A'
TO DETERMINE THE TOTAL LOAD.

NOTE: BRACKET MAY BE USED WITH VARIOUS HANGER, ROLLER,
GUIDE, U-CLAMP AND ANCHOR ASSEMBLIES

SA-10

SPACING SHALL BE AS REQ'D BUT NOT TO
EXCEED THOSE SPANS IN TABLE 'A'

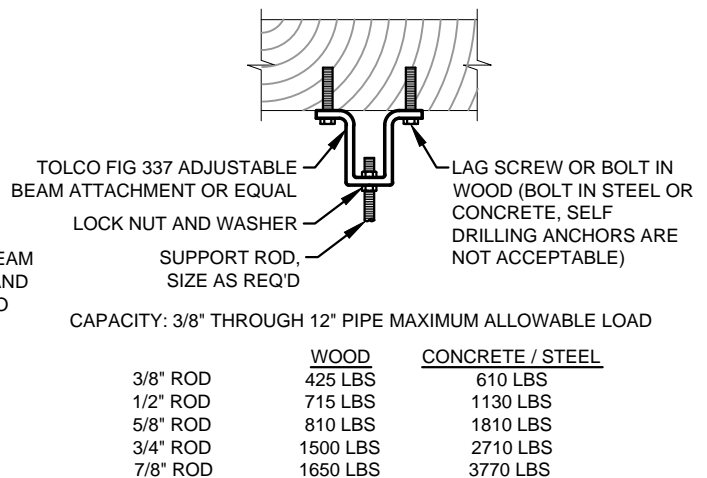
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN
TABLE 'A'

SA-7

SEE NOTE 5, TABLE 'A'

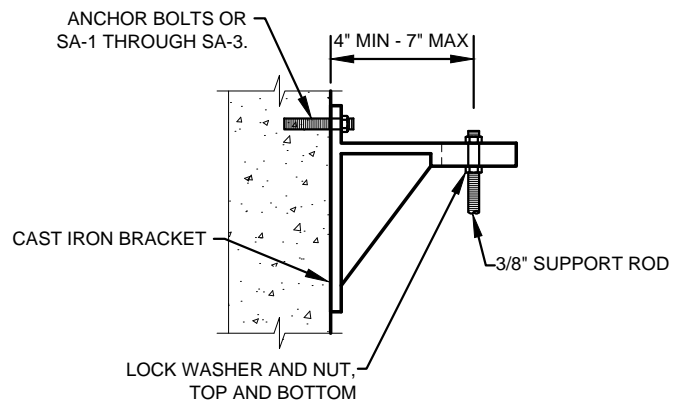


SPACING SHALL BE AS REQ'D BUT NOT TO
EXCEED THOSE SPANS IN TABLE 'A'

SA-9

SEE NOTE 5, TABLE 'A'

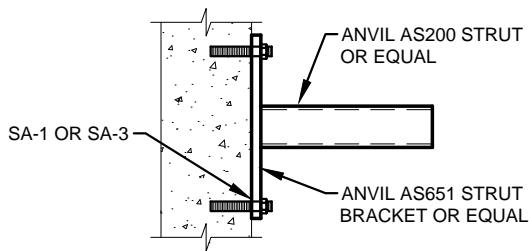
REFER TO MANUFACTURER
RECOMMENDATIONS FOR LOAD RATINGS.



CAPACITY: 3/8" THROUGH 2" PIPE
MAXIMUM ALLOWABLE LOAD = 180 LBS

SA-11

SEE NOTE 5, TABLE 'A'



BRACKET MAY BE USED WITH VARIOUS HANGER, ROLLER, GUIDE AND CLAMP ASSEMBLIES

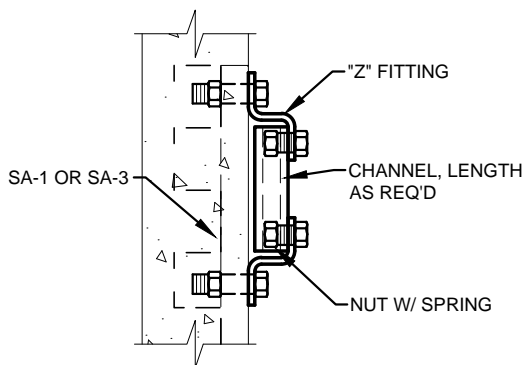
CAPACITY W/ A UNIFORM LOAD CAPACITY W/ LOAD AT THE END

<u>L</u>	<u>LOAD</u>	<u>L</u>	<u>LOAD</u>
6"	1200 LBS	6"	425 LBS
12"	600 LBS	12"	235 LBS
18"	400 LBS	18"	165 LBS
24"	300 LBS	24"	125 LBS

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

SA-12

REFER TO MANUFACTURER RECOMMENDATIONS FOR LOAD RATINGS.



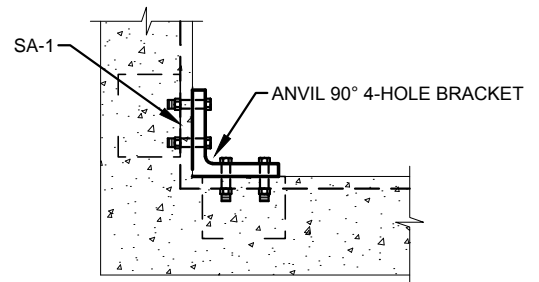
CAPACITY 3/8" THROUGH 8" PIPE

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

SA-14

GENERAL NOTES:

1. LOADS FOR SIZING ALL COMPONENTS SHALL BE DETERMINED USING THE DESIGN LOADS SHOWN IN TABLE 'A'.
2. WHEN SUPPORTING PIPING REQ'D HORIZONTAL FLEXIBILITY NORMAL TO THE BEAMS AXIS, USE SA-5 AND SA-6. SA-8 SHALL BE USED FOR PARALLEL FLEXIBILITY.
3. ALL COMPONENTS OF STRUCTURAL ATTACHMENTS SHALL BE HOT DIPPED GALVANIZED.



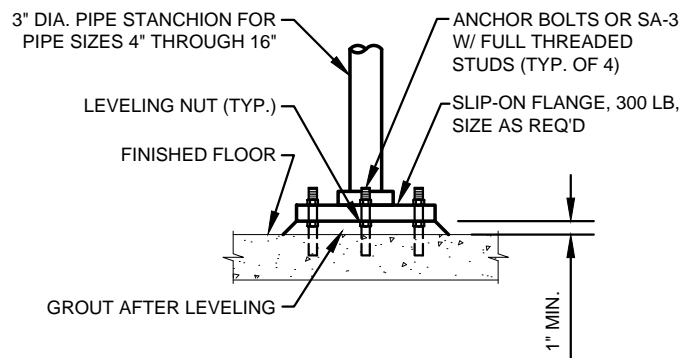
BRACKET MAY BE USED WITH VARIOUS HANGER, ROLLER, GUIDE AND CLAMP ASSEMBLIES

CAPACITY W/ A UNIFORM LOAD MOUNTED WITH 12GA CHANNEL IS 2000 LBS

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

SA-13

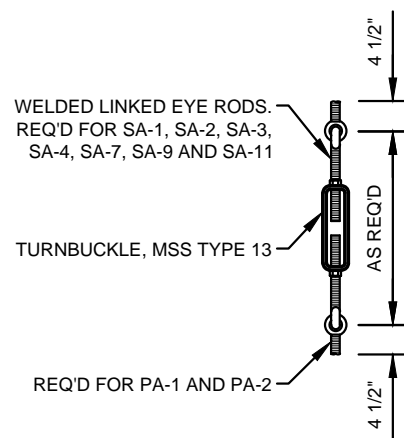
REFER TO MANUFACTURER RECOMMENDATIONS FOR LOAD RATINGS.



CAPACITY 2 1/2" THROUGH 12" PIPE

SPACING SHALL BE AS REQ'D BUT NOT TO EXCEED THOSE SPANS SHOWN IN TABLE 'A'

SA-15



TYPICAL SUPPORT ROD FOR PIPES SUBJECT TO HORIZONTAL MOVEMENT

SEE NOTE 5, TABLE 'A'

PIPING SYSTEM SPECIFICATION

RAW WASTEWATER 1

SANITARY DRAIN AND VENT2

PIPING SYSTEM SPECIFICATION

SERVICE RAW WASTEWATER				SYMBOL RW	
FLUID WASTEWATER			TEST MEDIUM		
			<input type="checkbox"/> AIR <input checked="" type="checkbox"/> WATER <input type="checkbox"/> _____		
			TEST DURATION 60 MIN.		
PRESSURE – PSIG			TEMPERATURE °F		
WORK	MAX	TEST	NORMAL		MAX
50	75	150	60		75
PIPE AND FITTING SPECIFICATION					
PIPE SIZE	EXPOSURE	PIPE		FITTINGS	
3" & Smaller	EXPOSED	Type 304 Stainless steel, screwed or welded joints		Type 304 Stainless steel, screwed or welded	
	BURIED EMBEDDED ENCASED	Polyethylene, heat fused		Polyethylene, heat fused	
4" & Larger	EXPOSED	SCH 10 Type 304 stainless steel, screwed or welded joints.		SCH 10 Type 304 stainless steel, screwed or welded.	
	BURIED EMBEDDED ENCASED	SCH 10 Type 304 stainless steel, screwed or welded joints.		SCH 10 Type 304 stainless welded.	
VALVE SPECIFICATION					
SIZE	EXPOSURE	TYPE	SPECIFICATION		
3" & Smaller	Exposed	Isolating	Eccentric Plug		
		Throttling	Eccentric Plug		
		Check	Swing Check with lever and weight		
4" & Larger	Exposed	Isolating	Eccentric Plug		
		Throttling	Eccentric Plug		
		Check	Swing check with lever and weight		
	Buried	Isolating	Eccentric Plug		
REMARKS: Buried valves shall have Clow Tyler or equal three piece valve box					

PIPING SYSTEM SPECIFICATION

SERVICE SANITARY DRAIN AND VENT				SYMBOL SD, SV		
FLUID WASTEWATER AND AIR			TEST MEDIUM			
			<input type="checkbox"/> AIR <input checked="" type="checkbox"/> WATER <input type="checkbox"/> _____			
			TEST DURATION 60 MIN.			
PRESSURE – PSIG			TEMPERATURE °F			
WORK	MAX	TEST	NORMAL		MAX	
		3 PSI				
PIPE AND FITTING SPECIFICATION						
PIPE SIZE	EXPOSURE	PIPE		FITTINGS		
Less than 1½"	EXPOSED	SCH 40 PVC DWV		SCH 40 PVC DWV, solvent weld		
	BURIED	SCH 40 PVC DWV		SCH 40 PVC DWV, solvent weld		
	EMBEDDED ENCASED					
1½" - 8"	EXPOSED	SCH 40 PVC DWV		SCH 40 PVC, solvent weld		
	BURIED	SCH 40 PVC DWV		SCH 40 PVC DWV, solvent weld		
	EMBEDDED ENCASED					
VALVE SPECIFICATION						
SIZE	EXPOSURE	TYPE	SPECIFICATION			
REMARKS:						

SECTION 40 05 16.61

VALVES – LIFT STATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section includes providing valves in size and type shown on plans and on the Piping System Specification Sheets.
- B. Related Sections and Divisions:
1. Applicable provisions of the General Conditions shall govern the work in this section.
 2. Section 01 78 23, Operation and Maintenance Data.
 3. Section 01 78 43, Installation and Training Checklist.
 4. Division 26, Electrical.
 5. Division 46, Water and Wastewater Equipment.

1.02 REFERENCE STANDARDS

- A. American Water Works Association (AWWA):
1. AWWA C111 Spec. for Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 2. AWWA C515 Spec. for manufacturing compliance for ductile iron castings.
 3. AWWA C550 Spec. for fusion bonded epoxy coating.
 4. AWWA C509 Spec. for elastomeric and cellular performed gasket & sealing material.
 5. AWWA C606 Standard for grooved ductile iron pipe ends.
 6. AWWA C504 Standard for rubber seated gate valve.
- B. American Society for Testing and Materials (ASTM):
1. ASTM A48 Spec. for Gray Iron Castings.
 2. ASTM A126 Spec. for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 3. ASTM A743 Spec. for Corrosion-Resistant Iron-Chromium, Iron-Chromium Nickel, and Nickel-Base Alloy Castings for General Application.
 4. ASTM A296 Spec. for Stainless Steel, Type 304 or 316.
 5. ASTM D1784 Spec. for PVC cell classification 12454A.
 6. ASTM D1784 Spec. for CPVC cell classification 23567A.
 7. ASTM A351 Spec. for stainless steel valve body.
 8. ASTM A240 Spec. for chromium & chromium nickel stainless steel plate, sheet and strip.
 9. ASTM B30 Spec. for copper alloys.
- C. American National Standards Institute (ANSI):
1. ANSI B18.2.1 General & dimensional Data Cap Screws & Boots.
 2. ANSI B16.5 Dimensions for flanges

1.03 SUBMITTALS

- A. Submit the following:
1. Shop drawings including assembly and installation drawings and materials of construction.
 2. Product data including:
 - a. Name of manufacturer.
 - b. Type and model.
 3. Parts and Dimensional Drawings
 - a. Product bulletins as applicable.
 4. Operation and maintenance manuals.
- B. Submit two (2) copies of a report documenting the field testing to the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Like equipment shall be the end produce of one manufacturer.
- B. Valves shall include all necessary actuators, operating handwheels, chain wheels, extension stems, worm and gear operators, operating nuts, chains, wrenches, floor stands, and other accessories to allow complete operation from the intended operating level.
- C. Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service.
- D. Valves shall be the same size as the adjoining pipe unless otherwise shown.
- E. Manufacturer and the size of the valve shall be identified on valve, a permanently attached plate in raised letters, or on the valve casting.
- F. Valve manufacturer shall provide valve maximum torque limits and coordinate with valve actuator manufacturer to insure maximum torque is not exceeded.
- H. Use or reuse of components and materials without the traceable certification is prohibited.

2.02 VALVES

- A. Plug Valves
1. Eccentric Plug Valves 3 inches and smaller.
 - a. Shall be of the non-lubricated type with attached wrench lever manual operator, rates 175-pound WOG. Valves shall have a cast iron body with screwed ends, balanced plug coated with Hycar or neoprene elastomer, and O-ring seals.
 - b. Manufacturers and Products:
 - 1) DeZurik Water Controls PEC; or equal.
 2. Eccentric Plug Valves 4-inch through 24-inch
 - a. Nonlubricated type rated 1/3 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, AWWA Standard C111.

- b. Bodies shall be of ASTM A126 Class B cast iron. Bodies in 4-inch (100 mm) and larger valves shall be furnished with a 1/8-inch (3mm) welded overlay seat of not less than 90% pure nickel. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Screwed-in seats shall not be acceptable.
- c. Plug shall be of ASTM A126 Class B cast iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug shall be Chloroprene (CR) or resilient facing suitable for application.
- d. Bearings shall have sleeve type metal bearings and shall be of sintered, oil impregnated permanently lubricated type 316 ASTM A743 Grade CF8M in ½-inch through 36 inches (15-900 mm) sizes. In valves larger than 36-inch (900mm), the upper and lower plug journals shall be fitted with ASTM A-240 type 316 stainless sleeves with bearings of ASTM B30, Alloy C95400 aluminum bronze. Non-metallic bearings shall not be acceptable.
- e. Shaft seals shall be of the multiple V-ring type and shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable.
- f. Pressure ratings shall be 175 psi (1210 kPa) on sizes ½ inch through 12-inch (15-300 mm) and 150 psi (1030 kPa) for 14-inch to 72-inch (350-1800mm). Every valve shall be given a hydrostatic and seat test with test results being certified when required by the specifications.
- g. Operators:
 - 1) Less than 6-inch valves: Wrench lever manual.
 - 2) 6-inch and larger valves: totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher.
 - 3) For buried service, all sizes. Provide completely sealed operator filled with heavy lubricant and 2-inch nut.
- h. Manufacturers and Products:
 - 1) DeZurik PEC or equal.

B. Check Valves

- 1. Swing Check Valve with Lever and Weight 2 inches and larger.
 - a. Ductile iron body and bolted flange cover, flanged ends. The swing check valve shall be Class 150 with a working pressure of 150 psi. Valve body, cover flange, disc, and disc arm material shall be ductile iron conforming to ASTM A536, Grade 65-42-12. Body seat ring, disc stem, pivot shaft, and pivot shaft retaining pin material shall be Type 304 stainless steel conforming to ASTM A582, Condition A. The valve shall have a Buna-N resilient seat. The interior and exterior of the valve shall have a fusion bonded epoxy coating. The swing check valve shall be equipped with a side mounted lever and weight. The valve shall provide an efficient flow path with an area equal to or greater than the area of the nominal valve size.
 - b. Manufacturers and Products:
 - 1) APCO series CVS-250/250A or equal.

C. Ball Valves:

1. Stainless Steel Ball Valve 2 Inches or Smaller:
 - a. Two-piece, full port, ASTM A351 CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psi CWP.
 - b. Manufacturers and Products:
 - 1) Nibco; T-580-S6-R-66-LL, or equal.

D. Air Release and Vacuum Break Valves

1. Combination Air Release and Vacuum Break Valve
 - a. Combination air valve, single body, double orifice. Valve shall allow large volumes of air to escape out of large orifice when filling the pipeline and allow large volumes of air to enter the large orifice when draining the pipeline to break the vacuum. Valve shall allow trapped pockets of air to automatically exit the pipeline through the small orifice when the pipeline is operating under pressure. Valve shall provide watertight shutoff to prevent discharge of water. The air release and vacuum break valve shall consist of a compact tubular all stainless steel fabricated body, hollow direct acting float and solid large orifice float in HDPE - stainless steel nozzle and woven dirt inhibitor screen, nitrile rubber seals and natural rubber seat. The valve shall have an integral "anti-surge" orifice mechanism, which shall operate automatically to limit transient pressure rise or shock induced by closure to less than 2 x valve rated working pressure. The intake orifice area shall be equal to the nominal size of the valve. Large orifice sealing shall be effected by the flat face of the control float seating against a nitrile rubber "O" ring housed in a dovetail groove circumferentially surrounding the orifice. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into the control float. The nozzle shall have a flat seating land surrounding the orifice so that damage to the rubber seal is prevented. The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to twice the designed working pressure. Connection to the valve inlet shall be facilitated by flanged ends conforming to ANSI B16.1 Class 125 Standards. Flanged ends shall be supplied with the requisite number of stainless steel screwed studs inserted for alignment to the specified standard. Nuts, washers or jointing gaskets shall be excluded. Valve shall operate to a maximum operating pressure of 150 psi and minimum pressure of 0 psi.
 - b. Each air release and vacuum break valve shall be provided with an isolation valve. Each air release and vacuum break valve shall be subjected to the following factory tests in the order represented. Hydrostatic test to 2X maximum rated working pressure. Low head leak test to 7 psi. Small orifice function test at maximum rated working pressure.
 - c. Size shall be as shown on plans.
 - d. Manufacturers and Products:
 - 1) Vent-O-Mat or equal.

E. LP and Natural Gas Valves

1. Natural Gas Shut-off Valves 2½-inch and smaller

- a. Plug valve, cast-iron body, threaded ends, bronze plug ball, full or conventional port, Teflon seat, blowout-proof stem, two-piece construction, suitable for 150 psig working pressure, U.L. listed for use as natural gas shut-off.
 - b. 2½-inch through 4-inch: Cast iron body, flanged ends, bronze bearings, electroless nickel-plated cast iron plug with Hycar resilient plug seal, Buna-N stem seal packing, lever actuator, 175 psi W.O.G., U.L. listed for use as natural gas shut-off. 5-inch and larger: Cast iron body, flanged ends, stainless steel bearings, resilient faced plugs, totally enclosed hand wheel actuators, 175 psi W.O.G., U.L. listed for use as natural gas shut-off.
 - c. Manufacturers and Products:
 - 1) DeZurik, Homestead, Rockwell, Walworth or approved equal.
- 2. Gas Pressure Regulators 2-inch and smaller:
 - a. Cast iron body, aluminum spring and diaphragm, Nitrile diaphragm, threaded ends, 150 psi W.O.G., -20°F to 150°F.

2.06 VALVE BOXES AND EXTENSION STEMS

- A. Acceptable manufacturer shall be Clow, Tyler, or equal.
- B. Valve boxes shall be three-piece assembly constructed of cast iron in accordance with ASTM A48, Class B.
- C. Valve box diameter shall be 5¼ inches.
- D. All valves shall be provided with extended stem terminated a maximum of 12-inches below grade, provide stainless steel, or hot dipped galvanized extension stems.
- E. Provide a 2-inch square operating nut.
- F. Provide one 4-foot long wrench for operation.
- G. Provide valve box hangers by Adaptor, Inc., or equal.
- H. Cast the wood water, sewage, gas, or drain into the top of the lid or label with a stainless steel tag permanently attached to the inside of the lid.

2.07 VALVE OPERATORS

- A. All valves shall open by turning counter-clockwise, unless otherwise shown or specified.
- B. Size operators and actuators to operate valves under full operating head and velocities.
- C. Worm and gear operators for manually operated valves:
 - 1. Provide a totally enclosed design.
 - 2. Provide a self-locking type to prevent the disc or plug from creeping.
 - 3. Self-locking worm gears:
 - a. One-piece design of AWWA gear bronze material, accurately machine cut.
 - b. Provide a hardened alloy steel worm, with thread round and polished.
 - 4. Provide proper lubricant for the reduction gearing.
 - 5. Provide with position indicators to show the position of the valve disc or plug.
 - 6. Paint the hand wheels the same color as the valve and associated pipeline.

7. Gera operators shall be provided by all valves in buried or submerged operation.
- D. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs, and washer shall be stainless steel.
- 2.08 FLOOR BOXES AND EXTENSION STEMS
- A. Provide a Clow F-5695, Neenah Foundry R 7506, or equal floor box.
- B. Provide valve extension stems where required to locate the operating nut in the floor box within 3 inches of the finished floor.
- C. Provide a 2-inch square operating nut.
- D. Provide all necessary anchor bolts in Type 304 stainless steel.
- E. Provide Type 304 stainless steel valve extension stems for submerged extension stem installations.
- F. Provide galvanized or epoxy coated steel valve extension stems for all non-submerged extension stem installations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with shop drawings and manufacturer's recommendations. After installation demonstrate trouble-free operation in the presence of the Engineer.

3.02 FIELD QUALITY CONTROL

- A. Field tests shall be conducted on the unit identified above.
1. Field tests shall be conducted when appropriate process liquid is available.
 2. Field test shall be conducted by manufacturer's representative in the presence of the Engineer.
 3. Engineer shall be notified in advance of any field tests.
- B. All defects noted during tests shall be corrected promptly at the expense of the manufacturer.
1. When necessary, field test shall be repeated until requirements of specifications have been met.
 2. All testing and modifications to equipment required to meet specification shall be at the expense of the manufacturer.
- C. When manufacturer is unable to demonstrate by test results that equipment conforms to requirements of specifications. The equipment shall be rejected and replaced with acceptable units at the manufacturer's expense.
- D. Minimum start-up operator training and final adjustment service by manufacturer shall be 1 day with a minimum of 1 trip.

- E. The time for start-up, operator training and final adjustment shall be designated by the Owner and shall be within the one year guarantee period after final acceptance.
- F. Qualifications of Start-up Personnel
1. Personnel shall be authorized by the manufacturer to start-up and initiate warranty of the equipment provided.
 2. Personnel shall come to the site with the required tools and electrical instruments.
 3. Personnel shall have full knowledge of electrical controls pertaining to the equipment and control panels furnished.
 4. Failure to provide personnel with full qualifications shall be cause for service trip to be disqualified as part of requirements and may be cause for reimbursement for costs incurred by the Owner due to services required for start-up inspections.

- END OF SECTION -

46

DIVISION 46

WATER AND WASTEWATER EQUIPMENT

SECTION 46 42 56.19

SUBMERSIBLE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Work Included: This section includes furnishing and installing submersible centrifugal pumps and accessories in accordance with the plans and specifications.
- B. Related Sections and Divisions:
 - 1. Applicable provisions of the General Conditions shall govern work in this section.
 - 2. Section 01 75 00 – Starting, Testing and Operator Training
 - 3. Section 01 78 23 – Operation and Maintenance Data
 - 4. Section 01 78 43 – Equipment, Installation, Training and Receipt of Spare Parts Checklists
 - 5. Division 26 – Electrical

1.02 REFERENCED STANDARDS

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A48 Standard Specification for Gray Iron Castings
- B. American National Standards Institute (ANSI):
 - 1. ANSI A2 1. 10 Ductile-Iron and Gray Iron Fittings, 3 inch through 48 inch for Water and Other Liquids
 - 2. ANSI B16.1 Pipe Flanges and Flanged Fittings
- C. Hydraulics Institute Standards.
- D. Anti-Friction Bearing Manufacturer's Association (AFBMA):
 - 1. Std 9-1978 Load Ratings and Fatigue Life for Ball Bearings
- E. National Electric Code (NEC)
- F. NEMA Electrical Standards
- G. Underwriter's Laboratory

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 32 19, Submittals:
 - 1. Shop drawings including assembly and installation drawings and naturals of construction.
 - 2. Assembled electrical and control equipment drawings for all components.
 - 3. Pump data including:
 - a. Name of manufacturer.
 - b. Type and model.
 - c. Design rotative speed.
 - d. Weight of pump including motor.
 - e. Electrical requirements

- f. Complete certified pump performance curves showing:
 - (1) Flow.
 - (2) Total Design Head.
 - (3) Net Positive Suction Head Requirements.
 - (4) Efficiency.
 - (5) Brake Horsepower.
 - g. Materials of construction and cross-sectional drawing.
 4. Field testing and start-up report.
- B. Submit operation and maintenance in accordance with Section 01 78 23, Operation and Maintenance Manuals.
- C. Submit installation and training checklists in accordance with Section 01 78 43, "Equipment, Installation, Training, and Receipt of Spare Parts Checklists."

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Gorman-Rupp, Sulzer, or equal.

2.02 PUMP

- A. Design each pump for the following design conditions:

<u>Requirements</u>	<u>Pumping System</u>
1. Type of liquid to be handled.	Raw Wastewater
2. No. of pumps.	2
3. Type of drive.	VFD
4. Design Conditions	
Design Point 1	
(1) Flow, GPM	90
(2) TDH, feet	22
Design Point 2	
(1) Minimum Flow, GPM	87
(2) TDH, feet	38
5. Pump RPM maximum.	1,200
6. Maximum motor horsepower.	3
7. Voltage, phase.	208, 3
8. Minimum efficiency % at design flow, RPM, TDH	27
9. Minimum spherical solids passed, inches.	3.0

- B. General

1. The pump shall be capable of handling unscreened, municipal wastewater.
2. The design shall be such that the pump unit will automatically and firmly connect to the discharge piping when lowered into place on its mating discharge connection, permanently installed in the wet well.
3. The pump system shall be designed to permit surface level removal of the pumping unit for inspection or service without dewatering the wet well or interrupting operation of the other units.
4. Each pump shall be fitted with a stainless steel chain or cable of adequate strength and length to permit raising and lowering the pump for inspection or removal. The

- chain/cable shall have quick disconnects at each end for attachment to the pump and lifting hook.
5. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet.
 6. Each pump shall be designed so that reverse rotation will not cause damage to the unit.

C. Pump Construction

1. General

- a. All major parts including motor, seal housing, sliding guide brackets, impeller and volute shall be gray cast iron in accordance with ASTM A48, Class 25.
- b. All surfaces in contact with wastewater shall be protected by a coating resistant to wastewater.
- c. All exposed bolts, nuts and other fasteners shall be 300 series stainless steel.
- d. The pump discharge shall be fitted with standard ANSI A21.10, 125-pound flange, forced and drilled.

2. Impeller

- a. The impeller shall be of the dynamically balanced vortex design.
- b. The impeller shall be non-clogging design, capable of handling 3-inch solids, fibrous material, and other matter found in wastewater applications.
- c. Construct with a long throughlet without acute turns.
- d. The impeller shall be dynamically balanced without deforming or weakening it. The impeller shall be a slip fit to the shaft.
- e. Volute case wear ring of 230 brass or stainless steel shall be provided which is easily field replaceable.

3. Shaft Seal System

- a. Each pump shall be provided with a mechanical rotating shaft seal system running in an oil reservoir having separate, constantly hydro-dynamically lubricated lapped seal faces. The (lower) seal unit between the pump and oil chamber shall contain one stationary and one positively driven rotating tungsten-carbide ring. The (upper) seal unit between the oil sump and motor housing shall contain one stationary ceramic ring and one positively driven rotating carbon ring. Each interface shall be held in contact by its own spring system supplemented by external liquid pressures.
- b. The seals shall require neither maintenance nor adjustment and shall be easily inspected and replaceable.
- c. The shaft sealing system shall be capable of operating submerged to depths of, or pressures equivalent to 65 feet. No seal damage shall result from operating the pumping unit out of its liquid environment. The seal system shall not rely upon the pumped media for lubrication.

4. Guide Bracket and Discharge Connection

- a. A sliding guide bracket shall be an integral part of the pump unit.
- b. The volute casing shall have a machined discharge flange to automatically and firmly connect with the cast iron discharge connection, which, when bolted to the floor of the sump and discharge line, will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices.
- c. Installation of pump unit to the discharge connection shall be the result of a simple linear motion the pump unit guided by no less than two guide bars.
- d. No other motion of the pump unit, such as tilting or rotating, shall be required. Sealing of the discharge interface by means of a diaphragm, o-ring or other devices will not be considered acceptable nor equal to a metal to metal contact of the pump discharge flange and mating discharge connection specified and

required. No portion of the pump unit shall bear directly on the floor of the wet well. There shall be no more than one 90° bend allowed between the volute discharge flange and station piping.

5. Tolerances and Mating Surfaces
 - a. Tolerances of all parts shall be such that allow replacement of any part without additional machining as required to ensure sealing as described above. No secondary sealing compounds greases or other devices shall be used.
 - b. All mating surfaces of major parts shall be machined and fitted with nitrile o-rings where watertight sealing is required. Machining and fittings shall be such that sealing is accomplished by automatic compression in two planes and o-ring contact made on four surfaces, without the requirement of specific torque limits to affect this. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered adequate or equal.
6. Cooling System
 - a. Each unit shall be provided with an adequately designed cooling system. Thermal radiators integral to the stator housing cast in one unit are acceptable.
 - b. Where water jackets alone or in conjunction with radiators are used, separate circulation shall be provided. Cooling media channels and ports shall be non-clogging by virtue of their dimensions. Provisions for external cooling and flushing shall be provided.
7. Pump Data Plates
 - a. Attach stainless steel data plates to each pump. Each data plate shall contain the following information:
 - (1) Manufacturer's name
 - (2) Pump model and size
 - (3) Serial number
 - (4) Flow Rate
 - (5) Design TDH
 - (6) Speed
 - (7) Motor horsepower
 - (8) Voltage and Phase
 - (9) Amperage
 - (10) Service Factor
 - (11) Impeller diameter and type

2.03 PUMP GUIDES

- A. Each unit shall be furnished with complete guides for pump installation and removal. Guide system shall be of stainless steel material and include the following:
 1. Upper guide holder and level sensor cable holder.
 2. Intermediate guide brackets.
 3. Lower guide bar holders shall be integral with the discharge connection.
 4. Guide bars shall be 2 inch stainless steel pipe.
 5. Guide system shall be of non-sparking design for explosion proof environment.
 6. Wet wells of greater than 15 feet in depth shall require stainless steel intermediate supports.

2.04 MOTOR AND CABLE

- A. Pump, motor and cable shall be explosion proof and shall be UL approved for Class 1, Division 1, Group D service.

- B. The pump motor shall be housed in a watertight casing and shall have moisture resistant Class F 155°C insulation. The motor shall be NEMA Design B, premium efficient with 1.15 nameplate service factor. Motor shall be air cooled or oil cooled induction type, and designed for continuous duty. Motors shall be wired to operate at voltage and phase shown in part 2.02 Pump, at 60 hertz.
- C. The cable entry water seal design shall be such that precludes specific torque requirements to insure a watertight and submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or terminal board which shall insulate the motor interior from foreign materials gaining access through the pump top.
- D. Pump motor cable installed shall be suitable for submersible pump applications and this shall be indicated by a code or legend permanently embossed on the cable. Cable sizing and configuration shall conform to NEC specifications rated SO, STO or better for pump motors and shall be adequate size to allow motor voltage conversion without replacing the cable.
- E. Furnish electrical cable(s), power and signal of sufficient length to go to the electrical connection point at the local control panel.
- F. Provide integral thermal sensors (one for each phase). Embed in stator to monitor stator temperature. Switches shall be wired in series and two leads brought up to the pump control panel.
- G. Provide integral moisture sensor in oil chamber or stator housing to detect seal or casing leakage. Two leads shall be brought up with cable to the pump control panel.
- H. Conductivity switch monitor shall be provided by pump supplier with pump. Conductivity switch monitor shall be installed in the control panel.
- I. A suitable thrust bearing shall be incorporated in the motor to be capable of carrying the weight of all rotating parts and the hydraulic thrust of the pump. Bearings shall have a minimum B-10 life of 50,000 hours.
- J. The cable shall have a factory installed rubber boot on the end to protect it during transit.
- K. The pump shall be non-overloading without the use of the service factor along the entire pump curve. Horsepower load shall not exceed nameplate rating of motor for full pump curve from shutoff to maximum runout capacity.

2.05 ELECTRICAL AND CONTROL SYSTEMS

- A. Pump control panel and associated equipment shall be provided as specified in Division 26.

PART 3 - EXECUTION

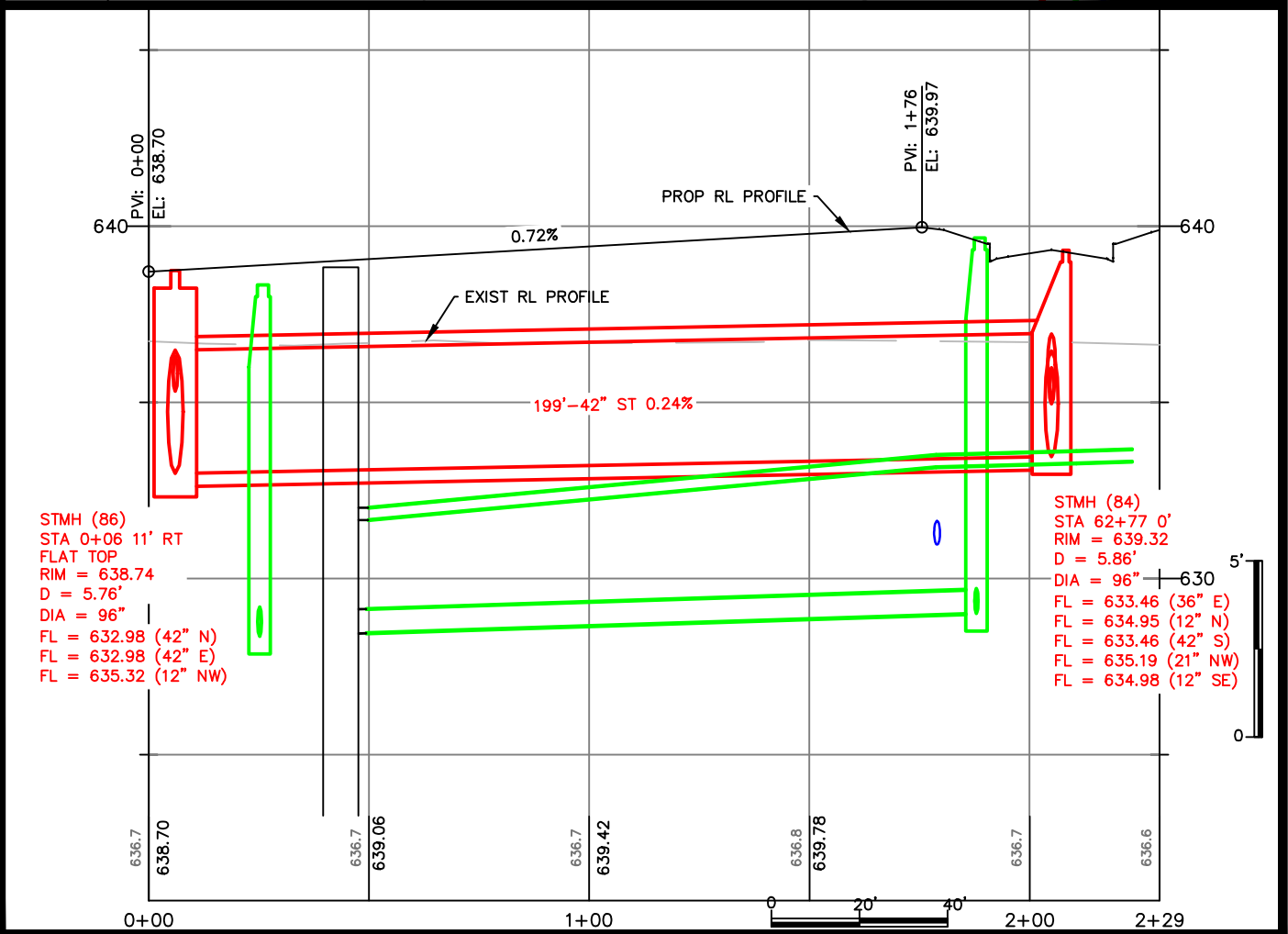
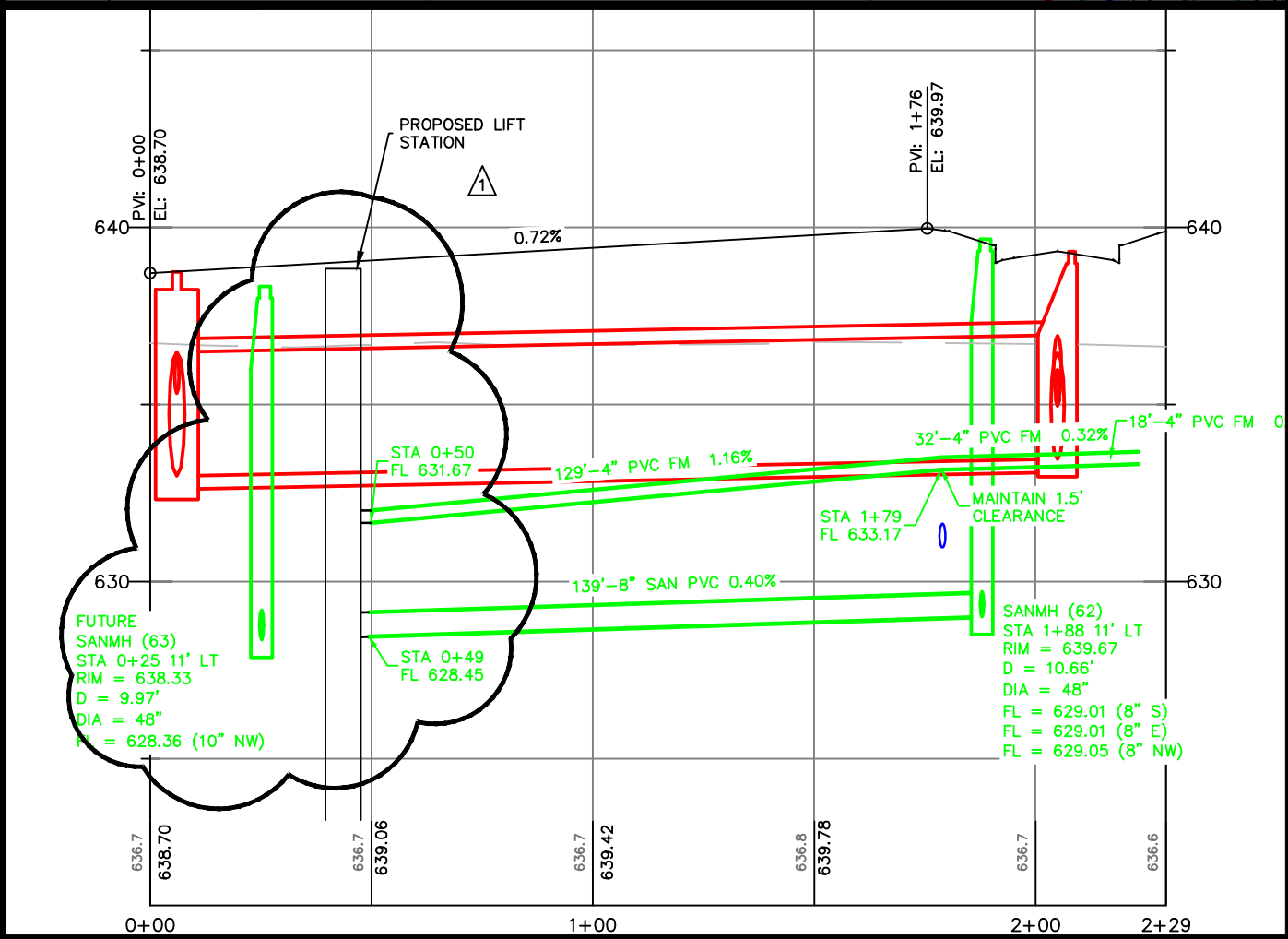
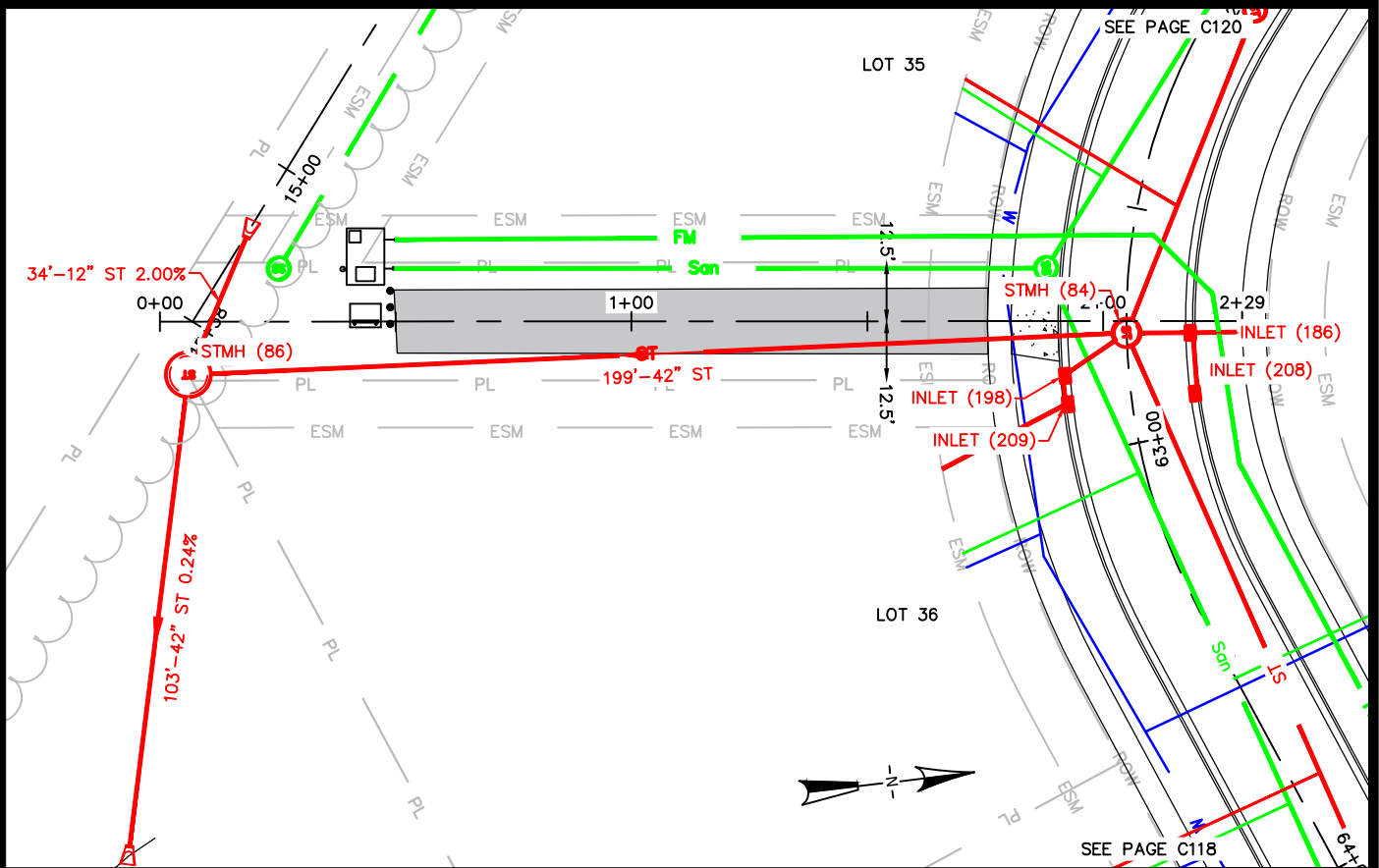
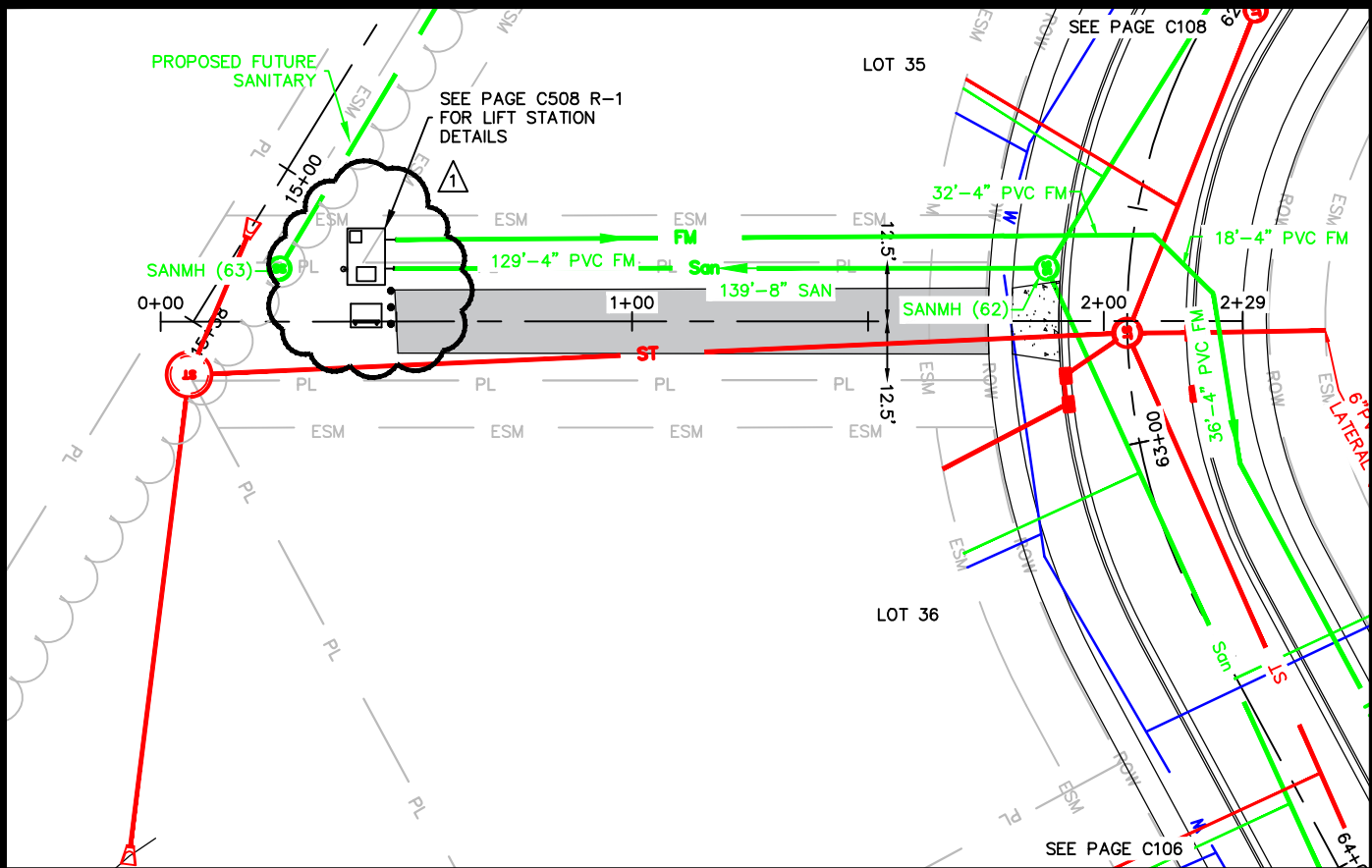
3.01 INSTALLATION

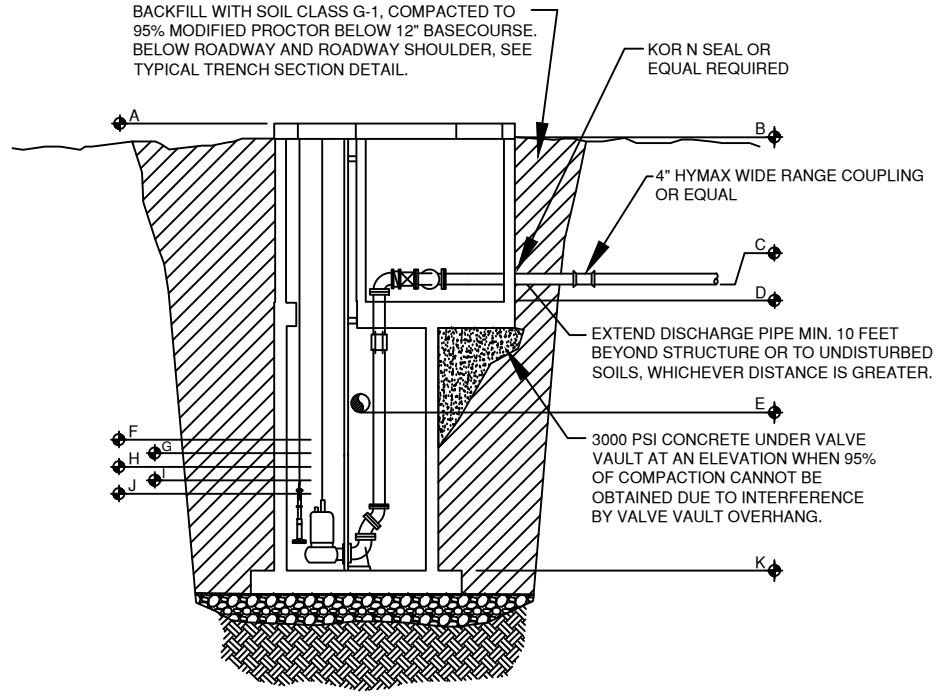
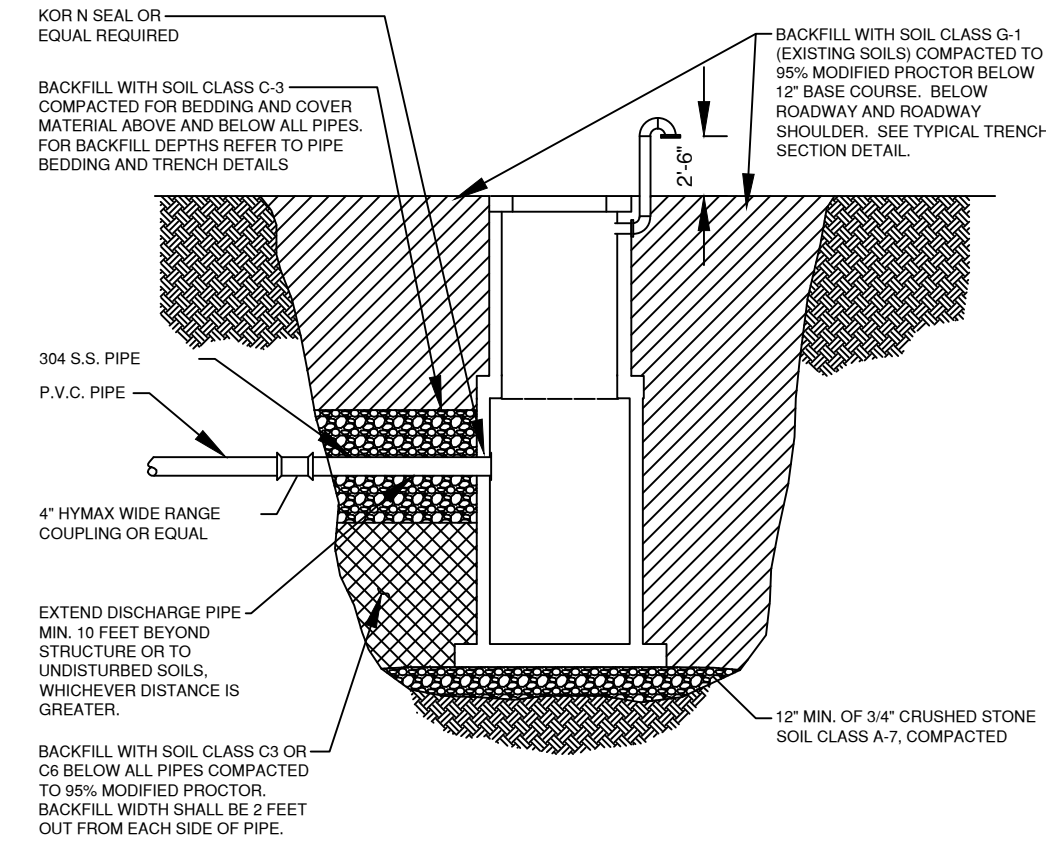
- A. Install in accordance with the shop drawings and manufacturer's recommendations. Submit installation checklist in accordance with Section 01 78 43, Equipment Checklists.

3.02 FIELD TESTING

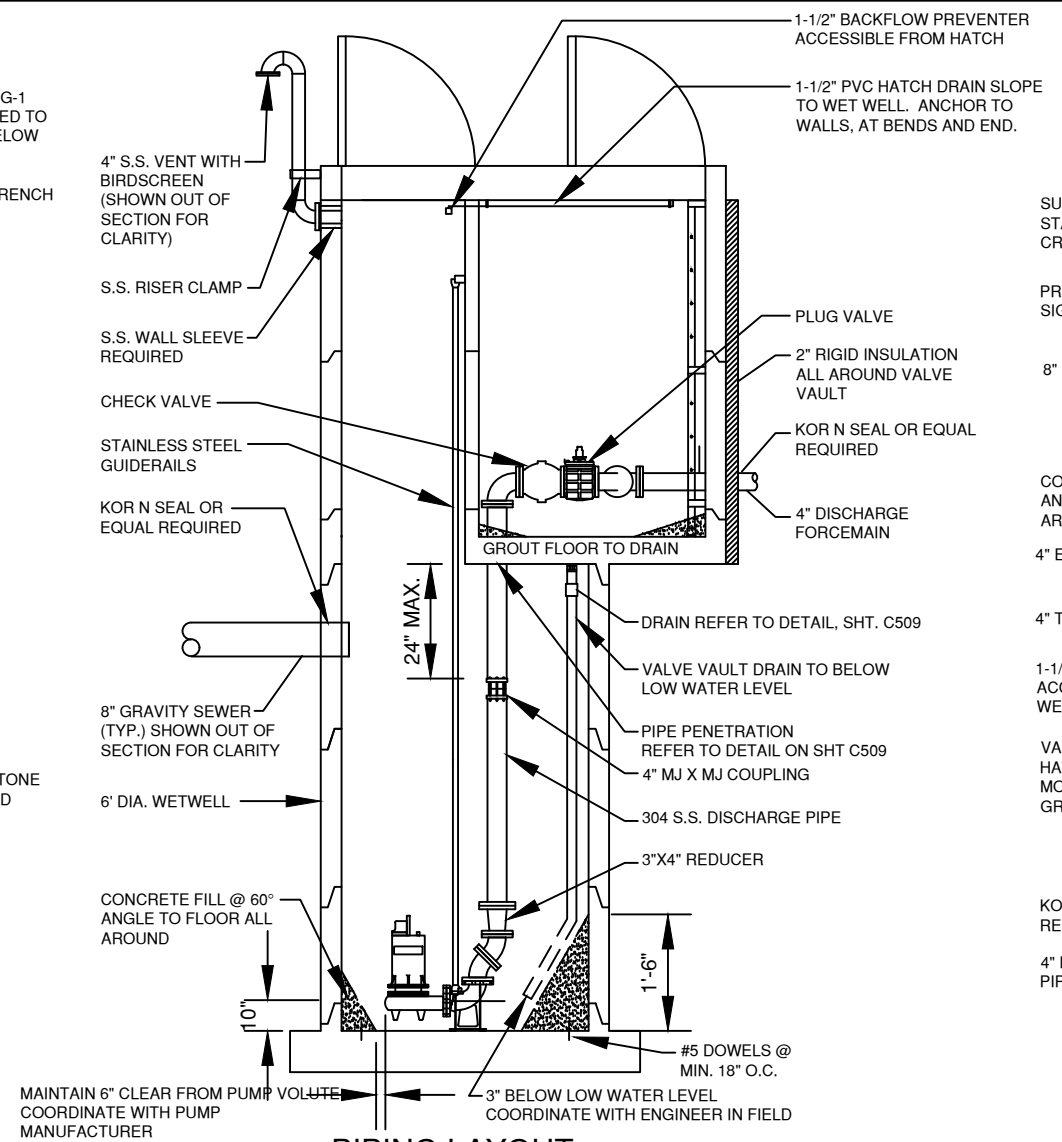
- A. Field testing shall be conducted on the equipment provided in accordance with Section 01 75 00 Startup, Testing and Operator Training. Each pump shall be subjected to a performance test before acceptance. Submit startup and performance checklist and certification upon completion of the testing.
- B. All defects noted during the field test shall be corrected promptly at the expense of the Contractor.
 - 1. When necessary, the field test shall be repeated until the requirements of the specifications have been met.
 - 2. All testing and modifications required to meet the specifications shall be at the expense of the Contractor.
- C. If the testing fails to demonstrate that the equipment conforms to the requirements of the specification, the equipment shall be rejected and replaced with acceptable equipment at the Contractor's expense.
- D. Minimum time for installation, startup, and operator training by the Manufacturer's representative shall be one (1) day with one (1) trip.
- E. The time for operator training shall be designated by the Owner and shall be within the one-year warranty period after final acceptance of equipment by the Owner. Submit equipment training checklist in accordance with Section 01 78 43, Equipment Checklists and Certifications.

- END OF SECTION -





INTEGRAL VALVE VAULT
SUBMERSIBLE LIFT STATION

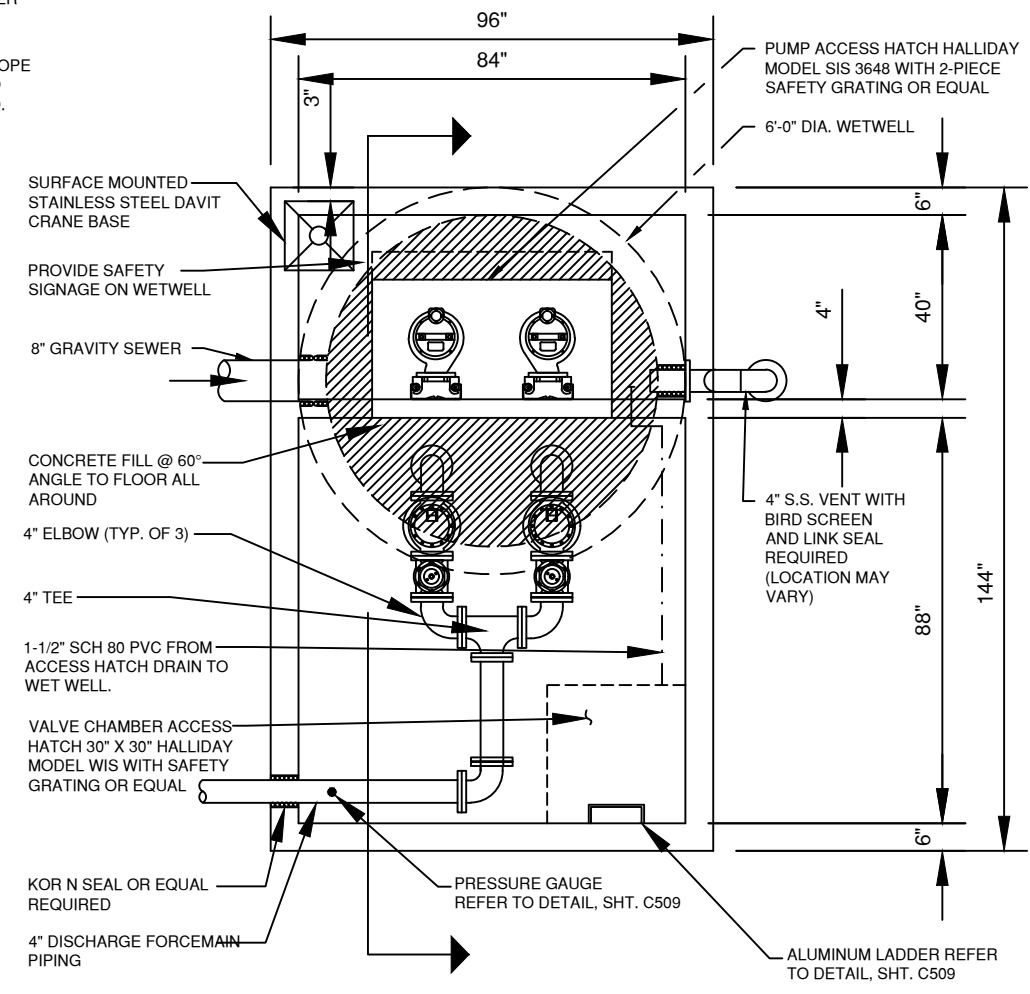


PIPING LAYOUT
SIDE VIEW

SCHEDULE OF ELEVATIONS FOR
SUBMERSIBLE LIFT STATION

ELEVATION	LEVEL TRANSDUCER CONTROL DESCRIPTION	BACKUP FLOAT CONTROL DESCRIPTION	LIFT STATION
A	TOP OF SUBMERSIBLE LIFT STA.		638.83
B	FINISHED GRADE ELEVATION		638.33
C	FM INV. ELEVATION		631.67
D	VALVE VAULT FLOOR		631.00
E	SANITARY SEWER INVERT		628.45
F	HIGH ALARM/BACK UP 'ON'	LEAD PUMP 'ON'	626.75
G	LAG PUMP 'ON'		626.50
H	LEAD PUMP 'ON'		626.20
I	ALL PUMPS 'OFF'	ALL PUMPS 'OFF'	625.20
J	LOW LEVEL ALARM	LOW LEVEL ALARM	624.70
K	WET WELL FLOOR		622.00
L	BOTTOM OF LEVEL TRANSDUCER		623.00

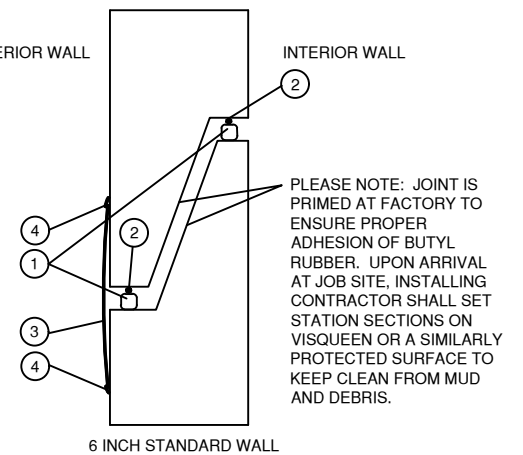
NOTE:
VERIFY PUMP SET POINTS WITH ENGINEER PRIOR TO START-UP



PIPING LAYOUT
TOP VIEW

JOINT INSTALLATION STEPS:

1. APPLY TWO BEADS OF BUTYL RUBBER ROPE, ONE ON EACH LIP, NOTING TO OFFSET THE SEAMS TO PREVENT ANY POSSIBILITY OF A LEAK.
2. APPLY A MINIMUM 1/2" BEAD OF LEAKMASTER LV-1 SEALANT.
3. INSTALL 9" WIDE SHEET BUTYL OVER JOINT.
4. APPLY TROWELABLE SEWER JOINT COMPOUND OVER BOTH EDGES OF 9" SHEET BUTYL.



FIELD JOINT-INTEGRAL VALVE VAULT
SEE INSTALLATION INSTRUCTIONS FOR FURTHER DESCRIPTION



Robert E. Lee & Associates, Inc.
ENGINEERING, SURVEYING, ENVIRONMENTAL SERVICES
1250 CENTENNIAL CENTRE BOULEVARD HOBART, WI 54155
920-662-9641 www.releeinc.com



CITY OF DE PERE

ENGINEERING DIVISION 925 S. SIXTH ST DE PERE WI 54115
OFFICE 920-339-4061 FAX 920-339-4071

SUBMERSIBLE LIFT STATION
PLAN AND SECTIONS

NAME:
MYSTIC CREEK SUBDIVISION
CONSTRUCTION
PROJECT # 21-16

NO.	DATE	BY	REVISIONS / ISSUES
1	1/18/2022	JJS	ADDENDUM NO. 1

PAGE NO.
C508
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UTILITY SERVICE AT THE STATION WILL BE 120/240 1PH. THE CITY OWNS A PORTABLE GENERATOR THAT CAN PROVIDE 120/208 3PH. THE CONTROL PANEL SHALL BE DESIGNED TO OPERATE ON BOTH 120/240 1PH AND 120/208 3PH. VARIABLE FREQUENCY DRIVES SHALL BE PROVIDED WHICH ARE PROGRAMMED TO ACCEPT EITHER 1PH OR 3PH AND 208 TO 240 VOLT INPUT POWER WITHOUT FAULTING, AND OUTPUT 3PH 208V TO THE PUMP MOTORS. ACROSS-THE-LINE BYPASS STARTERS WILL FUNCTION ONLY WHEN OPERATING ON GENERATOR SUPPLIED 208V 3PH, AND LOCKED OUT BY A PHASE-LOSS MONITOR WHEN OPERATING ON UTILITY 240V 1PH.

1. FINAL AS-BUILT CONTROL PANEL CIRCUITS MAY VARY IN MANUFACTURER'S AS-BUILT SHOP DRAWINGS. CONTRACTOR SHALL COORDINATE WITH EQUIPMENT SUPPLIER.
2. REFER TO SCHEDULES AND SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS.
3. ALL INSTALLATIONS AND WORK SHALL MEET NEC REQUIREMENTS, AS WELL AS ANY APPLICABLE STATE AND LOCAL REQUIREMENTS.

1. GENERATOR RECEPTACLE SHALL BE 100A, STYLE 1, REVERSE SERVICE, 4-WIRE, 4-POLE. VERIFY CHARACTERISTICS AND MODEL OF RECEPTACLE TO CONFIRM COMPATIBILITY WITH OWNER'S EXISTING EQUIPMENT.



Notes:

1. PUMP SUPPLIER TO PROVIDE PROTECTION RELAY TO INTEGRATOR FOR INSTALLATION IN CONTROL PANEL.
2. VERIFY APPROVED MOTOR AND PUMP PROTECTION RELAY CHARACTERISTICS AND REQUIREMENTS.

CKT	AMPS	POLES	LOAD SERVED	LOAD SERVED	POLES	AMPS	CKT
1	20	1	PCP RECEPT	PCP HEATER	1	15	2
3	15	1	FLOAT BACKUP CONTROL POWER	PLC CONTROL POWER	1	15	4
5	15	1	PUMP 1 CONTROL POWER	PUMP 2 CONTROL POWER	1	15	6
7	15	1	ENCLOSURE VENT / COOLING				

TOTALS:	33	3	3	0	0
	DI	DO	AI	AO	OTHER

NOTES: All AI and AO are 4-20mA unless otherwise noted.
All DI and DO are 24VDC unless otherwise noted.

CONTROL DEVICE SCHEDULE						
TAG	DESCRIPTION	VOLTAGE	WIRE	TO	SECTION	NOTES
AB-1	FLASHING ALARM BEACON	24VDC	TSP	PCP	26 90 00 PROCESS I&C	1
AH-1	ALARM HORN WITH SILENCE PUSHBUTTON	24VDC	TSP	PCP	26 90 00 PROCESS I&C	1
FS-1	FLOAT SWITCH - HIGH LEVEL	24VDC	MFR CABLE	PCP	26 90 72.76 LEVEL SWITCHES	2
FS-2	FLOAT SWITCH - PUMP START FLOAT	24VDC	MFR CABLE	PCP	26 90 72.76 LEVEL SWITCHES	2
FS-3	FLOAT SWITCH - PUMP STOP/LOW FLOAT	24VDC	MFR CABLE	PCP	26 90 72.76 LEVEL SWITCHES	2
LT-1	LEVEL TRANSMITTER, SUBMERSIBLE TRANSDUCER	24VDC	MFR CABLE	PCP	26 90 72.43 SUB PRESS TRANSDUCER	2
Notes: 1. MOUNTED ON CONTROL PANEL. 2. EXTERNAL CONNECTION FROM INTRINSIC SAFE RELAY/BARRIER IN CONTROL PANEL.						

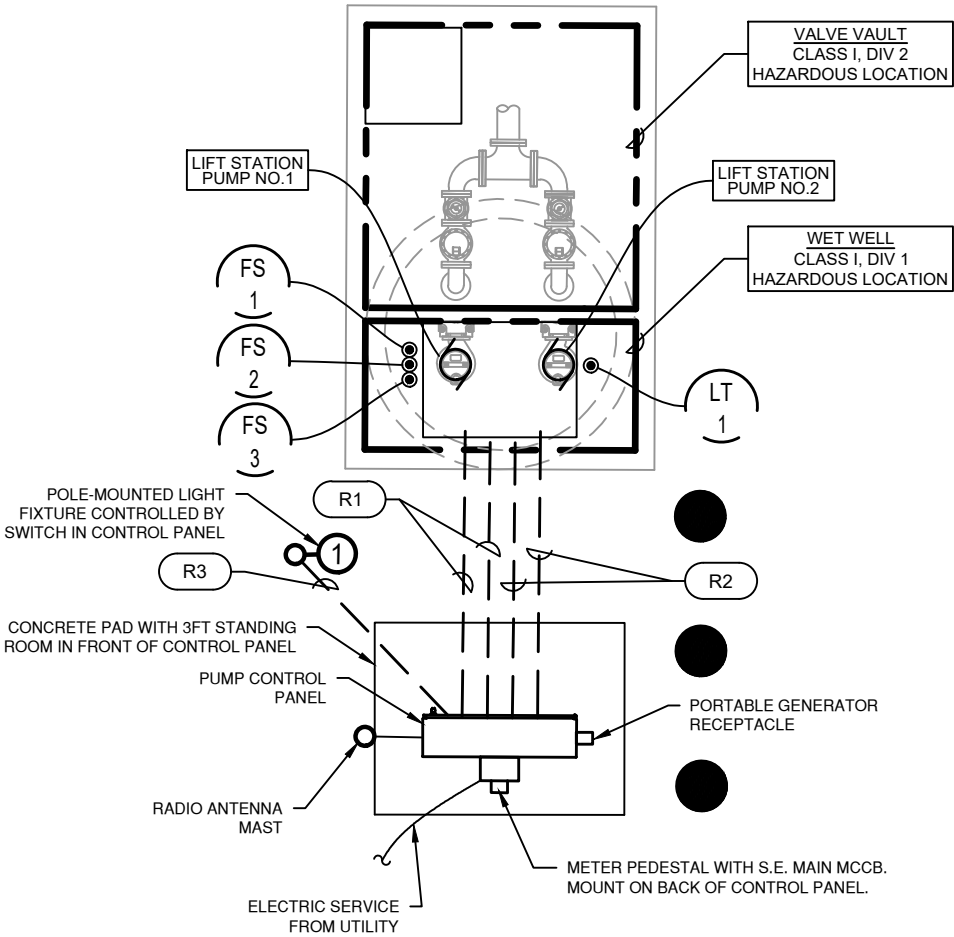
LUMINAIRE SCHEDULE			
TYPE	DESCRIPTION	MANUFACTURER	MODEL
1	LED AREA LUMINAIRE	LITHONIA	CSX1-LED-60C-700-40K-T3M-MVOLT-SPA-VG-BS-DDBXD
1	15FT ALUMINUM SQUARE POLE	LITHONIA	SSA-15-4C-DM19-DDB

GENERAL NOTES:

- ALL INSTALLATIONS AND WORK SHALL MEET NEC REQUIREMENTS, AS WELL AS ANY APPLICABLE STATE AND LOCAL REQUIREMENTS.
- CONDUIT LOCATIONS AND ROUTING TO BE DETERMINED BY THE CONTRACTOR IN THE FIELD.
- REFER TO SCHEDULES AND SPECIFICATIONS FOR ADDITIONAL INFORMATION.
- INSTALL EQUIPMENT PER MANUFACTURER REQUIREMENTS AND RECOMMENDATIONS.
- PITCH ALL CONDUITS FROM CONTROL PANEL TO WET WELL SLIGHTLY DOWN TOWARD WET WELL.

RACEWAY KEYED NOTES:

- PCP TO PUMPS, (2) 2" UNDERGROUND PVC COATED RMC. VERIFY SIZE AND QUANTITY REQUIRED BASED ON PUMP MFR CABLE(S).
- PCP TO LEVEL SENSORS, (2) 1-1/2" PVC COATED RMC. PROVIDE SEPARATE RACEWAY FOR TRANSDUCER AND FLOATS.
- PCP TO LIGHT, (1) 1" UNDERGROUND SCH 40 PVC CONDUIT.



1
E102
ELECTRICAL
SITE PLAN
SCALE: 1" = 5'



CITY OF DE PERE

ENGINEERING DIVISION 925 S. SIXTH ST DE PERE WI 54115
OFFICE 920-339-4061 FAX 920-339-4071

LIFT STATION
ELECTRICAL SITE PLAN

NAME:
MYSTIC CREEK SUBDIVISION
CONSTRUCTION
PROJECT #
21-16

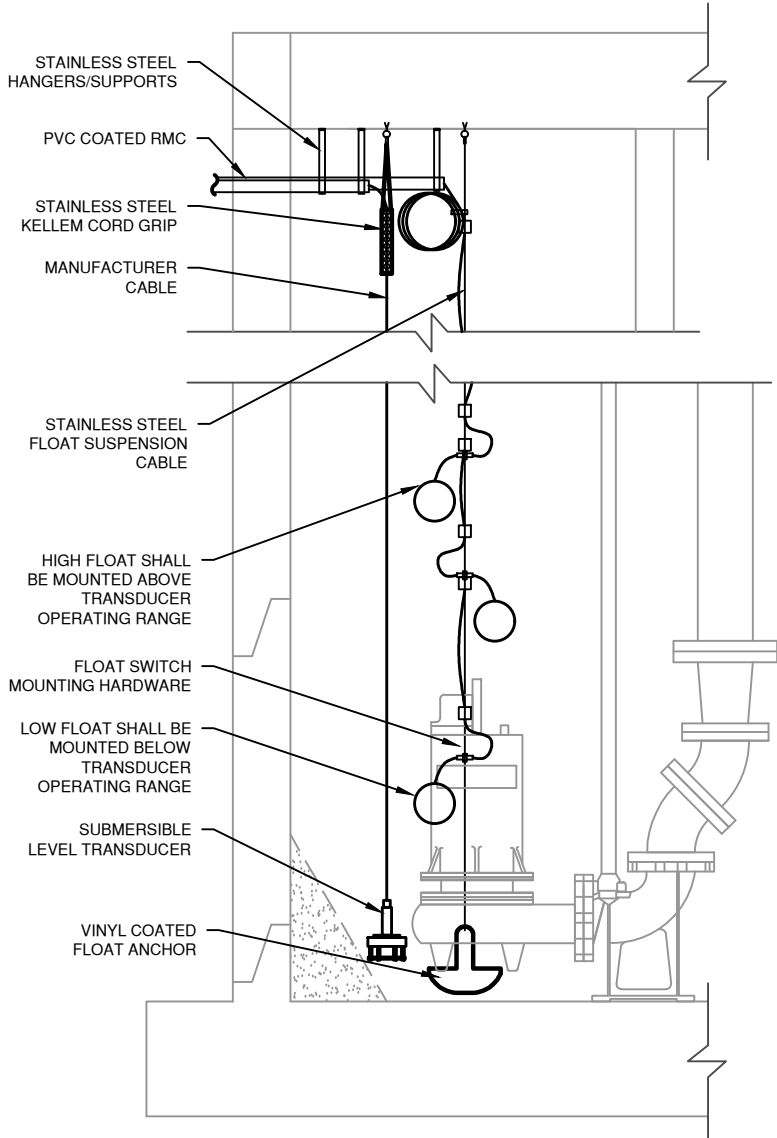
	BY	DATE	REVISIONS / ISSUES			
			NO.	DATE	BY	REMARKS
SURVEYED			1	1-18-2022	JJS	ADDENDUM NO. 1
DRAWN	SHG	1-2022				
DESIGNED	SHG	1-2022				
CHECKED	BWG & PRK	1-2022				

LEVEL SENSOR NOTES:

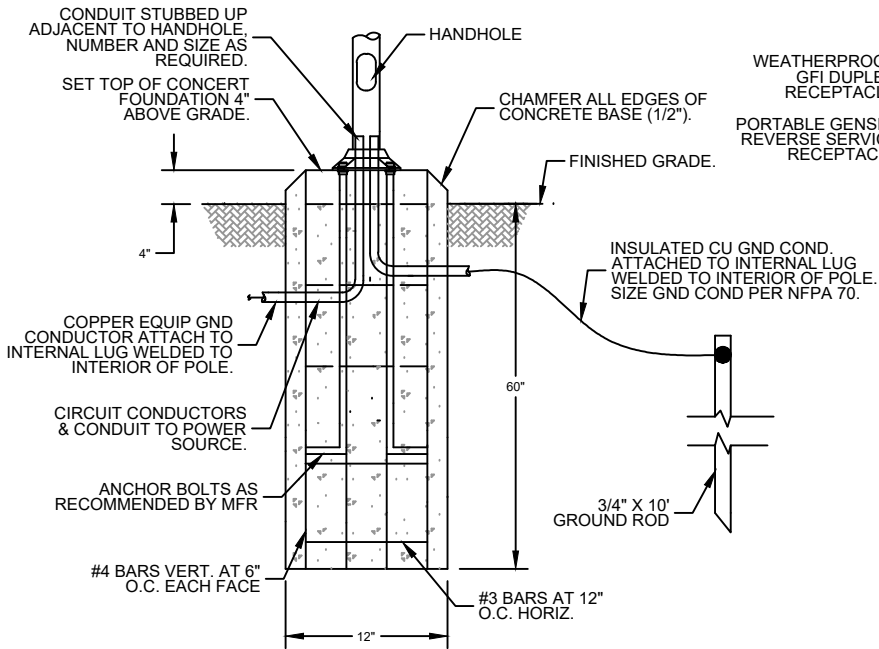
- 1. ALL INSTALLATIONS AND WORK SHALL MEET NEC REQUIREMENTS, AS WELL AS ANY APPLICABLE STATE AND LOCAL REQUIREMENTS.
- 2. ALL FASTENERS / ANCHORS IN THE WET WELL SHALL BE STAINLESS STEEL.
- 3. INSTALL NEW BACKUP FLOATS AND PRESSURE TRANSDUCER. INSTALL SUCH THAT TRANSDUCER AND FLOAT HANGERS AND CABLES ARE ACCESSIBLE FOR MAINTENANCE.
- 4. FIELD VERIFY EXACT MOUNTING LOCATIONS AND ELEVATIONS OF FLOATS & TRANSDUCER WITH ENGINEER.
- 5. INSTALL PER MANUFACTURER'S INSTRUCTIONS.

GENERAL NOTES:

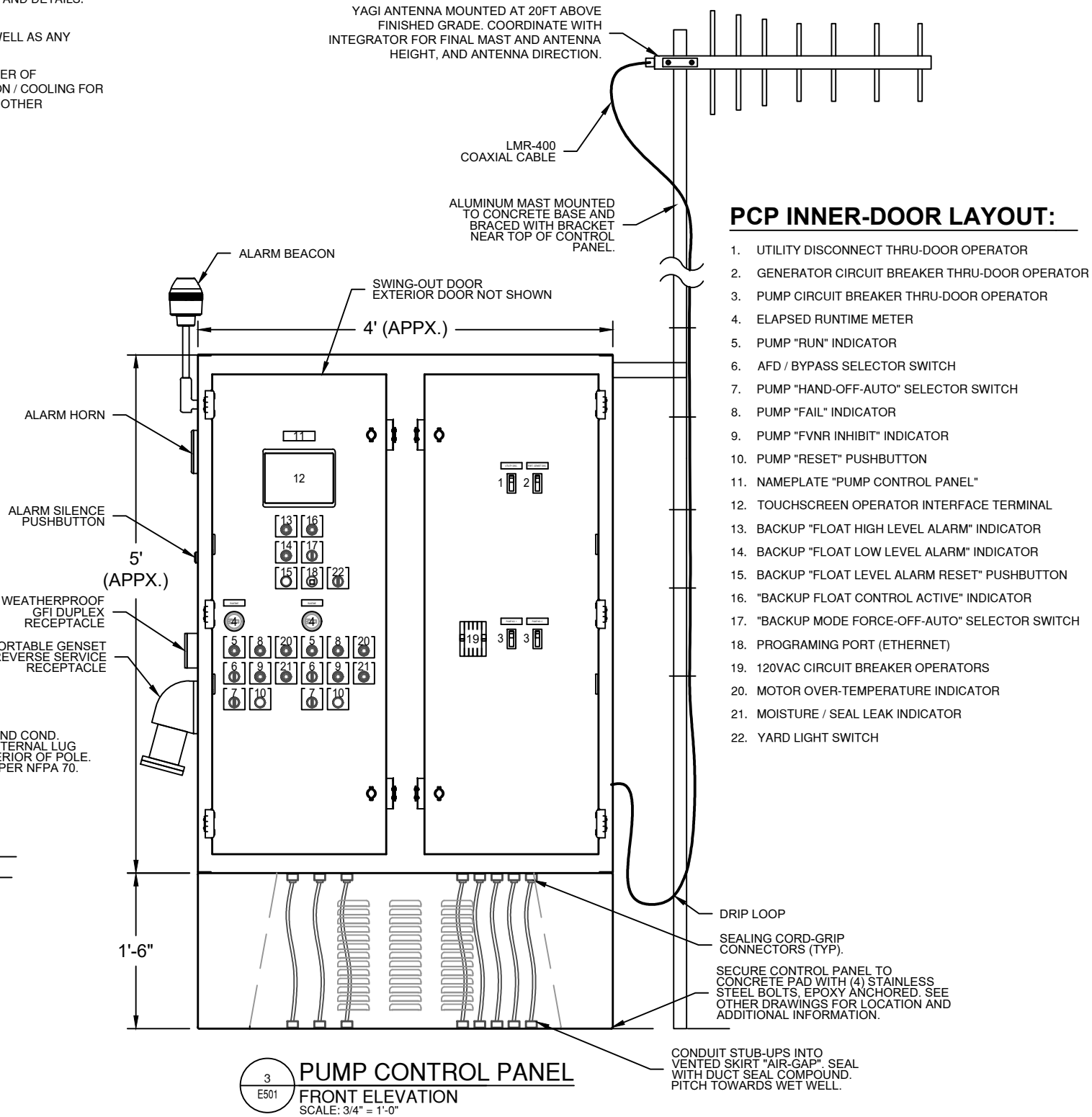
- 1. LAYOUT IS APPROXIMATE. SYSTEMS INTEGRATOR TO SUBMIT A FINAL LAYOUT TO ENGINEER FOR APPROVAL.
- 2. CONSTRUCT IN ACCORDANCE WITH AND SERIALIZE FOR UL698A (AND UL508A AS APPLICABLE) STANDARDS.
- 3. REFER TO APPROVED EQUIPMENT SUBMITTALS FOR FINAL DIMENSIONS AND DETAILS. INSTALL PER MANUFACTURER'S INSTRUCTIONS.
- 4. ALL INSTALLATIONS AND WORK SHALL MEET NEC REQUIREMENTS, AS WELL AS ANY APPLICABLE STATE AND LOCAL REQUIREMENTS.
- 5. PROVIDE NEMA 3R VENTILATION, HEAT-EXCHANGER, OR AIR CONDITIONER OF SUFFICIENT SIZE / CAPACITY TO PROVIDE NECESSARY HEAT DISSIPATION / COOLING FOR RELIABLE OPERATION OF AFD(S) BASED ON HEAT LOSS OF DRIVES AND OTHER COMPONENTS HOUSED IN THE CONTROL PANEL.



1 LEVEL SENSOR
E501
INSTALL DETAIL
SCALE: 1/2" = 1'-0"



2 LIGHT POLE BASE
E501
INSTALL DETAIL
SCALE: 3/4" = 1'-0"



PCP INNER-DOOR LAYOUT:

- 1. UTILITY DISCONNECT THRU-DOOR OPERATOR
- 2. GENERATOR CIRCUIT BREAKER THRU-DOOR OPERATOR
- 3. PUMP CIRCUIT BREAKER THRU-DOOR OPERATOR
- 4. ELAPSED RUNTIME METER
- 5. PUMP "RUN" INDICATOR
- 6. AFD / BYPASS SELECTOR SWITCH
- 7. PUMP "HAND-OFF-AUTO" SELECTOR SWITCH
- 8. PUMP "FAIL" INDICATOR
- 9. PUMP "FVNR INHIBIT" INDICATOR
- 10. PUMP "RESET" PUSHBUTTON
- 11. NAMEPLATE "PUMP CONTROL PANEL"
- 12. TOUCHSCREEN OPERATOR INTERFACE TERMINAL
- 13. BACKUP "FLOAT HIGH LEVEL ALARM" INDICATOR
- 14. BACKUP "FLOAT LOW LEVEL ALARM" INDICATOR
- 15. BACKUP "FLOAT LEVEL ALARM RESET" PUSHBUTTON
- 16. "BACKUP FLOAT CONTROL ACTIVE" INDICATOR
- 17. "BACKUP MODE FORCE-OFF-AUTO" SELECTOR SWITCH
- 18. PROGRAMING PORT (ETHERNET)
- 19. 120VAC CIRCUIT BREAKER OPERATORS
- 20. MOTOR OVER-TEMPERATURE INDICATOR
- 21. MOISTURE / SEAL LEAK INDICATOR
- 22. YARD LIGHT SWITCH



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LIFT STATION
ELECTRICAL DETAILS

NAME: MYSTIC CREEK SUBDIVISION CONSTRUCTION		BY	DATE	REVISIONS / ISSUES				PAGE NO. E501 B-1
				NO.	DATE	BY	REMARKS	
PROJECT # 21-16		SURVEYED		1	1-18-2022	JJS	ADDENDUM NO. 1	
		DRAWN	SHG	1-2022				
		DESIGNED	SHG	1-2022				
		CHECKED	RWG & PRK	1-2022				