

WPTP Raw Sewage Pumps (RSP) and Grit Classifier Replacement Project

Contract KC001060

Funded in part by the
Department of Ecology Clean Water State Revolving Fund,
and the U.S. Environmental Protection Agency (EPA)

Volume 4 of 11

Technical Specifications
Raw Sewage Pumps (RSP)
Division 31 through 49

March 2024

Protection of the Environment:

No construction related activity shall contribute to the degradation of the environment, allow material to enter surface or ground waters, or allow particulate emissions to the atmosphere, which exceed state or federal standards. Any actions that potentially allow a discharge to state waters must have prior approval of the Washington State Department of Ecology.



King County

Department of Natural Resources and Parks
Wastewater Treatment Division

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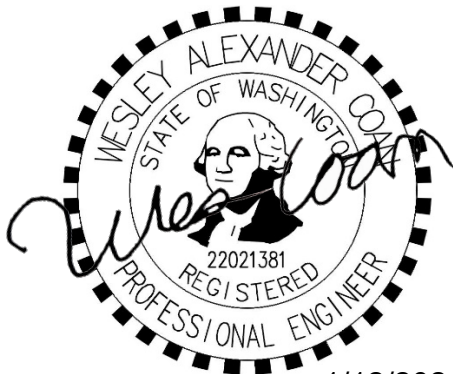
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West Point Treatment Plant Raw Sewage Pump Replacement

The West Point Treatment Plant Raw Sewage Pump Replacement individual sections were developed by those identified in the table below.



1/12/2024



1/12/2024



01/12/2024



1/12/2024



1/12/2024



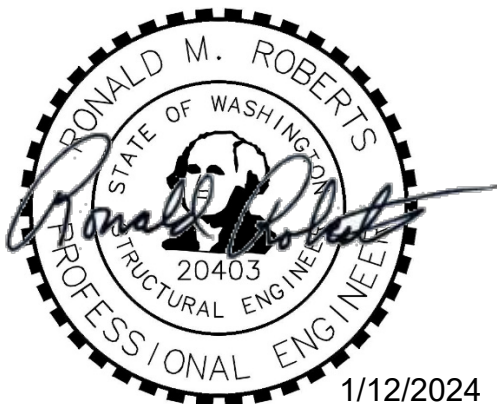
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01/12/2024



1/12/2024



1/12/2024



01/12/2024

**Raw Sewage Pump Replacement
Volume 4 - Stamping Responsibilities**

		STAMPING FIRM				
Specification	Primary Author	Jacobs	HDR	Roberts	SAGE	Stantec
31 05 01	Jacobs	W. Coan				
31 25 00	Jacobs	W. Coan				
32 12 00	Jacobs	W. Coan				
32 16 00	Jacobs	W. Coan				
33 01 30.71	Jacobs	K. Moffat				
40 05 01	Jacobs	B. Farmer				
40 05 17	Jacobs	B. Farmer				
40 05 23	Jacobs	B. Farmer				
40 05 24	Jacobs	B. Farmer				
40 05 31	Jacobs	B. Farmer				
40 05 33	Jacobs	B. Farmer				
40 05 40	Jacobs	B. Farmer				
40 05 41	Jacobs	B. Farmer				
40 05 42	Jacobs	B. Farmer				
40 05 44	Jacobs	B. Farmer				
40 05 47	Jacobs	B. Farmer				
40 05 48	Jacobs	B. Farmer				
40 05 57	Jacobs	B. Farmer				
40 05 59.33	HDR		C. Petilla			
40 05 62	HDR		L. Meschke			
40 05 64	Jacobs	B. Farmer				
40 05 65.23	Jacobs	B. Farmer				
40 05 72	Jacobs	B. Farmer				
40 05 80	HDR		L. Meschke			
40 05 82	HDR		C. Petilla			
40 05 93	Jacobs	J. Hellen				
40 05 94	Jacobs	J. Hellen				
40 06 22	Jacobs	J. Thompson				
40 06 70	Jacobs	J. Thompson				
40 06 71	Jacobs	J. Thompson				
40 06 72	Jacobs	J. Thompson				
40 06 73	Jacobs	J. Thompson				
40 41 00	Jacobs	B. Farmer				
40 42 00	Jacobs	B. Farmer				
40 61 13	Jacobs	J. Thompson				
40 61 22	Jacobs	J. Thompson				
40 63 53	Jacobs	J. Thompson				
40 65 01	Jacobs	J. Thompson				
40 65 02	Jacobs	J. Thompson				
40 65 03	Jacobs	J. Thompson				
40 65 04	Jacobs	J. Thompson				
40 65 05	Jacobs	J. Thompson				
40 65 06	Jacobs	J. Thompson				
40 65 08	Jacobs	J. Thompson				

January 2024

West Point Treatment Plant

Raw Sewage Pump Replacement

**Raw Sewage Pump Replacement
Volume 4 - Stamping Responsibilities**

40 65 09	Jacobs	J. Thompson				
40 67 00	Jacobs	J. Thompson				
40 68 71	Jacobs	J. Thompson				
40 70 10	Jacobs	J. Thompson				
40 70 20	Jacobs	J. Thompson				
40 70 30	Jacobs	J. Thompson				
40 78 00	Jacobs	J. Thompson				
40 79 39	Jacobs	J. Thompson				
40 79 53	Jacobs	J. Thompson				
40 79 56	Jacobs	J. Thompson				
41 22 13.13	Jacobs	K. Kasick				
42 11 40	Jacobs	R. Grove				
43 05 01	HDR		L. Meschke			
43 05 50	HDR		C. Petilla			
43 05 51	Jacobs	B. Farmer				
43 05 60	Jacobs	B. Farmer				
43 05 61	Jacobs	B. Farmer	K. Sutton			
43 05 62	Jacobs	B. Farmer				
43 05 63	Roberts		C. Petilla	R. Roberts		
43 23 04	HDR		C. Petilla			
43 23 06	HDR		L. Meschke			
43 23 32	Jacobs	R. Grove				
44 05 10	Jacobs	B. Farmer				

SECTION 31 05 01

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies earthwork related to structures, pipes, conduits, and embankments which consists of excavation, materials, backfilling, compacting, grading and testing within the City of Seattle.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³))
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture Content of Soil and Rock by Mass)
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Method (Shallow Depth)
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
WAC 173-303	Dangerous Waste Regulations
COS	City of Seattle Standard Specifications for Road, Bridge and Municipal Construction

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Samples of all fill materials to be used 30 days in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.
- C. Laboratory test reports and samples of fill materials to be used, certifying:
1. Moisture density relationships and gradation test reports and curves.
 2. Gradation tests for non-cohesive materials.
- D. Geotextile fabrics: One square foot sample for each fabric proposed for use.

1.04 DEFINITIONS

- A. Compaction: the degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.

- B. Excavation slope: an inclined surface formed by removing material from below existing grade.
- C. Embankment slope: an inclined surface formed by placement of material above existing grade.
- D. Imported backfill: select material which meets the Fill Class specified and is obtained from a supplier regularly engaged in the business of supplying soil/fill material. It is not material which is obtained from on-site excavation.
- E. Native material: materials excavated from within the Project limits.
- F. Suspect Material: any material in the excavation which is potentially contaminated based on visual observation or odor; includes soils, water or foreign material found within the excavation limits.

1.05 TESTING

- A. Prior to placement, submit samples of materials to be used to an approved testing laboratory. Submit laboratory test results to the Project Representative. Provide adequate time for test results to be received and verified for compliance.
- B. Obtain services of an approved independent testing laboratory to perform quality control tests and to document compliance with Contract requirements.
- C. Ensure that work meets contract requirements in accordance with ASTM E329 and the following:

Test	Standard Procedure
Moisture content	ASTM D3017, ASTM D2216
Gradation	ASTM C136, ASTM D476
Density in-place	ASTM D1556, ASTM D6938
Moisture-density relationships	ASTM D1557

PART 2 MATERIALS

2.01 FILL MATERIALS

- A. Type A (Pit Run Sandy Gravel, COS Aggregate Type 15):
 - 1. Select granular material free from organic matter.
 - 2. The coefficient of uniformity shall be three or greater.
 - 3. The material may be an imported quarry waste, clean natural sand or gravel, or a mixture thereof.
 - 4. Conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
3/4-inch	100
No. 4	19-38
No. 200	0-10 (wet sieving)

- B. Type B (Bank Run Gravel for Trench Backfill, COS Aggregate Type 17):
 - 1. Clean gravel-sand mixture free from organic matter.
 - 2. Conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
3 inch	95-100
No. 4	24-71
No. 200	0-5 (wet sieving)

Dust Ratio:	2/3 max
Sand Equivalent	60 min

C. Type N (Foundation Material, COS Material Type 2):

1. Free of stones greater than 2-1/2 inches in the greatest dimension, free from clay and organic matter, moisture content that is less than the material's optimum value and compacts readily.
2. Conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
1-1/4 inch	100
1-inch	80-100
5/8-inch	50-80
No. 4	25-45
No. 40	3-18
No. 200	0-7.5 (wet sieving)
Sand Equivalent	40 min

D. Type P (Crushed Surfacing Top Course, COS Material Type 1):

1. Crushed surfacing shall be manufactured from ledge rock or talus.
2. The material shall be uniform in quality and substantially free from wood, roots, bark, and other extraneous material and shall meet the following quality test requirements:
 - a. Los Angeles Wear, 500 Rev, 35% max.
 - b. Degradation Factor 25 min
3. Crushed rock must be a totally crushed material with no naturally occurring faces and must apply to material retained on each sieve size No. 10 and above if that sieve retains more than 5 percent of the total sample.
4. The portion retained on the No. 4 sieve shall not contain more than 0.15 percent wood waste.
5. Conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
3/4 inch	100
No. 4	44-66
No. 40	8-24
No. 200	0-10 (wet sieving)
Sand Equivalent	40 min

E. Type Q (Crushed Surfacing Base Course, COS Material Type 2):

1. Crushed surfacing shall be manufactured from ledge rock, talus, or gravel.
2. The material shall be uniform in quality and substantially free from wood, roots, bark, and other extraneous material and shall meet the following quality test requirements:
 - a. Los Angeles Wear, 500 Rev, 35% max.
 - b. Degradation Factor 15 min
3. Crushed rock must be a totally crushed material with no naturally occurring faces and must apply to material retained on each sieve size No. 10 and above if that sieve retains more than 5 percent of the total sample.
4. The portion retained on the No. 4 sieve shall not contain more than 0.15 percent wood waste.
5. Conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
1-1/4 inch	100
1-inch	80-100
5/8-inch	50-80

No. 4	25-45
No. 40	3-18
No. 200	0-7.5 (wet sieving)
Sand Equivalent	40 min

F. Pea Gravel is not acceptable for trench backfill or bedding.

2.02 GEOTEXTILE MATERIALS

A. Geotextile for wall underdrain shall be nonwoven and meet the following (Type: Underground Drainage):

Property	Test	Requirements
AOS	ASTM D4751	No. 40 max.
Water permittivity	ASTM D4491	0.50 sec-1 min.
Grab Tensile Strength	ASTM D4632	115 lbs min.
Grab Tensile Elongation	ASTM D4632	<50%
Puncture	ASTM D6241	220 lbs min.

B. Geotextile for trench stabilization (over-excavation) shall meet the following (Type: Stabilization):

Property	Test	Woven	Non-Woven
AOS	ASTM D4751	No. 40 max.	No. 40 max.
Water permittivity	ASTM D4491	0.10 sec-1 min.	0.10 sec-1 min.
Grab Tensile Strength	ASTM D4632	315 lbs min.	200 lbs min.
Grab Tensile Elongation	ASTM D4632	<50%	>50%
Puncture	ASTM D6241	620 lbs min.	430 lbs min.

2.03 RECYCLED PORTLAND CEMENT CONCRETE RUBBLE

- A. Recycled Portland cement concrete rubble may be used as, or blended with: pit run, clean gravel-sand, crushed rock, ballast, unclassified, structural fill, trench backfill, crushed surfacing base course, crushed surfacing top course, bedding material for pipe, and bedding material for flexible pipe if it meets the gradation requirements.
- B. A preliminary sample of the recycled concrete, and native material if any, used for ballast, crushed surfacing base and top course, and structural fill shall be submitted for testing for Los Angeles Wear and Degradation Factor for the type of application being used.
- C. Recycled Asphalt Concrete Pavement: A maximum of 20 percent by weight of recycled asphalt concrete pavement may be used in the blended product. The asphalt concrete content is calculated as the amount of asphalt particles retained on all screens U.S. No. 4 and above.
- D. The recycled aggregates shall be stockpiled in such a manner that each certified test report will identify a single stockpile of not more than 10,000 tons.
- E. The Contractor shall certify that the recycled material is neither hazardous nor toxic. The certification shall address the toxicity characteristics prescribed in WAC 173-303-090(8) under sampling and testing according to WAC 173-303-110. Sampling and testing shall be one per 10,000 tons from any single source and not less than one sample from any single source.
- F. Acceptance of the recycled concrete rubble aggregate for hazardous and toxic requirements shall be by Manufacturer's Certificate of Compliance with accompanying test reports.

- G. Gradation, sand equivalent, and fracture requirements will be per the specific product outlined in these specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. Control of water:
 - 1. Keep excavations free from water during construction.
 - 2. Draw down the static water level a minimum of two feet below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of pipe.
 - 3. Disposal of water: per Section 01 35 43 and Section 31 25 00.
- B. Monitor:
 - 1. Monitor all excavation by observation and smell for suspect materials including potentially contaminated soil, water or foreign substance.
 - 2. If any suspect material is detected, inform the Project Representative.
- C. Over excavation:
 - 1. Notify the Project Representative if inadequate soils are encountered and they will direct the Contractor on how to proceed.
 - 2. Where the undisturbed condition of natural soils is inadequate for support of the planned construction, over excavate to adequate supporting soils
 - 3. Fill the excavated space to the specified elevation with class backfill shown on the Drawings or per Table A if not shown.
 - 4. Unless otherwise specified, the over excavated space under footings and structures shall be filled with Type N.
 - 5. All costs involved in the excavation and disposal of the inadequate soil material and placement of the fill shall be considered over excavation. Unless otherwise indicated, if over excavation is required as a result of the in-situ material below the foundation material depth indicated in the Drawings, then payment will be per Section 00 72 00 General Conditions .
 - 6. Should the excavation be carried below the lines and grades indicated on the Drawings because of the Contractor's operations, refill such excavated space with material specified in the drawings or in this specification to the proper elevation.
- D. Excavated material:
 - 1. Select structural fill removed for structural excavation, or final grading or paving, shall be stockpiled outside of the existing structurally filled area.
 - 2. Dispose of unsuitable excavated materials, such as peat, off-site.
 - 3. Dispose of surplus excavated material off-site in accordance with applicable ordinances and environmental requirements.
 - 4. Material shall not be stockpiled on the existing structurally filled area. In addition, material shall not be stockpiled to a depth greater than five feet above foundation grade, or within 25 feet of any excavation or structure.
 - 5. Use construction methods which preserve the stability of the soil adjacent to the excavation.
 - 6. Protect materials stockpiled for reuse from wind or rain erosion and water saturation by covering with tarps or other effective methods.
- E. Hauling and Haul Roads: per Section 01 52 00.
- F. Finish grading:
 - 1. Finished surfaces shall be smooth, compacted, and free from irregularities.
 - 2. Finished grade shall be as specified by the contours +0.10-foot, except where a local change in elevation is required to match sidewalks, curbs, maintenance holes, and catch basins, or to ensure proper drainage.
 - 3. When the work is an intermediate stage of completion, the lines and grades shall be as specified +0.5-foot to provide adequate drainage.

- G. Control of erosion: maintain earthwork surfaces true and smooth, and protected from erosion. Where erosion occurs, provide fill or excavate as necessary to return earthwork surfaces to the grade and finish specified.

3.02 QUALITY CONTROL

- A. Compaction tests for each lift for each day or more frequently if materials, moisture or other factor should change. Submit documented test results.

3.03 CLASSIFICATION OF FILL

- A. Fill material shall be placed in horizontal layers and compacted with power operated tampers, rollers, idlers, or vibratory equipment.
- B. Material type, maximum layer depth, relative compaction, and general application are specified in Table A below.
- C. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

TABLE A - FILL CLASSIFICATIONS				
Fill Class	Material Type	Maximum Layer Depth Inches	Minimum Uncompacted Compaction Percent	General Application
A	B	8	95	Fill under slabs and structures and against foundations
B	A	8	90	Fill and subsequent pipeline backfill in all roadways, roadway shoulders, and in right of way
N	N	8	90	Trench foundation backfill to replace unsuitable over excavated materials
P	P	6	95	Roadway top course
Q	Q	8	95	Roadway base course

3.04 EARTHWORK FOR STRUCTURES

- A. Structure excavation:
1. Unless otherwise shown or specified, any method of excavation within the work limits and easements shown may be used which, in the opinion of the Contractor and as approved by the Project Representative, is considered best. At those locations where the excavation extends below the static groundwater level or the natural soils are saturated and of low strength, take whatever precautions are necessary to maintain the undisturbed state of the foundation soils at and below the bottom of the excavation.
 2. Ground shall not be dug by machinery nearer than three inches from finished subgrade. The last three inches shall be removed without disturbing the subgrade.
 3. The bottom shall not be more than 0.15-foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15-foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5-foot from specified grade unless the excavation is in rock where the maximum variation shall be two feet.
 4. Should the excavation be carried below the lines and grades specified on the Drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require over excavation and backfill, refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. When the result of Contractor's over excavation, this is not a basis for requesting added quantities.

5. Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, and installation of services, except where concrete is specified to be placed directly against excavated surfaces or shoring.

B. Structure backfill:

1. Unless otherwise specified, placement of fill materials shall be in accordance with Table A.
2. After completion of construction below the elevation of the final grade, and prior to backfilling, concrete forms shall be removed (unless specified otherwise) and the excavation shall be cleaned of debris.
3. Do not place backfill until the subgrade portions of the structure have been inspected by the Project Representative.
4. No backfill material shall be deposited against concrete structures until the concrete has been in place for 28 days or until the concrete has developed a strength of not less than allowed by local code, whichever occurs first.
5. Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure.
6. Accomplish compaction by using power-operated tampers, rollers, or vibratory equipment. Perform compaction within two feet of walls with hand-operated vibratory compactors.
7. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.
8. If there is a void between the shoring and the formwork for the wall construction, fill the void with approved structural backfill in accordance with Table A.

3.05 EARTHWORK FOR PIPELINES AND CONDUITS

- A. Specified in Table A and/or on the Drawings.

3.06 EARTHWORK FOR EMBANKMENTS

A. Foundation soil preparation:

1. The surface of the foundation soils shall not contain standing water and shall be free of loose material, foreign objects, and rocks greater than 6 inches in maximum dimension.
2. Immediately prior to placement of embankment fill material, the foundation soil surface shall be thoroughly moistened, scarified to a depth of 6 inches, moisture conditioned again as necessary, and recompact to 95 percent relative compaction.
3. After the preparation has been completed, promptly place and compact the first lift of embankment on the foundation soil to prevent damage to the surface. If the foundation soil surface is damaged, repair the surface to the specified condition.
4. In areas where materials become soft or yielding, remove, dispose of, and replace with specified material.
5. The surface of the embankment shall be maintained to permit travel of construction equipment.
6. Fill and level ruts in the surface of a layer before compacting.

B. Embankment fill:

1. Place in accordance with Table A.
2. Do not place rocks, broken concrete, or other solid materials, which are larger than four inches in greatest dimension, in the embankment fill.
3. Place fill material having a sand equivalent value less than ten in the lower portions of embankments and not within 2.5 feet of finished grade.
4. When the embankment material consists of large, rocky material or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, distribute the material throughout the embankment. Place sufficient earth or other fine material around the larger material as it is deposited to fill the interstices and produce a dense, compact embankment.
5. Unless otherwise specified, the embankment shall be raised to form an approximately horizontal plane extending transversely to the final slopes. The embankment shall be crowned at all times during construction so that water drains readily off the embankment.

6. The temporary differential elevation between two adjoining zones of the embankment due to construction operations shall not exceed 24 inches.
7. If the compacted surface of a layer of material is too smooth to bond properly with the succeeding layer, the surface shall be scarified. If required, the surface shall be sprinkled or otherwise moisture conditioned before the succeeding lift is placed. Surface crust formed on a layer of fill material that has been dumped and spread shall be broken up by harrowing and, if required, the full depth of the affected layer shall be moisture conditioned immediately prior to compaction.

C. Embankment tolerances:

1. Embankment slopes within four feet of shoulder grade shall vary less than 0.5 feet from the designated slope. Slopes beyond four feet from shoulder grade shall vary less than 1 foot from the designated slope. Make measurements for variance perpendicular to the slope. Slopes which are 6:1 grade or flatter shall vary less than 0.2 feet from the designated slope.
2. Roadway and railroad embankment tolerances:
 - a. The excavated surface shall be less than 0.08 feet above or below the grades specified after deducting for the roadway pavement thickness or railroad ballast thickness.
 - b. Vertical alignment tolerances permitted on the roadway or railroad surface shall not exceed +0.30 feet from the vertical alignment specified, with the provision that within the tolerance range, local surface irregularities shall not exceed 0.15 feet as measured by the gap between the roadway or railroad surface and a 10-foot straightedge placed on any flat graded surface. On vertical curves, the same standards will apply except that an additional gap allowance will be made for the road surface curvature over the 10-foot length of the straightedge.
 - c. Horizontal alignment tolerances permitted shall not exceed 1 foot providing the departure is relatively uniform over any specific length of the roadway or railroad embankment.

3.07 FINISH

- A. Areas covered by the work, including excavated and filled sections and transition areas, shall be graded uniformly to the elevations shown.
- B. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes.
- C. The finish surface shall be not more than 0.2 feet above or below the established grade.
- D. Ditches shall be finished to drain readily.
- E. The surface of areas to be paved on which a base course is to be placed shall not vary more than 0.05 feet from established grade and cross section.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies constructing and maintaining the surface water drainage and temporary erosion and sediment control system, referred to as "Temporary Erosion Control System" or "Erosion Control System."

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A392	Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM D882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
ASTM D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1388	Standard Test Method for Stiffness of Fabrics
ASTM D1777	Standard Test Method for Thickness of Textile Materials
ASTM D3776	Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D3786	Standard Test Method for Bursting Strength of Testing Fabrics – Diaphragm Bursting Strength Tester Method
ASTM D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4596	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
ASTM D4623	Standard Test Method for Determination of In Situ Stress in Rock Mass by Overcoring Method – Three Component Borehole Deformation Gauge
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile
Chapter 173-201A WAC	Water Quality Standards for Surface Waters of the State of Washington

1.03 QUALITY ASSURANCE

- A. Qualifications:
1. Certified Erosion and Sediment Control Lead (CESCL):
 - a. Active certification through a CESCL course approved by Ecology.
 - b. Minimum of one year of experience and one similar project.
- B. Comply with all applicable requirements of the City of Seattle
1. City of Seattle Stormwater Code
 2. King County Surface Water Management Code
- C. Do not allow activities which lead to violations of:

1. Local and state Water Quality Standards for stormwater discharge, including, but not limited to surface water quality standards, ground water standards, sediment management standards and human health-based criteria in the National Toxics Rule (40 CFR PART 131.36)
2. Local agency sewer discharge permits if discharge is placed in sanitary sewer system.

D. Conform to the requirements of the permits listed in Section 01 41 26.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Qualifications of CESCL.
- C. Erosion and Sediment Control Plan (ESC Plan).
- D. Shop drawings and product data.

1.05 DEFINITIONS

- A. See Section 01 14 00 for wet and dry season definitions.

1.06 EROSION AND SEDIMENT CONTROL PLAN (ESC PLAN)

- A. Consists of Best Management Practices (BMPs) that control erosion and sedimentation from the Contractor's activities and treats stormwater to meet discharge requirements.
- B. Submit the ESC Plan with Drawings and receive a review action of "1" or "2" per 01 33 00 prior to commencement of work.
- C. During the construction period, the BMPs shall be upgraded and modified as needed to meet discharge requirements for changing construction activities, storm events, and changing site conditions.
 1. Indicate the minimum requirements at the start of work.
 2. Schedule BMP implementation correlated to Wet and Dry Season activities. This may include activities such as temporary seeding and permanent seeding activities that change with the seasons.
- D. Update the ESC Plan and Drawings thirty days prior to the start of the Wet Season each year of construction until Substantial Completion is granted by the County.
- E. Maintain a copy of the current ESC Plan in the Environmental Mitigation Binder at the Site at all times. Refer to Section 01 35 43.
- F. Provide at a minimum, the following information:
 1. All requirements in the Drawings and Specifications.
 2. Locations and construction details of all proposed ESC BMPs.
 3. Approximate slopes, contours, and direction of stormwater flow before and after major grading activities
 4. Location of cut and fill slopes.
 5. Location of off-site material, stockpiles, waste storage, borrow areas, and vehicle/equipment storage areas.
 6. Location of all surface water bodies, including wetlands, ponds, lakes, streams, drainage ditches, and catch basins.
 7. Locations, types, and quantities of all plantings, slope coverings, and ditch liners.
 8. Rerouting of existing surface water and underground drainage within the Site around the Project site and release to the offsite drainage systems or natural water bodies.
 9. Measures to prevent the addition of Process Water or domestic wastewater into the stormwater.

10. Location of water quality sampling stations.
11. Maintenance schedule of ESC Plan.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Catch basin insert:
 1. Prefabricated units specifically designed for storm drain inlet protection.
 2. Remain securely attached to the drainage structure when fully loaded with sediment and debris.
 3. Lifting handle for removal.
 4. Overflow to prevent ponding.
- B. Quarry spalls: Type R per Section 31 05 01.
- C. Plastic sheeting:
 1. Color: Clear.
 2. Minimum thickness of 6 mil.
- D. High viz fence:
 1. High visibility fence should be composed of a high-density polyethylene material.
 2. Post for the fencing should be steel or wood.
 3. The color of the fencing should be high-visibility orange.
 4. The fence tensile strength should be 360 lbs/ft using the ASTM D4596 testing method.
- E. Reinforced plastic fabric:
 1. Construed, copolymer laminate.
 2. Reinforcing: Non-woven grid of high strength nylon cord submerged in a permanently flexible adhesive medium.
 3. Equal tear resistance in all directions.
 4. Color: Black.
 5. Ultraviolet light stabilized.
 6. Material to be from a single manufacturer.
 7. Physical strength requirements:
 - a. Tear strength, lbs: 130 per ASTM D1004.
 - b. Elongation percent: 620 per ASTM D882.
 - c. Minimum life expectancy: 2-1/2 years of normal outdoor exposure.
- F. Geotextile fabric:
 1. Stabilized construction entrance geotextile fabric shall meet the following:

Property	Test	Survivability
AOS Sieve	ASTM D4751	20-45 US Standard Sieve
Grab Tensile Strength	ASTM D4751	200 PSI
Grab Tensile Elongation	ASTM D4623	30% max.
Mullen Burst Strength	ASTM D3786	400 psi min.

2. Geotextile fabric for silt fence shall meet the following:

Geotextile Property	Test Method	Posts with Wire or Polymeric Mesh
AOS slit	ASTM D4751	0.60 mm max. for film wovens (#30 sieve). 0.30 mm max. for all other geotextile. 0.15 mm min. (#100 sieve).
Water permittivity	ASTM D4491	0.02 sec-1 min.
Grab Tensile Strength	ASTM D4632	100 lbs. min.

Geotextile Property	Test Method	Posts with Wire or Polymeric Mesh
Ultraviolet (UV) Radiation Stability	ASTM D4355	70% strength retained min., after 500 hrs. in weather meter

- G. Temporary silt fence wire backing:
1. 2-inch x 2-inch mesh, 14 gage or approved equal.
 2. Hot-dip galvanized, ASTM A392, Class 2.
 3. Height: As shown on Drawings.
- H. Permanent revegetation mat:
1. Highly flexible polymeric mat with a three dimensional web-like weave.
 2. Color: Green.
 3. Biologically inert.
 4. Acid and alkaline resistant.
 5. Ultraviolet degradation resistant.
 6. Physical properties:
 - a. Porosity: 85% - 95%.
 - b. Flexibility: 2000 mg/cm ASTM D1388.
 - c. Weight: 18 oz/sy ASTM D3776.
 - d. Thickness: 0.12-inch ASTM D1777.
 - e. Tensile strength: Length 15 lbs, width 5 lbs.
 - f. Elongation: Length 150%, width 100%.
- I. Erosion control blankets:
1. Biodegradable wood materials.
 2. No chemical additives.
 3. Photo degradable extruded plastic netting top and bottom.
 4. Smolder resistant.
 5. Physical properties of blanket for slope protection:
 - a. Weight: 0.98 lbs/sy.
 - b. Netting: 1-inch x 2-inch.
 - c. Physical properties of blanket for channel protection:
 - 1) Weight: 1.0 lbs/sy.
 - 2) Netting: 5/8-inch x 3/4-inch.
- J. Hold downs:
1. Sand bags.
 2. Secure with 1/4-inch polypropylene rope at 10 ft on center maximum each way.
 3. Anchor rope with 2-inch x 4-inch fir, standard or better.
- K. Sandbags:
1. Woven polypropylene fabric.
 2. Fill material:
 - a. Non-cohesive, class 1 or class 2 permeable material.
 - b. Free from clay or deleterious material.
- L. Straw wattles:
1. Netting: Synthetic photodegradable netting secured at both ends.
 2. Straw mix: 100% weed free.
 3. Acceptable manufacturers:
 - a. ACF West Inc. Fiber Roll.
 - b. PermaTex Straw Wattle.
 - c. HD Supply.
 - d. Approved Equal.
- M. Compost socks: Unvegetated compost material encased in a biodegradable mesh tube.

PART 3 EXECUTION

3.01 SEQUENCING AND SCHEDULING

- A. Submit the ESC Plan and receive a review action of "1" or "2" per Section 01 33 00 prior to commencement of Work.
- B. Construct Erosion and Sediment Control System prior to commencing the Work.
- C. Schedule or phase excavation to minimize impacts to critical habitat, mitigation areas, wetlands, streams and creeks.
- D. Install perimeter protection (silt fence) or temporary berms prior to clearing and grubbing.
- E. Construct erosion and sediment control BMPs prior to commencing trenching, cut and fill, or other earthwork activity.

3.02 PREPARATION

- A. Prior to clearing, demolition below grade, excavation, and placement of fill; install clearing limits fences, perimeter silt fences, temporary stabilized construction entrance and perimeter control.
- B. Prepare Site for surface water to flow away from excavations and disturbed soils.
- C. Sediment control BMPs (sediment tanks, traps, diversion dikes, berms, etc) shall be constructed as a first step in grading. These BMPs shall be functional before other land disturbing activities take place.
- D. The boundaries of the clearing/construction limits indicated on the Drawings shall be clearly marked in the field by a continuous length of high visibility fencing.
 - 1. No disturbance beyond the clearing limits shall be permitted.
 - 2. Maintain the clearing limit fencing for the duration of construction.
- E. Protect catch basin inlets to drainage system from sediment influx by installing and maintaining inlet protection.
- F. In preparation of paving, clean all catch basins and conveyance lines. The cleaning operation shall not flush sediment-laden water into the downstream system.
- G. Prepare any permanent flow control facilities that will be used as a temporary settling basin with the necessary erosion control measures and provide adequate storage capacity.

3.03 INSTALLATION

- A. Catch basin inserts:
 - 1. Install at all locations indicated on the Drawings, ESC Plan, and where inspection deems necessary.
 - 2. Install according to manufacturer's recommendations.
 - 3. Install in existing catch basins prior to any earth disturbing activity uphill of the catch basin.
 - 4. Install in new catch basins prior to allowing any water to flow into the catch basin.
- B. Quarry spalls:
 - 1. Install at locations indicated on the Drawings and ESC Plan.
- C. Plastic sheeting:
 - 1. The use of plastic sheeting shall be limited to the covering stockpiles, or very small graded areas for short periods of time. Duration of installation is limited to 30 days before permanent measures are installed.

2. Embed edges a minimum of 6 inches in soil around the entire perimeter of plastic sheeting.
 3. Overlap joints with minimum two feet lap and tape seam.
 4. Install hold downs at all excavation faces and at stockpiles.
 5. Secure hold downs with polypropylene rope at ten feet on center, 10 feet maximum each way, across the entire surface of plastic sheeting.
 6. Anchor the polypropylene rope by driving 2-inch x 4-inch stake at the top of excavations or bottom of stockpiles and tying rope to stake.
- D. Sandbag hold-downs:
1. Secure with 1/4-inch polypropylene rope at ten feet on center maximum each way.
 2. Anchor rope with 2-inch x 4-inch fir, standard or better.
- E. Silt fence:
1. Install filter fabric over wire backing.
 2. Secure filter fabric to wire fabric:
 - a. Secure at top, middle, and bottom of each post.
 - b. Wire fabric to extend to the top edge of the above ground filter fabric.
 3. Use steel fence posts:
 - a. Set posts at six foot on-center maximum.
 4. Bury wire fabric in trench upslope and adjacent to the steel posts for the full length.
 5. Bury bottom 8 inches of fabric in a 4x4 trench upslope.
 6. Field joints:
 - a. Lap joints:
 - 1) 2-foot minimum.
 - 2) Remove all dirt, dust, moisture, and foreign materials.
 - 3) Splice only at support posts with wire fabric.
 - b. Repairs:
 - 1) Patch with filter fabric.
 - 2) Extend lap six inches from damaged area in all directions.
 - 3) Proceed as specified for joint.
- F. Erosion control blanket or mat:
1. Install per manufacturer's installation instructions and consistent with SSWWMM.
 2. Ensure through surface preparation and staking that the material is in continuous contact with the ground surface.
 3. Mulch open weave netting in order to prevent erosion.
- G. Pipe slope drains:
1. Install at all locations where storm water will be conveyed over cut or fill slopes or away from bare soils to prevent gullies, channel erosion, and saturation of slide-prone soils.
 2. Install diversion dikes or swales to collect and route water to the slope drain at the top of the slope.
 3. The soils around and under the pipe and entrance section shall be compacted to prevent undercutting.
 4. The pipe shall be secured to prevent movement.
 5. The area below the outlet shall be stabilized with an energy dissipation structure.
- H. Sandbag check dams:
1. Install at all locations indicated on the Drawings and at all locations required by the ESC Plan.
 2. Stack sandbags at least 2-3 bags high and 1-2 bags thick.
 3. Butt ends of bags tightly.
 4. Overlap butt joints of row beneath with each successive row.
 5. Leave a weir gap at the center of the check dam:
 - a. Ensure that the edges of the structure are at a higher elevation than the weir gap to prevent flow from escaping around the sides of the dam.
 - b. Place a sand bag(s) as a splash pad on the downstream side of the weir opening.
- I. Soils and slopes:

1. If soil stockpiles (imported or native) are placed on or along a street Right-of-Way, these shall be covered with plastic at all times when not being actively worked, use hold-downs where appropriate.
 2. Any areas of exposed soils (i.e. excavated areas, spoil piles and imported or stored fill) that will not be disturbed for two days during the wet season or seven days during the dry season shall utilize approved erosion control BMP methods to prevent turbid runoff into surface waters.
- J. Temporary spoil piles:
1. Place material in a contained area with sediment control:
 - a. Contain area with ecology blocks and/or sediment fences to control runoff.
 - b. Cover or sprinkler to control dust and sediment runoff.
- K. Stabilized construction entrance:
1. Install in accordance with the Drawings and at all locations vehicles access and exit the Site.
 2. Constructed of 4-inch to 8-inch quarry spalls, placed to a minimum thickness of 12 inches.
 3. Separation geotextile shall be placed under the quarry spall to prevent fine sediment from pumping into the rock pad.
 4. Install driveway culvert if there is a roadside ditch present.
- L. Temporary outlet protection (energy dissipation):
1. Install adequate energy dissipation and stabilization at the outlet of all surface water conveyance systems.
 2. Meet or exceed minimum design standard of the SMMWW.
- M. Straw wattles:
1. Install as soon as construction allows.
 2. Live stakes are allowed for permanent installations. Live stakes are not a replacement for wood stakes.
 3. Install from the base of the slope uphill.
 4. Spread evenly and lightly compact excavated material from trench on the uphill side of the wattle.
- N. Compost socks:
1. Install as shown on the Drawings.
 2. Upon completion of project cut open compost sock, spread soil, and remove and dispose of mesh sock.
- O. Rock check dam:
1. Construct out of 4-inch to 8-inch quarry spalls.
 2. Construct at locations shown on the ESC Plan.

3.04 MAINTENANCE

- A. Be responsible for the implementation of the ESC Plan, including all revisions, and the construction, inspection, maintenance, replacement, and modification of the erosion and sedimentation control facilities.
- B. Make revisions to the ESC Plan and perform the work necessary to meet the requirements of the SMMWW.
- C. If unanticipated site circumstances require installation of additional BMPs, the additional BMPs shall be installed within ten calendar days.
- D. Use form "Construction Stormwater Site Inspection Checklist" from Ecology Publication #06-10-020 or approved equal to conduct weekly Construction Site Stormwater Site Inspections:
 1. Assign a CESCL to conduct these inspections when a Construction Stormwater NPDES Permit has been issued for the Project and/or Local Jurisdictions require CESCL Inspections.

- E. When results of weekly Construction Stormwater Site Inspection Checklist show that a BMP needs repair or maintenance or that an additional BMP is needed, the corrective actions shall be implemented within 10 days of the date of the inspection.
- F. Prevent solids or turbid runoff from entering storm drains or local surface water bodies by utilizing appropriate source control BMPs.
- G. Where erosion occurs, make modifications to the source control BMPs to eliminate the cause of the erosion and then mitigate its effects.
- H. General maintenance activities:
 - 1. Inspect BMPs as required in this Section and by the permits.
 - 2. Repair or replace damaged or missing BMPs as soon as possible, but no later than 10 days after noting the item in the Construction Stormwater Site Inspection Checklist.
 - 3. Maintain seeded surfaces throughout construction.
 - 4. Remove accumulated sediment.
- I. Street cleaning: See Section 01 35 43.
- J. Rock check dams:
 - 1. Remove accumulated sediments when the accumulated sediment depth reaches 6 inches or $\frac{3}{4}$ of the height of the check dam, whichever is first.
 - 2. Prevent sediments from being flushed to the downstream system during cleaning.
- K. Silt fences:
 - 1. Remove sediment from behind silt fences when deposits are 6 inches deep or greater.
 - 2. Remove filter fabric where deteriorated.
 - 3. Replace sections of filter fabric that have been torn or ripped.
- L. Catch basin inserts:
 - 1. Remove sediment and replace inserts when no longer providing filtration and through-flow according to manufacturer's recommendations.
- M. Plastic sheeting:
 - 1. Inspect installed sheeting for erosion, undermining, and anchorage failure.
 - 2. Repair any failures immediately.
 - 3. Replace torn sheets and repair open seams.
 - 4. Remove all plastic sheeting when no longer needed.
- N. Erosion control blanket or mat:
 - 1. Repair and staple any areas of the net or blanket that are damaged or not in close contact with the ground.
 - 2. Fix and repair eroded areas.
- O. Be responsible for performing the required BMP maintenance as defined within the SMMWW.
- P. Provide necessary ditches, swales, and dikes to collect and convey stormwater runoff in a non-erosive manner.
- Q. Cover all areas that will be unworked for more than seven days during the dry season or two days during the wet season with erosion blankets, mats, wood fiber mulch, compost, plastic sheeting, or equivalent.
- R. Stabilize all areas within seven days of reaching final grade.
- S. Catch basin closure and pump system:

1. Operate and maintain pipe plug to prevent leakage.
2. Replace plug if leaks cannot be stopped.
3. Operate and maintain automated sump pump to ensure site water in closed catch basins is discharged to the site water treatment system at all times.

T. Wheel Wash:

1. Vehicle speed shall be limited to provide adequate cleaning of tires and undercarriage.
2. Hand spray tires when wheel wash does not provide adequate cleaning.
3. Prevent dirty wash water from leaving the site.
4. Replace turbid water in storage/recycling tank with clean water to prevent track out onto public roads.
5. Spray wash entrance and exit ramps to remove sediment tracked onto the ramps or from turbid water dripping from vehicles.

3.05 COMPLETION OF CONSTRUCTION

A. ESC BMPs:

1. Shall be kept operational until the Site has undergone final stabilization (e.g., soils have been stabilized by permanent measures, landscaping is installed, etc.) and through Substantial Completion of the Work.
2. Remove within 30 days after the Site has undergone final stabilization.

3.06 SYSTEM COMPLIANCE

- A. The Project Representative and regulatory agencies will determine the effectiveness of the ESC Plan.
- B. Upgrade and modify ESC Plan as required within five days of written Correction Notice from the Project Representative until effective. Refusal to modify and upgrade the ESC Plan may result in the work being completed by the Project Representative and the cost of the work being deducted from the Application for Payment.
- C. Non-compliance with the erosion control requirements and water quality requirements may result in stoppage of work.

END OF SECTION

SECTION 32 12 00

FLEXIBLE PAVING (SDOT)

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for one or more layers of plant-mixed hot mix asphalt (HMA) on prepared foundations or base in accordance with this Section and in conformity with the lines, grades, thicknesses, and typical cross-sections indicated in the Drawings.
- B. This Section includes references to portions of the City of Seattle Standard Specifications For Road, Bridge, and Municipal Construction (Seattle Standard Specifications) and Seattle Standard Plans. Such references are to define the technical standards to be met for this Section; only the technical standards are referenced. Administrative provisions (such as Measurement and Payment) of the Seattle Standard Specifications or Seattle Standard Plans shall not apply to this Contract in any instance.
- C. References to Engineer in the Seattle Standard Specifications shall mean Project Representative.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
City of Seattle	City of Seattle Standard Specifications For Road, Bridge and Municipal Construction, Current Edition
City of Seattle	City of Seattle Standard Plans For Municipal Construction, Current Edition
WSDOT	WSDOT Standard Operating Procedure (SOP) 732
WSDOT	WSDOT Materials Manual M 46-01

- B. Terms Related to HMA per Seattle Standard Specification 5-04.3(1).

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Mix Design submittal as required by Seattle Standard Specifications 5-04.3(6).
- C. As required per Seattle Standard Specifications for materials in this Section.
- D. HMA Paving Plan per Seattle Standard Specification 5-04.3(17)B.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Per Seattle Standard Specification 5-04.2.
- B. Materials for Ballasting and Crushed Surfacing per Seattle Standard Specification 4-04.2.
- C. Use of Substitute Materials per Seattle Standard Specification 5-04.2(1).

- D. Tack Coat per Seattle Standard Specification 5-04.3(4)B4A.
- E. Surface Sealant (Fog Seal) per Seattle Standard Specification 5-04.3(18).
- F. Anti-Stripping Additive per Seattle Standard Specification 5-04.3(6)C2.

2.02 EQUIPMENT

- A. Mixing Plant per Seattle Standard Specifications 5-04.3(2).
- B. Paving and Related Equipment per Seattle Standard Specification 5-04.3(3) through 5-04.3(3)C.
- C. Tack Coat Distributor Equipment per Seattle Standard Specification 5-04.3(4)B.
- D. Compaction Rollers per Seattle Standard Specification 5-04.3(9)A.
- E. Smoothness Testing Equipment per Seattle Standard Specification 5-04.3(12) and 5-05.3(3)E.
- F. Equipment for Ballasting and Crushed Surfacing per Seattle Standard Specifications 4-04.3(1).

2.03 MIX DESIGN

- A. HMA shall be composed of asphalt binder and mineral materials as may be required, mixed in the proportions specified to provide a homogeneous, stable, and workable mixture.
- B. HMA Mix Design per Seattle Standard Specification 5-04.3(6):
 - 1. HMA (CL ½"), PG 64-22 for Wearing Course.
 - 2. HMA (CL 1"), PG 64-22 for Leveling Course.

2.04 FABRICATION / MIXING

- A. Heating of Asphalt Binder per Seattle Standard Specification 5-04.3(5).
- B. HMA Mixing Process per Seattle Standard Specification 5-04.3(7).
- C. Anti-Stripping Additive per Seattle Standard Specification 5-04.3(19).

2.05 SOURCE QUALITY CONTROL

- A. As required per Seattle Standard Specifications for testing of materials in this Section.

PART 3 EXECUTION

3.01 SUBGRADE AND BASE COURSE PREPARATION

- A. Subgrade preparation per Seattle Standard Specification 2-09:
 - 1. Exception: Includes all survey and survey staking.
- B. Gravel Base per Seattle Standard Specification 4-04.3(2).
- C. Base course shall be placed per Seattle Standard Specification 4-04 through 4-04.3(9).

3.02 PREPARATION

- A. Preparation of Street Surfaces per Seattle Standard Specification 5-04.3(4).

- B. Utility Adjustments per Seattle Standard Specification 5-04.3(8)A.

3.03 INSTALLING

- A. Spreading and Finishing per Seattle Standard Specification 5-04.3(8).
- B. Applying Tack Coat per Seattle Standard Specification 5-04.3(4)B4.
- C. HMA Compaction per Seattle Standard Specification 5-04.3(9).
- D. HMA Joints per Seattle Standard Specification 5-04.3(10).
- E. Weather Limitation per Seattle Standard Specification 5-04.3(15).
- F. Paving and Planing Under Traffic per Seattle Standard Specification 5-04.3(17).
- G. Sealing of Pavement Surfaces per Seattle Standard Specification 5-04.3(18).
- H. Temporary Pavement Patching per Seattle Standard Specification 5-04.3(23).

3.04 FIELD QUALITY CONTROL

- A. Acceptance of prepared subgrade and compaction testing per Seattle Standard Specification 2-09.3(1).
- B. Acceptance of prepared base course and compaction testing per Seattle Standard Specification 4-04 and 2-11.
- C. Acceptance of tack coat application method and rate per Seattle Standard Specification 5-04.3(4)B4A.
- D. Acceptance Sampling and Testing – HMA Mixture per Seattle Standard Specification 5-04.3(7)B.
- E. HMA Compaction per Seattle Standard Specification 5-04.3(9).
- F. Surface Smoothness per Seattle Standard Specification 5-04.3(12).

END OF SECTION

SECTION 32 16 00

CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies construction of concrete curbs, gutters, and sidewalks.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AASHTO T 99	Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pounds) Rammer and a 305 mm (12 in.) Drop
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
ADAAG	ADA (American Disabilities Act) Accessibility Guidelines, Current Edition

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data:
- Expansion Joint Filler.
- C. Cement, concrete and concrete products per Section 03 30 00.
- D. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

PART 2 PRODUCTS

2.01 WELDED WIRE FABRIC

- A. See Section 03 20 00.

2.02 EXPANSION JOINT FILLER

- A. Preformed asphalt-impregnated, expansion joint material meeting ASTM D994, 1/2-inch thick.

2.03 CONCRETE

- A. Per Section 03 30 00.
- B. Ready-mixed with compressive strength of 4,000psi at 28 days.
- C. Maximum Aggregate Size: 3/4 inch.

- D. Total Air Content: 2-4 Percent
- E. Slump: 2 inches to 4 inches.

PART 3 EXECUTION

3.01 FORMWORK

- A. Lumber Materials:
 - 1. 2-inch dressed dimension lumber or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed, curb, gutter, and sidewalk.
 - 2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.
- B. Metals: Steel in new undamaged condition.
- C. Setting Forms:
 - 1. Construct forms to shape, lines, grades, and dimensions.
 - 2. Stake securely in place.
- D. Bracing:
 - 1. Brace forms to prevent change of shape or movement resulting from placement.
 - 2. Construct short-radius curved forms to exact radius.
- E. Tolerances:
 - 1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.
 - 2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.
 - 3. Do not vary vertical alignment at joints more than 1/16 inch.

3.02 PLACING CONCRETE

- A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.
- B. Place concrete as soon as possible and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.
- C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304 and Section 03 30 00. Wherever requirements differ, the more stringent shall govern.
- D. To compact, vibrate until concrete becomes uniformly plastic.

3.03 CURB CONSTRUCTION

- A. Expansion Joints: Place expansion joints at maximum 45-foot intervals and at the beginning and end of curved portions of curb, and at connections to existing curbs and sidewalks. Install expansion joint filler at each expansion joint.
- B. Curb Facing: Do not allow longitudinal joints within 7 inches from top of curb.
- C. Contraction Joints:
 - 1. Maximum 15-foot intervals in curb.
 - 2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
 - 3. Insert steel sheet to full depth of curb.

4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
- D. Front Face:
1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
 2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
 3. Apply curing compound to exposed surfaces of curb upon completion of finishing.
 4. Continue curing for minimum of 5 days.
- E. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.
1. Backfill per Section 31 05 01.
- F. Finish top of curb with steel trowel and finish edges with steel edging tool.

3.04 SIDEWALK CONSTRUCTION

- A. Connection to Existing Sidewalk:
1. Sawcut and remove old concrete back to an existing contraction joint.
 2. Clean the surface.
 3. Apply a neat cement paste immediately prior to placing new sidewalk.
- B. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.
- C. Contraction Joints:
1. Provide transversely to walks at locations opposite contraction joints in curb.
 2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
 3. Construct straight and at right angles to surface of walk.
- D. Finish:
1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
 2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
 3. Apply curing compound to exposed surfaces upon completion of finishing.
 4. Protect sidewalk from damage and allow to cure for at least 7 days.
 5. Saw cutting: Where shown on Drawings. Provide saw cut joints with dimensions 3/8-inch wide by 1/3 depth of slab.

3.05 CLEANING AND PROTECTION

- A. Protect detectable warning tiles against damage during construction period to comply with tile manufacturer's specifications.
- B. During and after the detectable warning tiles installation and the concrete curing stage, it is imperative that there are no walking, leaning, or external forces placed on the tile to rock the tile, causing a void between the underside of the tile and the concrete substrate.
- C. Remove protective plastic sheeting from detectable warning tiles within 24 hours of installation.
- D. Clean tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of the project.

END OF SECTION

SECTION 33 01 30.71

GEOPOLYMER LINING FOR CONCRETE REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

- A. It is the intention of this Specification to set a standard of quality and design for the application of all geopolymer materials used in the rehabilitation of the raw sewage discharge sewer pipe. The geopolymer lining is to act as an abrasion resistant, corrosion resistant barrier in a low pressure high corrosion environment, for a concrete encased steel discharge pipe. The Contractor shall select one renewal option for renewal of the raw sewage pump discharge piping between geopolymer as specified within this Section or a high build abrasion resistant epoxy as specified per Section 09 90 00. Extents of renewal are as shown on drawings for all pump trains.
- B. Work and components include:
1. Pre-Installation cleaning and closed-circuit television (CCTV) inspection.
 2. Pipe cleaning and preparation.
 3. Ventilation and application of geopolymer liner.
 4. Quality control measures, health & safety, and testing.
 5. Post rehabilitation CCTV inspection.
 6. Site cleanup.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standards referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM C-39/39M-10	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C-109/ 109M-05	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C-78	Standard Test Method Flexural Strength of Concrete
ASTM C-469-02e1	Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C-496/ C496-04e1	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C-882-05	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C-1140-03A	Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels
ASTM F-2414	Practice for Sealing Sewer Manholes Using Chemical Grouting
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 305R-99	Hot Weather Concreting
ACI 306R-88	Cold Weather Concreting
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
	ACI Certified Concrete Field Testing Technician, Level 1

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. The following shall be submitted prior to any field work:
 - 1. Detailed shop drawings and/or legible catalog cuts of all items included within this Section including product data for all materials to be used.
 - 2. Detailed installation procedures and specific geopolymer procedures for geopolymer rehabilitation including details of proposed means of preparation the surface to receive the geopolymer lining, list of the proposed equipment, details of proposed methods for control and disposal of waste materials, application, tapering of liner thickness at pump end, finishing and testing. Safety data sheets for each material.
 - a. Liner Thickness Control: Identify method and equipment to install liner and field verify within specified tolerances.
 - b. Contingency Plan: Materials and equipment required to implement contingency plans. Identify the location of all required materials and equipment.
 - c. Minimum liner thickness validation: Proposed plan to certify that the installed geopolymer liner meets the minimum thickness requirements as stated within the liner product requirements. The plan shall include the proposed geopolymer liner thickness to be installed.
 - 3. Certified copies of all test reports on materials referred to within this Section in accordance with ASTM or Federal Specification requirements.
 - 4. Schedule of Work: plan and sequence of lining installation.
 - 5. Testing Agency.
 - 6. Daily Records: Nozzleman name, helper name, Contractor's QC Representative, date, temperature, humidity, day start and end time, placement start and end time, shotcrete equipment type, location of shotcrete, grout volume used.
 - 7. Curing methods, sampling.
- C. The following shall be submitted after cleaning and CCTV inspection and prior to beginning any lining of the discharge:
 - 1. Digital video copy and log (via external hard drive) of the CCTV inspection of the areas to be rehabilitated in the format specified within this Section.
 - 2. In the event actual field conditions require a deviation from the submittal, a revised minimum design thickness calculation for the new liner shall be submitted for approval.
- D. After rehabilitation, the following shall be submitted:
 - 1. Digital video copy and log (via external hard drive) of the CCTV inspection of the completed work in the format specified within this Section shall be submitted to the Project Representative within 48 hours of completion.
 - 2. Test results of samples of geopolymer liner.

1.04 QUALITY ASSURANCE

- A. Manufacturer and Installer Experience:
 - 1. The installing Contractor shall certify that the geopolymer liner to be used is the exact system for which all submittals and certifications were made. No substitutions will be allowed, and misrepresentations or omissions will be grounds for contract termination with the Contractor waiving all claims against the Owner for work performed or costs incurred.
 - 2. The geopolymer lining rehabilitation system and installing contractor shall have a minimum proven performance record, using the exact name brand product shall have been installed. The experience in the successful completion of similar projects to the tolerances indicated for the size of pipe and quantities shown on the Contract Documents.
 - 3. The licensed Contractor shall have completed a minimum of five (5) projects in the last 10 years for sewer applications of 60 inches or greater, and a minimum of 2,000 linear feet of pipeline, that involved the installation of the name brand product proposed. The Contractor shall provide a certificate as a Business-in-Good Standing from the state that the company resides in and disclose

- any criminal or fraudulent rulings for shotcrete work against former or current company Owners in the last 15-year period. Provide a list of all litigations that are relevant to project elements.
4. The Contractor shall have been actively involved in the direct field installation of the exact name-brand product proposed for three years prior to date of proposal.
 5. Ability to demonstrate that company construction support staff (safety, general superintendent, project managers, and construction managers) has educational session credits through an industry-appropriate continuing education program specifically addressing shotcrete design, construction, or administration.
- B. Qualifying Superintendent and Crew:
1. The Contractor is required to have at least one Qualifying Superintendent on the job during construction activities. The Qualifying Superintendent and crew that will be undertaking the work shall meet the experience requirements.
 2. The Qualifying Superintendent shall have been trained by the pump and spray manufacturer and have received a certificate of completion. This factory certification of completion of the required training is to be kept on file. The Qualifying Superintendent shall be thoroughly familiar with all aspects of the operation including safety and quality control measures. The Qualifying Superintendent shall have been superintended on a minimum of five (5) projects in the last 15 years for similarly sized projects.
 3. The Qualifying Superintendent shall provide a list of qualifying experience to the Project Representative. All required information, including: project name, owner, and contact person, phone number, diameter and length of pipe and date completed shall be furnished for each project completed. The Qualifying Superintendent shall be onsite during all activities.
 4. The work crew will have been thoroughly trained in the specific aspects of their jobs. This training includes training received from equipment manufacturers and in-field training. Fully trained field technicians shall apply the geopolymer liner with not less than five years of experience gained on similarly sized projects. Moreover, the field technicians are required to have a good understanding of the work and product usage. Field technicians shall be capable of properly cleaning the discharge pipe, developing a repair strategy for stopping any minor water infiltration, and spray applying the geopolymer liner to fully rehabilitate the pipe. The trained field technicians are required to follow the manufacturer's guidelines and keep in good standing with the product manufacturer. All work including the cleaning course of action, furnishing the materials, preparation of the materials and repair area, providing the installation of the materials and the testing method will be accomplished according to the manufacturer's specific recommendations.
- C. Warranty
1. The material shall meet or exceed the design criteria specified in this Section.
 2. Should any of the furnished and installed material specified in this Section fail to meet the indicated performance parameters as indicated herein for a period of TEN (10) YEARS from the date of final acceptance, this shall be repaired at no cost the Client. The date of final acceptance shall be the date final payment is made.
 3. The finished geopolymer liner shall be continuous over the entire length of the rehabilitated segment and be as free as commercially practicable from visual defects such as foreign inclusions, dry or thin spots and infiltration. It shall also meet the test requirements specified in this Section. During the guarantee period, any defects, which will affect the integrity or strength of the geopolymer, shall be repaired at the Contractor's expense.
- D. Quality Assurance Control:
1. The quality and performance of the material shall be maintained by one or all of the following measures to be determined and specified by the Project Representative:
 - a. Material should be delivered in packaged and sealed condition and free of moisture. Do not use materials that have been exposed to moisture or there is visible damage to the packaging.
 - b. Application equipment shall have mortar feed, high shear mixer and pump as a single operating unit. In addition, the application equipment shall have sensors that maintain uniform operation of all three functions and shut down the equipment in the event of interruption of any of the functions.

- c. Application equipment shall have visible display for the rate of water addition to ensure water/cement ratios are known and controlled. Water/cement ratio shall be maintained below 0.20.
 - d. Application equipment shall measure back pressure on the discharge side of the pump to alert the operator to any potential changes in flow rates. Do not exceed 25 bars of back pressure.
 - e. Spinner head shall be capable of spraying in a clockwise and counterclockwise direction and at multiple angles.
 - f. Spinner head shall be attached to a reciprocating mechanism to layer the materials. The reciprocating mechanism shall oscillate the spinner head by a minimum of 6 inches.
 - g. The retraction system shall be capable of pulling the spinner head at a minimum rate of 4 inches per minute with no more than +/-5% tolerance and have a visible display that monitors the rate of retraction.
 - h. The rate of retraction, material discharge volume, dry material usage and length of pipe covered should be monitored and recorded on a daily basis.
 - i. All equipment shall be in clean and good working conditions.
 - j. Maintenance and service shall be performed on the equipment to manufacturer's standards.
 - k. Extra equipment should be kept on site to ensure rapid redeployment in the event of equipment failure.
2. Initial Trial Mockup
- a. Mockup Objectives:
 - 1) Develop cementitious mix by initial field trial work prior to actual application of cementitious liner to a mockup surface. The mockup surface can either be a test piece of the same material of a similar size or the existing pipe forming part of the permanent works.
 - 2) Perform field trials to demonstrate capability of equipment, workmanship, and material under field conditions.
 - 3) Perform tests to determine whether cementitious wall facade meets Contract requirements.
 - 4) Conduct a demonstration of surface preparation, obtaining minimum design thickness, and surface finishing.
 - 5) Prepare mockups for examination by the Project Representative prior to execution. If mockup surface is to be pipe forming part of permanent works, mockup is to be performed at far upstream or downstream extents so as to facilitate access for mockup examination.
 - b. Mockup Preparation:
 - 1) Required for each nozzleman who will be employed in application of the cementitious mix on the Work. Per nozzleman, apply cementitious mix on an area of at least 10 sq. ft.
 - 2) Mockups shall have accessories installed.
 - 3) Mockups shall not entrap rebound.
 - 4) Label mockups; note name of nozzleman.
 - 5) Prepare 3 cylindrical concrete test specimens from the same batch of cementitious product used in the mockup.
 - c. Mockup Testing:
 - 1) Designate independent testing laboratory which shall perform testing and inspection services as required under this section and throughout performance of the Work. Services of this testing laboratory shall be paid for by the Contractor.
 - 2) Laboratory shall obtain specimens which are supplied by the Contractor and prepared in accordance with specified methods.
 - 3) Cut or broken surfaces shall be dense and free from laminations, sand pockets, and hollow pockets.
 - 4) Specimens shall be tested in accordance with ASTM C39 for 3-day, 7-day, and 28-day strength.
 - 5) Test specimens shall be individually labeled and logged to record the following:
 - a) Owner's Project number and title.
 - b) Sample number.
 - c) Name of Contractor.
 - d) Location and by whom tested.
 - e) Results of test.

- 6) Notify the Project Representative a minimum of 1 day prior to field testing procedures. Perform field testing procedures in presence of the Project Representative.
 - 7) Conduct and submit written and photographic documentation of surface finish testing to the Project Representative.
 - 8) The installation of the cementitious liner may proceed if, in the opinion of the Project Representative, the following requirements are met:
 - a) Surface finish meets minimum requirement of Specification.
 - b) Strength test results of 3-day and 7-day tests meet minimum requirement of Specifications.
 - 9) The final Work will not be approved or accepted if 28-day test does not meet minimum requirement of Specifications.
 - 10) Nozzleman whose surface finish, specimen quality, and tests, in the opinion of the Project Representative, are not of adequate quality, shall not apply cementitious wall facade on the Contract.
 - 11) Remove and reapply cementitious wall facade that does not satisfy compressive strength requirements of Specification.
- d. Additional mockups shall be prepared and tested for every change in the wall facade thickness, cementitious product mix, additional new nozzleman, or other change in project conditions at the discretion of the Project Representative. After completion of mockups, Contractor shall not proceed with cementitious wall facade without written approval of the Project Representative.

1.05 DESIGN CRITERIA

- A. The finished liner shall be such that when the geopolymer liner sets, the total wall thickness will be homogeneous and monolithic.
1. Physical Properties:
 - a. The cured geopolymer lining material shall conform to the following 28-day minimum physical properties:

PROPERTIES	VALUE
Compressive Strength (ASTM C39)	Min. 8,000 psi @ 28 days
Modulus of Elasticity ASTM C-469/469M-10	Minimum 5,800,000 psi @ 28 days
Flexural Strength (ASTM C78)	Min. 1500 psi @ 28days
Bond Strength (ASTM C882)	Min. 2500 psi
Density	
Dry	127.7 pcf
Wet	139.3 pcf.
Tensile Strength ASTM C496	28 Day 800 psi
Shrinkage ASTM C1090	56 Day <0.05%
Freeze/Thaw Durability ASTM C666	Durability factor above 80 percent
Abrasion Resistance ASTM C1138	5 Cyl. 28 Day < 2% Loss

- B. Materials: Geopolymer Liner
1. The geopolymer lining material shall be a micro-fiber reinforced ultra-dense geopolymer. This material shall provide a high strength fiber reinforced mortar specifically designed for ease of mechanical pumping, spraying and spin-casting. Unless otherwise designated by the Project Representative, fibers shall be added to the shotcrete mix at 1.5 lbs/cyd rate/dosage or higher as recommended by the manufacturer of the fiber to mitigate temperature and shrinkage cracking.

2. The geopolymer liner shall be designed to produce a liner with improved compressive and flexural strength, high adhesion to damp surfaces, lower permeability and increased resistance to aggressive chemical attack.
3. The surface shall be completely dry for three (3) days prior to being exposed to sewerage. Curing to be undertaken in accordance with the manufacturer's recommendations.
4. This Specification does not consider all spin-cast cementitious mortars and materials to be geopolymer. For the purposes of this Work, the Modulus of Elasticity (MOE) value is key in classifying whether a product material constitutes a true geopolymer product. Any product exhibiting a MOE less than specification minimum requirements shall not be considered as complying with this specification.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Deliver material in Manufacturer's original unopened and undamaged package. Clearly identify manufacturer, brand name, contents, and stock number on each package. Packages showing indications of damage that may affect condition of contents are not acceptable.
- B. Storage of Materials:
 1. Store in original packaging under protective cover and protect from damage. Store all materials at temperatures recommended by manufacturer.
 2. Stack containers/bags in accordance with manufacturer's recommendations.
 3. Unload and store with minimum handling.
 4. Do not store materials directly on the ground.
- C. Handling of Materials: Handle materials in such a manner as to prevent damage to products or finishes.

PART 2 PRODUCTS

2.01 LINER

- A. Apply to a 1.5-inch thickness at the location indicated on the Drawings with a variation in thickness of lining: minus 0" to plus 0.5". The Contractor may submit an alternate thickness for consideration to the Project Representative based on a minimum of three case studies of successfully installed geopolymer lining for abrasion resistant, corrosion resistant, low-pressure installation. Approval of an alternative minimum thickness shall be at the discretion of the Project Representative.
- B. Thickness control pins shall be used to ensure the appropriate and designated finished pipe profile is achieved. Prior to the application of the first layer of geopolymer, Contractor shall furnish and install adequate ground wires, measuring pins, or other approved means to establish the thickness, surface planes, and finish lines of the geopolymer. Contractor shall maintain specified tolerances by keeping ground wires secure and taut. Pins shall be non-corrosive and so designed as not to cause infiltration of water through the geopolymer. Pins shall be installed on 5-foot centers at position 12, 3, 6 and 9 with the subsequent set offset at 1:30, 4:30, 7:30 and 10:30, and alternating accordingly, and at other locations as may be directed by the Project Representative.
- C. Additive: High Corrosion Environment (HCE) additive or approved equal to be used.
- D. Acceptable Geopolymer Liner Manufacturers:
 1. To establish product quality and installation standards, the approved geopolymer lining rehabilitation system shall be:
 - a. GeoSpray / GeoTree lining system manufactured by ClockSpring NRI.
 - b. GeoKrete lining system manufactured by Quadex.
 - c. Approved Equal.
 2. Where discrepancies exist between this specification and established manufacturer's product and process specifications, this Specification shall govern. Any discrepancies shall be brought to the attention of the Project Representative.

PART 3 EXECUTION

3.01 GENERAL

- A. All rehabilitation of the discharge piping shall follow the procedures listed below:
 - 1. The Contractor shall carry out the operations in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving work and entry into a confined space.
 - 2. All details of the point of water connection, backflow protection, conveyance methods, and all local conditions regarding the use of water shall be approved by the Project Representative prior to commencement of work. All equipment, labor, and material required for obtaining water for the work shall be provided by the Contractor. Contractor is responsible for running piping or booster pumps, as required, to service the works.

3.02 INSTALLATION PROCEDURES

- A. Pipe Cleaning and Preparation:
 - 1. The full circumference of the pipe shall be thoroughly cleaned and made free of all materials including dirt, grit, grease, sludge and all debris or material that may be present.
 - 2. Locations to be rehabilitated shall be thoroughly cleaned using high-pressure jetting (minimum 3,500 psi and 5 gpm) equipment or by hand. Loose debris shall be removed in order to facilitate the proper installation of the geopolymer liner material.
 - 3. All debris extracted shall be removed and disposed of at a dumpsite designated by the Project Representative at no additional cost to the Owner prior to application of the geopolymer lining material.
 - 4. Locations to be rehabilitated shall be cleaned to the satisfaction of the Project Representative.
 - 5. Project Representative shall inspect the locations to be rehabilitated prior to any liner material application.
 - 6. All loose or defective concrete or grout shall be removed to provide an even surface prior to application of the geopolymer lining material.
- B. Inspections:
 - 1. The Contractor's experienced personnel trained in location breaks and obstacles by CCTV inspection shall perform inspection of the discharge pipe(s). Utilizing a color video inspection system with data recording capabilities, the entire pipe section to be rehabilitated shall be recorded on digital video. This inspection shall be performed, one section at a time, by a color video inspection system. The interior of the pipe shall be carefully inspected to determine the location of any conditions, which may prevent the proper installation of the geopolymer liner, and it shall be noted so that these conditions can be corrected. The digital file and suitable log shall be submitted to the Project Representative via an external hard drive or equivalent.
- C. Application of Centrifugally Cast Geopolymer Liner Material:
 - 1. The work consists of spray applying and /or centrifugally casting geopolymer liner to the inside of the existing pipe as noted on the Drawings.
 - 2. Mixing Geopolymer Lining Material
 - a. Contractor shall add the geopolymer material to the batch water not to exceed a 0.20 water/cement ratio.
 - b. Water to cement ratios shall be monitored and maintained throughout the application process to ensure consistent material strength.
 - c. The geopolymer lining material shall be mixed in a high shear mixer.
 - d. The geopolymer lining material shall be pumped through an adjustable rotor stator pump for continuous delivery to the appropriate application device.
 - e. Mixing operations shall be performed so that the minimum of dust is released into the surrounding environment. Tents shall be used to cover the mixing area including pumps.
 - f. Mixing shall be accomplished with an automated mix/pump system to maintain consistent:
 - 1) Water/cement/polymer ratios.

- 2) Mix time, mix speed and dwell time.
- g. Pumps shall be equipped with multiple sensors to stop the pump if material either breaks containment or overflows.
- h. A backup pump, spin casting unit and multiple nozzles shall be onsite at all times during the course of the work under this Contract. Multiple nozzles may be required to produce the required depth or finish of the liner surface.
3. Spray Application of Geopolymer Lining Material:
 - a. Prior to geopolymer application, install measuring pins to surfaces to be lined for purpose of indicating proper thickness of geopolymer lining at 5-foot centers at position 12, 3, 6 and 9 with the subsequent set offset at 1:30, 4:30, 7:30 and 10:30, and alternating accordingly.
 - b. The geopolymer delivery hose shall be coupled to a high-speed rotating applicator device. The rotating casting applicator shall then be positioned within the center or positioned higher than centerline inside the pipe as required by pipe diameter.
 - c. The geopolymer lining material delivery hose shall be coupled to a medium-velocity spray application nozzle. Pumping of the material shall commence and the mortar shall be atomized by the introduction of air at the nozzle, creating a medium-velocity spray pattern for material application.
 - d. The spin cast nozzle shall be capable of bidirectional operation.
 - e. A variable speed reciprocating spin head for making multiple position changes per minute is required. The reciprocating head allows the spin cast mechanism and the associated selected nozzle to make multiple passes on the pipe wall in a single pass of the sled assembly. The rotating applicator head shall travel and spray to provide a uniform material thickness.
 - f. Spraying shall be performed from the downstream to upstream of the sewer unless otherwise authorized by the Project Representative.
 - g. Retraction of the spin cast assembly shall be monitored and performed at a measurable, uniform rate. At the beginning of each application the retraction device shall be calibrated. The calibration process includes setting the digital readout to the desired retrieval rate (in inches per minute). Then the retrieval chain is laid out and marked to show the distance traveled in two minutes. The rate obtained shall be within 5% of the desired application speed. Prior to the lining of each pipe discharge, the Contractor shall submit to the Project Representative the desired application spin head speed and retraction rate. These values shall be based upon the condition of the discharge pipe as made known by the Contractor's pre-installation CCTV inspection.
 - h. The geopolymer liner shall be applied to a specified uniform minimum thickness no less than 1/4 inch per pass until the required design thickness is achieved.
 - i. The high-speed rotating applicator shall then be initialized and pumping of the material shall commence. As the mortar begins to be centrifugally cast evenly around the interior of the cavity, the rotating applicator head shall uniformly travel back and forth at the center point of the pipe at a controlled frequency conducive to providing a uniform material thickness to the pipe walls. Controlled multiple passes are then made until the specified finished thickness is attained.
 - j. Material thickness shall be verified with depth gauges and shall be no less than the design thickness at any point within the pipe discharge. If additional material is required at any level, the rotating applicator head shall be placed at the location and application shall recommence until that area meets the required thickness. When measures do not verify the specified minimum thickness, the Project Representative may request cores be taken from the installed liner. The average thickness measured shall be taken as the actual thickness of the liner. If the average thickness is not above 100% of the specified minimum thickness, the liner is considered out of tolerance.
 - k. The geopolymer lining material shall be applied to a damp surface, with no free or flowing water.
4. The medium-velocity spray nozzle and the centrifugal spin casting head may be used in conjunction to facilitate uniform application of the mortar material to irregularities in the contour of the pipe walls.
5. The geopolymer liner shall be troweled following the spray application. Initial troweling shall be in an upward motion, to compress the material into voids and solidify the pipe wall. Troweling shall be

performed with firm pressure such as to flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities not to exceed the following:

- a. Class A as per ACI 117.
 - b. Equivalent of Environmental Surface Finish 3.0 as per ACI 350.
 - c. Surface Finish Flatness of 3/8 inch or better, defined as the measured depression below a 10-foot straightedge placed on the finished surface.
 - d. Proper steps shall be taken to ensure the material is cured in a moist and moderate climate. In the event dry and/or hot conditions are present, the use of a wind barrier and fogging spray shall be required.
6. The geopolymer material shall not be applied when the ambient temperature is 36 degrees Fahrenheit and falling or, when the temperature is anticipated to fall below 36 degrees Fahrenheit during the next 24 hours, unless specific precautions are employed.
 7. During extreme hot weather conditions, chilled water may be used to mix the geopolymer. The geopolymer mortar shall be maintained at a temperature lower than 90 degrees F.

D. Termination and Sealing of Geopolymer Installation:

1. Termination of the geopolymer liner shall be completed by hand applying the geopolymer liner to the outer surface of the pipe or into the interior of the concrete structure to the satisfaction of the Project Representative. There shall be no annular spaces evident between the host pipe and polymer material. Tapering of the geopolymer shall be performed, as necessary, at the upstream end to facilitate diameter transition from pump to discharge piping.

3.03 FINAL INSPECTION

- A. At the completion of the rehabilitation of the discharge pipe, a video inspection and log of the completed line segments shall be given to the Project Representative by the Contractor. This inspection shall be performed, one section at a time, by a color video inspection system. The finished geopolymer shall be continuous over the entire length of all inversion runs and be free of defects to the satisfaction of the Project Representative.

3.04 SAMPLE PREPARATION AND TESTING OF GEOPOLYMER LINER

- A. All test samples are to be taken by a National Association of Corrosion Engineers (NACE) certified person.
- B. Submit the following information to the Project Representative: Product data, including manufacturer and brand name along with laboratory tests results to verify 28-day compressive strength in accordance with Test ASTM C109/C109M-05. Samples of the applied material shall be taken daily. The samples may be taken from the pump immediately before discharge into the hose or at the spin caster, if feasible. Three samples will be obtained and formed into cylinders as required by ASTM C 109.
- C. Compressive strength testing shall be performed in accordance with ASTM C39 by an independent ACI certified testing agency after 28 days (additional samples may be held for retesting at 56 days if necessary). Strength testing frequency shall be daily.
- D. Submit test results and identify any results that do not meet specified requirements within four days of test completion. Test specimens shall meet specified quality requirements with average compressive strength equal or exceeding 0.85 f'c with no individual core less than 0.75 f'c. Average of three cubes taken from a test panel shall equal or exceed f'c with no individual cube less than 0.88 f'c. Provide corrective action as recommended by the geopolymer manufacturer, subject to approval by the Project Representative.
 1. The samples shall be undisturbed for a period of at least 24 hours before they can be transported. The material thickness shall be determined by using depth gauges during the spraying process. The depth measurements should be made at four clock positions around the pipe and near both ends and the middle of the pipe. These measurements shall be written down in a log book which

will be submitted to the Project Representative at the end of the project, along with digital photos of the completed pipe.

2. The Contractor shall furnish all equipment and personnel necessary to conduct all required sample preparations and bear the associated testing costs.

END OF SECTION

SECTION 40 05 01

PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies general requirements for pipes and testing.
- B. More detailed specifications for the components listed in the Piping System Specification Sheets (PIPESPEC) may be found in other Sections of Divisions 21, 22, 23, 33, and 40. Use this Section in conjunction with those Sections.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME A13.1	Scheme for the Identification of Piping Systems
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 260 and 800
ASME B16.3	Malleable-Iron Threaded Fittings Class 150 and 300
ASME B16.5	Pipe Flanges and Flanged Fittings, NPS 1/2 – NPS 24
ASME B16.9	Factory-Made Wrought-Steel Buttwelding Fittings
ASME B16.11	Forged Fittings, Socket Welding and Threaded
ASME B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ASME B31.3	Process Piping
ASME BPVC Section IX	Qualification Standard for Welding Procedures, Welders and Welding Operators
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105	Forgings, Carbon Steel, for Piping Applications
ASTM A106	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A403	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Ductile Iron Castings
ASTM A570	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88	Seamless Copper Water Tube
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D635	Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D1248	Poly ethylene Plastics Molding and Extrusion Materials

Reference	Title
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3261	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D4101	Polypropylene Injection and Extrusion Materials
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3-Inch Through 48-Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids
AWWA C200	Steel Water Pipe - 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger--Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 Inches Through 144 Inches
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Water Pipe - A Guide for Design and Installation
EPA SDWA Section 1417(d)	Reduction of Lead in Drinking Water Act Requirements, Amendments to Safe Drinking Water Act (SDWA), effective January 4, 2014
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests
NACE RP-0169	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP-0286	Electrical Isolation of Cathodically Protected Pipelines
NFPA 54	National Fuel Gas Code
NSF 61	Health effects criteria (Lead Content Compliance) for water system components
NSF 372	Lead Content Compliance Guidelines for water system components
UPC	Uniform Plumbing Code

1.03 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
 - 1. For each piping system, catalog cuts and other information for pipe, fittings, linings, coatings, cathodic protection, piping identification, and valving to be used for each pipe size category.
 - 2. Certification that each length of pipe has been pressure tested and has satisfactorily passed such tests.
 - 3. Piping layouts and layout schedule showing pipeline locations for all piping systems in that area with respect to structures, other piping and utilities (ductwork, conduits, etc.) and details and location of joints, anchors, fittings, connections, penetrations, supports, seismic restraints (per Section 40 05 42), valves, piping appurtenances, flexible couplings, thermal expansion, cathodic protection equipment, maintenance holes, and clean-outs as applicable. Drawings shall be original layouts by the Contractor; photocopies of Contract Drawings are not acceptable.
 - 4. A copy of all related contract schematic, structural, and mechanical drawings with all piping, foundations, supports, and layout sizes and dimensions requiring Contractor confirmation marked.
 - 5. Locate wire electrical continuity test results.
 - 6. Welding data: see section 05 05 20 Welding.
 - 7. CWI and NDE test reports.

1.04 DEFINITIONS

- A. Pressure terms used in this Section and elsewhere in the technical specifications are defined as follows:
 - 1. Maximum: The greatest continuous pressure at which the piping system operates.
 - 2. Test: The hydrostatic pressure used to determine system acceptance.
 - 3. PSI: Pressure above atmospheric; gauge pressure (PSIG)

1.05 BASIS OF BURIED PIPE DESIGN [NOT USED]

PART 2 PRODUCTS

2.01 MATERIALS

- A. Unless otherwise specified, provide piping materials listed in the PIPESPEC, including pipe, gaskets, fittings, joint assemblies, connections, linings and coatings, conforming to detailed specifications for each type of pipe and piping appurtenance specified in other Sections of Divisions 21, 22, 23, 33, and 40.
- B. Where temporary piping and valving are required, piping material and accessories shall be selected by the Contractor and submitted to the Project Representative for review. Such piping shall be suitable for operation at the test pressure and maximum range of operating service temperature of the permanent piping system which the temporary piping is replacing, as specified in the PIPESPEC. Temporary piping shall be provided with supports at intervals which prevent sagging or liquid accumulation.
- C. Fitting and Coupling Compatibility: To assure uniformity and compatibility of piping components, fittings and couplings for grooved end piping systems shall be furnished by the same manufacturer.

2.02 PIPING IDENTIFICATION

- A. Plastic Coding Markers for exposed pipe:
 - 1. Plastic markers for coding pipe shall comply with ASME A13.1. Markers shall be the precoiled type that is easily removable. Markers shall be resistant to petroleum based oils and grease and shall

meet criteria for humidity, solar radiation, rain, salt-fog, and fungus, as specified by MIL-STD-810 and shall withstand a continuous operating temperature range of - 40 to 250 degrees F. Markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic including directional arrows. Legends and arrows shall be subsurface printed on polyester and overlaminated with Tedlar.

2. Acceptable Manufacturers:
 - a. Marking Services Style MS-995.
 - b. Brady Style B-915.
 - c. Approved Equal.
3. Minimum marker lengths and letter heights:

Outside Diameter of Pipe or Covering	Minimum Length of Marker	Minimum Height of Letters
Less than 1-1/2 inch	8 inch	1/2 inch
1-1/2 to 3 inch	8 inch	1-1/8 inch
Greater than 3 inch	12 inch	2-1/4 inch

- a. Outside diameter shall include insulation and protective wrapping.
 - b. Pipe markers shall include uni- and bidirectional arrows in the same sizes and colors as the legend.
4. Color:
 - a. Background color shall match existing or shall be as specified in the PIPESPEC.
 - b. Legends and arrow color shall match existing or shall be white on blue, black, or red backgrounds; black on all other color backgrounds.

2.03 VALVES

- A. Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non-asbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ASME B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111.
- B. Valve operators: Section 40 05 57.

2.04 PIPE CORROSION PROTECTION

- A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

PART 3 EXECUTION

3.01 GENERAL

- A. Location:
 1. Provide piping as specified except for adjustments to accommodate architectural and structural features.
 2. Coordinate with electrical construction.
- B. Preparation
 1. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.
- C. Potable Water Connections:
 1. Connect potable waterlines in accordance with all municipal codes and ordinances, and laws and regulations of the State and City.
 2. All potable water system components shall utilize lead free materials as defined in accordance with EPA's Safe Drinking Water Act Section 1417 Requirements, effective January 4, 2014. All

products shall meet NSF Standard 61 or NSF Standard 372. Refer to products listed in Annex G of NSF Standard 61 or NSF Standard 372.

D. Pipe Support, Anchorage and Bracing:

1. Support piping by anchor brackets, guides, saddles or hangers.
2. Seismic anchorage and bracing: See Sections 01 73 00 for seismic criteria and 40 05 42.
3. Acceptable types of supports, guides, saddles, hangers and structure attachments for general pipe support, seismic bracing, as well as anchorage details, and expansion/contraction are shown on the Drawings and specified in Section 40 05 41 and 40 05 42.
4. The Drawings do not attempt to show all required supports, hangers, seismic braces, or thermal expansion/contraction methods. These items are shown only where special requirements exist or where necessary to convey a special or particular design intent.
5. Where a specific type of support or anchorage is indicated on the Drawings, then only that type shall be used at that location.
6. Pipe hangers, guides, and saddles are generally not shown on the Drawings.
7. Locations and type of rigid pipe anchorage generally are shown on the Drawings.
8. Where not more specifically shown on the Drawings, minimum spacing and type of pipe support shall be in accordance with Table A/M STD 4005-252, Table B/M STD 4005-253 for general support, and Table C/M STD 4005-401 for seismic bracing.
9. Provide supports on each run at each change of direction.
10. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
11. Anchor piping with flexible connections and/or expansion joints such that the intended uses of these joints are maintained in the piping system.
12. Unless otherwise specified, pipe support and seismic restraint materials of construction shall be as indicated on the Drawings and in Section 40 05 41 and 40 05 42.

E. Anchorage for Buried Piping: [NOT USED]

F. Bedding and Backfill: [NOT USED]

G. Joint and Fitting Options:

1. Pipe connection (joint and fitting) options for a particular piping system shall be as specified on the particular system PIPESPEC sheet.
2. Takedown couplings shall be provided for all piping systems in accordance with Section 40 05 40. Takedown couplings shall be provided around equipment and at standard pipe lengths for all straight runs of pipe.
3. Continuous welding for straight runs of pipe is acceptable only where the individual PIPESPEC sheet allows welding as a connection option.
4. Where connections are shown, the connections shall be specifically where shown; however, if several connection options are allowed for the particular piping system on the PIPESPEC sheet, then any option may be consistently used, for example, if flanged or grooved are acceptable and grooved are shown, then flanged may be substituted.
5. Integrity of rigid, non-rotating connections shall be maintained at all valves and other equipment.

H. Connections to Existing Piping:

1. Isolation valves, as specified in this Section, shall be installed at every location where new pipes connect to existing piping systems.
2. Isolation valves shall be used to minimize existing system shutdowns and existing system interference with new pipeline testing.

3.02 PIPING AND VALVE IDENTIFICATION

A. Pipe Marker Coding:

1. After application of the specified coating and insulation systems, label all exposed piping, including piping in ceiling spaces, pipe trenches, pipe chases and valve boxes with plastic markers as specified.

2. Locate legend markers and directional arrows at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, inside valve boxes and vaults, and at approximately 20-foot centers as required in Part 3.
3. Attach with stainless straps, plastic straps are not acceptable.

B. Valves:

1. Asset Tags per Section 01 78 41 with the specified valve identification.

3.03 PIPE INSTALLATION

A. Protection of Work:

1. Cover openings in piping, and temporarily seal to protect from contamination.
2. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water by using raised platforms.
3. Protect unfinished work at end of each workday from damage, contamination and moisture by use of plugs, caps or covers.
4. Protect piping and valves from damage pending performance of system tests.

B. Installation:

1. Install piping parallel to walls. Clear obstructions, preserve headroom, and keep openings and passageways clear.
2. Should structural difficulties or other work prevent running of pipes or setting of equipment at locations indicated, necessary minor deviations will be allowed, as approved by the Project Representative.
3. Expanding or swaging of tubing to fit IPS fitting sockets will not be permitted.
4. Use reducing fittings where change in pipe size occurs.
5. Use couplings only where required pipe runs between fittings are longer than standard length of pipe being used.
6. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.
7. Make changes in direction only with fittings.
8. Provide expansion loops or bends where indicated to allow for proper pipe expansion. Construct bends with long radius welded fittings.
9. Use proper length bolts for each size flange on flanged connections. Bolts with excessive length of exposed threads will not be permitted. Minimum of 3 full threads shall be exposed beyond nut after tightening assembly.
10. Prevent entry of foreign matter during handling, assembling and installation. Use compressed air, wire brush, solvent and other acceptable means to remove residual scale, dirt and other foreign matter from interior of piping before final connections are made. Protect open ends of pipe by capping, plugging or other acceptable means.
11. Install piping with sufficient pitch to ensure adequate drainage and venting.
12. Provide unions or flanges in piping connections to equipment.
13. Electrically isolate connections between dissimilar metal piping with dielectric couplings or fittings.
14. Install class of piping as indicated.
15. Do not run water piping over electric switchboards, transformers or electric motor starters.
16. Protect against external corrosion pipes which pass through, under or otherwise in contact with soil, cinders, concrete or other corrosive material. Protect by protective wrappings.

C. Sewer and Waste Piping:

1. Run horizontal drainage piping as straight as practicable and at uniform pitch.
2. Install pipe with pitch of not less than 1/4-inch per foot unless otherwise indicated on the Drawings.
3. Install sanitary sewers within or adjacent to any building or structure at slope which will produce computed velocity of not less than 2 feet per second.

D. Cast Iron Soil Piping:

1. For bell and spigot pipe, make joints with neoprene push-on gasket.

2. For neoprene gasketed plain spigot end pipe, insert gaskets, lubricate inside of gaskets and outside of pipe, and join together with suitable tool as recommended by manufacturer.
 3. For hubless pipe, install in accordance with CISPI and government plumbing codes.
- E. Pipe Joints and Connections:
1. Cut pipe with appropriate tool and deburr. Make joints tight. Test and remake leaky joints with new materials. Do not use thread cement or caulking to remake joints. Do not use sharp-toothed wrench in making up brass pipe or chrome-plated items.
 2. Provide thread forms and length in accordance with ASME standards. Use lubricant or sealant on male threads suitable for proposed pipe service.
 3. Clean joint before soldering. Use appropriate flux and alloy for operating temperature level as indicated.
 4. Apply standard rules for welding of pipe joints as contained in ASME B31.3 Normal Fluid Service for pressure piping including welding procedures, qualification of welders and nondestructive weld testing. Follow applicable local safety codes.
 5. Provide gasket coated with recommended lubricant between contact faces of flanges.
- F. Unions, Flanges and Gaskets:
1. Provide unions where indicated and at each threaded or soldered connection to equipment, tanks and valves with the following exceptions:
 - a. Only 1 union is required at each manually operated threaded valve.
 - b. None required at compression stops.
 - c. Locate unions so piping can be easily disconnected for removal of equipment or valve.
 - d. Provide flanges at each flanged connection to equipment and valves. Provide matching flange faces at each connection.
 - e. Tighten fastener system to indicated torque.
- G. Pipe Hangers and Supports:
1. Provide piping systems with anchorages, sway braces, guides and supports as required by applicable portions of ASME B31.3.
 2. Provide support for vertical and horizontal loads, including vibration imposed loads.
 3. Necessary hangers and supports including beam and purlin clamps, rods, pipe rolls, angles, channels and plates as well as any changed from indicated design, shall have prior approval of the Project Representative.
 4. Use of building structural steel for supporting hangers will be permitted only where indicated or approved by Project Representative.
 5. Do not weld transversely across tension flange or any member under stress, use bracing, girts and other secondary members for support, nor burn or drill holes in building steel.
 6. Support vertical piping with approved steel brackets to prevent swaying, sagging, vibration and resonance.
 7. Allow for thermal expansion between supports or anchors.
 8. Do not use flat steel strap hangers.
 9. Do not support piping by wire, rope, strap, chain, wood or similar devices.
 10. Provide pipe hangers of same size, or nearest commercial size available, as pipe or tubing on which they are to be used. Allow for thickness of insulation in sizing hangers.
 11. Supporting structures, including supporting frames, anchors and guides common to mechanical and electrical work, shall be submitted and have the prior approval of the Project Representative.
 12. Use adjustable iron hangers for 1¼-inch and smaller pipe, and clevis type for 1½-inch and larger pipe. Where copper tubing is directly supported, use copper-plated hangers.
 13. Protect dissimilar metals by wrapping pipe with 1/16 inch thick neoprene.

3.04 TESTING

A. General:

1. Upon completion of piping, but prior to application of insulation on exposed piping, test the piping systems.
2. Pressures, media and test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated.
3. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range.
4. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.
5. Notify the Project Representative at least 24 hours prior to each test.
6. Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve.
7. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. Gas and Air Systems:

1. The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include propane and sludge (digester) gas systems. Unless otherwise specified for each pipe system, the allowable leakage rate for other systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure.

C. Liquid Systems:

1. Testing medium and procedures for hydraulic and lube oil systems.
2. The allowable leakage rate for other systems shall be zero at the specified test pressure throughout the specified duration.

D. Chlorine and Sulfur Dioxide Systems: (NOT USED)

E. Hydraulic and Lube Oil Systems: [NOT USED]

F. Refrigerant Systems: Test with the refrigerant for which it is intended.

G. Drains: Drain systems, other than pumped drain systems, shall be tested in accordance with UPC.

3.05 HYDROSTATIC TESTING OF PIPELINES AND APPURTENANCES

- A. Water for testing pipelines shall be furnished by the Contractor. Be responsible to convey the water from the source to the points of use.
- B. Submit per Section 01 33 00 a testing plan and schedule, including method for water conveyance, control, and disposal, and disinfection (if applicable).
- C. Pressure pipelines shall be tested; those for potable water shall be disinfected, chlorinating and testing operations shall be performed in the presence of the Project Representative. Meet the requirements of the AHJ.
- D. Disposal of flushing water and water containing chlorine shall be in accordance with Section 31 25 40.
- E. Determine and select test equipment, temporary valves, bulkheads, and other water control equipment.

- F. Pipeline 24-inches diameter and larger shall be video inspected in accordance with Section 33 01 30.11 prior to hydrostatic testing.
- G. Prior to hydrostatic testing, pipelines shall be flushed.
- H. Test pipelines in sections not to exceed one mile in length.
- I. Test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water.
- J. Be responsible for ascertaining that test bulkheads, valves, concrete thrust blocking or other means of restraint are suitable to resist the thrust of the test pressure without damage to or movement of the adjacent pipe.
- K. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment.
- L. Remove or protect pipeline-mounted devices that may be damaged by the test pressure.
- M. Provide sufficient means to allow trapped air to exit. Air relief valves shall be open during pipeline filling.
- N. Pipeline shall be filled at a rate which will not cause surges or exceed the rate at which the air can be released through the release valves.
- O. Air within the pipeline shall be allowed to escape completely.
- P. Differential pressure across the orifices in the air release valves shall not be allowed to exceed five psi at any time during filling.
- Q. After the pipeline has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining to absorb water and to allow the escape of air from air pockets.
- R. During this period, bulkheads, valves, and connections shall be examined for leaks.
- S. If leaks are found, corrective measures satisfactory to the Project Representative shall be taken.
- T. Hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of four hours.
- U. Test pressure for piping shall be as specified in the PIPESPEC for the type and size of piping being tested.
- V. Test pressure shall be achieved for all elevations along the pipeline.
- W. No pressure test will be required for a reservoir overflow line.
- X. Leaks that appear during testing shall be repaired in a manner acceptable to the Project Representative. If a leak in buried pipeline is detected, it shall be excavated, located, repaired and retested until pipeline passes the pressure test requirements.
- Y. Add water to restore the test pressure if the pressure decreases five psi below test pressure during the test period.

- Z. Connection to the existing wastewater system shall be made following successful completion of hydrostatic testing.

3.06 CLEANING AND FLUSHING

A. General:

1. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating, or instrumentation equipment.
2. The Contractor may, at its option, clean and test sections of buried or exposed piping systems.
3. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system.
4. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab. Upon completion of the cleaning, connect the piping systems to related equipment and structures.

B. Temporary Screens:

1. Upon completion of the cleaning, connect the piping systems to related process equipment and structures. Temporary screens, provided with locator tabs which remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 to 1	1/16
1-1/4 to 3	1/4
3-1/2 to 6	1/2
over 6	1

2. Maintain the screens during testing, initial start-up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. Remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation.
3. Systems handling solids are exempt.

C. Gas and Air Systems:

1. Unless otherwise specified, gas and air system piping 6 inches in diameter and smaller shall be blown out, using air or the testing medium specified.
2. Piping larger than 6 inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe.
3. After connection to the equipment or structure, it shall then be blown out using the equipment.
4. Upon completion of cleaning, the piping shall be drained and dried with an air stream.
5. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 PSI until put in service.

D. Liquid Systems:

1. After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water.
2. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens.

E. Chlorine and Sulfur Dioxide Systems: (NOT USED)

F. Steam Systems: (NOT USED)

G. Hydraulic and Fluid Power Oil Systems: (NOT USED)

H. Potable Water Systems:

1. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C600 and C651.

3.07 PIPING SPECIFICATION SHEETS (PIPESPEC)

- A. Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets. Piping systems are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of systems is identified by a piping system number. Piping systems specified and shown on the Drawings are arranged by designated symbols (abbreviations as shown in Table A and B below). Tables also indicates the system number, fluid category, and pipe marker background color of each service.
- B. Unless otherwise shown on Drawings or Drawing schedule, piping system materials, fittings and appurtenances are subject to requirements of specific piping specification sheets.

TABLE A: PROCESS AND FACILITY PIPING SYSTEMS

Symbol	Service	System	Fluid Category	Pipe Marker
AS	Starting Air	2	Air	Orange
CD	Condensate Drain	24	Water	Green
ASG	Auxiliary Sludge Gas	11	Gas	Yellow
D	Drain	24	Drain/Vent	Green
DR	Process Drain	24A	Drain/Vent	Green
ECW	Emergency Cooling Water	10	Water	NA
ECWD	Emergency Cooling Water Drain	10	Water	NA
EE	Engine Exhaust	31	High Temperature Gas	Yellow
FP	Fire Protection	per Section 21 13 00	Water	White
FV	Fuel Vent	18	Petroleum	White
HRS	Heat Reservoir Supply	8	Water	Red
HRR	Heat Reservoir Return	8	Water	Red
HRWR	Heat Recovery Water Return	8	Water	Green
HRWS	Heat Recovery Water Supply	8	Water	Green
HWS	Heating Water Supply	8	Water	Green
HWR	Heating Water Return	8	Water	Green
IA	Instrument Air	2	Air	Orange
JWR	Jacket Water Return	8	Water	
JWS	Jacket Water Supply	8	Water	
LOR	Lube Oil Return	18	Petroleum	White
LOS	Lube Oil Supply	18	Petroleum	White
LSG	Low (Pressure) Sludge Gas	11	Gas	Yellow
MPG	Medium Pressure (Sludge) Gas	11	Gas	Yellow
MPGV	Medium Pressure (Sludge) Gas Vent	11	Gas	Yellow
P	Propane	5	Gas	Yellow
PD	Pumped Drainage	12	Wastewater	Green

Symbol	Service	System	Fluid Category	Pipe Marker
PHW	Primary Heating Water	8	Water	Red
RD	Roof Drain	24	Drain/Vent	Green
RG	Refrigerant Gas	7	Refrigerant	Yellow
RL	Refrigerant Liquid	7	Refrigerant	Yellow
RS	Raw Sewage	12	Wastewater	Green
SA	Service Air	2	Air	Orange
SAM	Sample	34	Wastewater	Purple
SD	Sanitary Drain	24	Drain/Vent	Green
SHW	Secondary Heating Water	8	Water	Red
STD	Storm Drain	24	Drain/Vent	Green
V	Vent	24	Drain/Vent	Yellow
VP	Vent, Propane Gas	5	Gas	Yellow
VP	Vent, Petroleum	18	Petroleum	White

TABLE B: UTILITY WATER SYSTEMS

Symbol	Service	System	Fluid Category	Pipe Marker
C1	Domestic Potable Water	7A	Water	Blue
C2	Nonpotable Water City Water	7	Water	Green
C3	C3 Water	7	Water	Green
CW	City Water	7A	Water	Blue
DH	Potable Hot Water	7A	Water	Green
SW	C2 Seal Water	7	Water	Green

3.08 PIPING SYSTEM 2

Piping Symbol / Service:	IA – Instrument Air SA – Service Air AS – Starting Air
<u>Test Requirements:</u>	
Test Medium:	Water. Ref. Section 40 05 01
Test Pressure:	200 PSI
Duration:	120 minutes
Leakage:	Zero. Ref. Section 40 05 01
<u>Gasket Requirements:</u>	
Flanged:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
Push on/Mechanical coupling:	N/A
<u>Exposed Pipe and Valves in Process Corrosive Areas:</u>	(See Drawings for pipe size and valve type)
(2 1/2" and smaller)	
Pipe:	Stainless Steel: ASTM A312, Type 316 Schedule 40S. Seamless. Ref. Section 40 05 23. Connections: threaded, ASME B1.20.1. See Remarks 6 and 7. Fittings: ASTM A403, ends and wall thickness to match pipe.
Valves:	Ball: Nibco T-560-S6-R-66-FS-LL, or approved equal.
<u>Exposed Pipe and Valves in Areas other than Process Corrosive Areas:</u>	(See Drawings for pipe size and valve type)
(1/2" and smaller)	
Pipe:	Copper tube: ASTM B88, Type L, drawn. Ref. Section 40 05 17. See notes. Connections: solder type Fittings: wrought copper or bronze, ASME B16.22
Valves:	Ball: Nibco T-585-70-66, Apollo 77-140, Crane Fig. 93303-S, or approved equal. Globe: Crane 7TF or 17TF, Lunkenheimer 123 or 214, or approved equal. Lift Check: Lunkenheimer 1616, Crane 366E, or approved equal.
(3/4" through 2")	
Pipe:	Copper tube: ASTM B88, Type L, drawn. Ref. Section 40 05 17. See notes. Connections: solder type. Fittings: wrought copper or bronze, ASME B16.22
Valves:	Ball: Nibco T-585-70-66, Apollo 77-140, Crane Fig. 93303-S, or approved equal. Globe: Crane 7TF or 17TF, Lunkenheimer 123 or 214, or approved equal. Lift Check: Lunkenheimer 1616, Crane 366E, or approved equal.

(2 1/2" through 6")	
Pipe:	<p>Steel: ASTM A53, ERW, Grade B, black, no lining. Ref. Section 40 05 24.</p> <p>Connections: Butt weld, flanged for valves.</p> <p>Fittings: Steel, ASTM A234, ASME B16.9; ends to match pipe.</p>
Valves:	<p>Ball: Jamesbury 5150-31-2200TT, Nibco F-510, or approved equal.</p> <p>Check: Ported plate style designed for use with pulsating flow; Hoerbiger Depend-A-Check or Compact-A-Check, Dienes Type DL-RF, or approved equal.</p>
<u>Bubbler Tube and Valves:</u>	
Tubing and Valves:	Ref. Section 40 70 10.
<u>Buried and Encased Pipes and Valves:</u>	NOT USED
<p>Remarks:</p> <ol style="list-style-type: none"> 1. Piping between compressors and aftercoolers shall be insulated in accordance with Section 40 42 00. 2. Lateral connections shall be made in the top half of the main line. Provide drip legs with valves at low points in the piping system. 3. Combination filter/regulator with gauge shall be Balcrank BC 820283, or approved equal, 0-175-psig reduced pressure range, 175-psi-maximum supply pressure, 120 degrees F maximum operating temperature, metal bowls, sight-glass, 0-200-psi pressure gauge, automatic filter drain. Size and location shall be as shown on Drawings for all compressed air stations. 4. Quick-connect coupling shall be Dixon Air King, or approved equal. 5. Pipe joints shall be welded except where connections to valves or flanged appurtenances and as required by installation constraints. 6. Provide NPT union couplings spaced approximately 10 feet apart for future disassembly. 	

3.08 PIPING SYSTEM 5

Piping Symbol/Service:	P- Propane VPG – Vent Propane Gas
<u>Testing Requirements:</u>	
Medium:	Water.
Pressure:	25 PSI
Duration	120 minutes
Allowable leakage:	Zero. Reference this Section for leakage testing requirements
<u>Gasket Requirements:</u>	
Flanged:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push on/Mechanical Coupling:	N/A
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(2" and smaller)</u>	
Pipe:	Steel: ASTM A106, seamless, Grade B, black, no lining. Ref. Section 40 05 24. Connections: butt weld, threaded (ASME B1.20.1), or flanged couplings where specified or indicated on the Drawings. Note: Threaded connections prohibited on piping connected to hot water boilers. Flexible connections are required where boiler skid is connected to building. Fittings: malleable iron, ASTM A197, ASME B16.3, Class 150; ends to match pipe.
Valves:	Ball: Jamesbury fig. 351, Nibco T-580 BR, or approved equal. Globe: Crane 229C, NIBCO T-2554, Hammond IB420, or approved equal. Lift Check: Crane 366E, Lunkenheimer 1616, or approved equal.
<u>(2 1/2" through 8")</u>	
Pipe:	Steel: ASTM A53, seamless, Grade B, black, no lining. Ref. Section 40 05 24. Connections: butt weld, flanged for valves. Flexible connections are required where boiler skid is connected to building. Fittings: steel, ASTM A234, ASME B16.9; ends to match pipe.
Valves:	Lubricated Plug through 5": cast iron, flanged, Teflon or molydisulfide coated plug, Rockwell Fig. 143, Walworth Fig. 1797F, or approved equal, thru 5 inch; worm gear operator. Lubricated Plug 6" through 8": Rockwell Fig. 149, Walworth Fig. 1727F, or approved equal, 6 to 8 inch. Butterfly: ref. Section 40 05 64. Check: Pennsylvania Aircheck, Hoerbiger, or approved equal.

<u>Buried and Encased Pipe and Valves:</u>	NOT USED

3.08 PIPING SYSTEM 7A

Piping Symbol / Service:	C1 – Potable Water CW – City Water DH – Potable Hot Water
<u>Test Requirements:</u>	
Medium:	Water - Ref. this Section.
Pressure:	150 PSI
Duration:	120 minutes
<u>Exposed Pipes and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(3" and smaller)</u>	
Pipe:	All materials shall be lead free per EPA SDWA and NSF/ANSI Standards 61 or 372. Copper tube: ASTM B88, Type L, drawn. Ref. Section 40 05 17. Connections: solder type Fittings: wrought copper or bronze, ASME B16.22. Pipe Insulation: Ref. Section 40 42 00
Valves:	All materials shall be lead free per EPA SDWA and NSF/ANSI Standards 61 or 372. Ball: Nibco T-585-70-66, Apollo 77-140, Jamesbury Fig. 351, or approved equal. Gate: Nibco T-113, Crane Fig. 1701, or approved equal. Globe: Crane 7TF or 17TF, Lunkenheimer 123 or 214, or approved equal. Swing Check: Crane 137, Lunkenheimer 230, or approved equal.

3.08 PIPING SYSTEM 7

Piping Symbol / Service:	C2 – Nonpotable City Water C3 – Process Water RG – Refrigerant Gas RL – Refrigerant Liquid SW – Seal Water
<u>Test Requirements:</u>	
Medium:	Water. Ref. This Section. Refrigerant. Ref. This Section
Pressure:	150 PSI. See Remarks for Seal Water
Duration:	120 minutes
<u>Gasket Requirements:</u>	
Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
Push-On/Mech Cpl:	EPDM or neoprene
<u>Exposed Pipes and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(3" and smaller)</u>	
Pipe:	Copper tube: ASTM B88, Type L, drawn. Ref. Section 40 05 17. Connections: solder or brass compression fitting. Fittings: wrought copper or bronze, ASME B16.22. Pipe Insulation: Ref. Section 40 42 00
Valves:	Ball: Nibco T-585-70-66, Apollo 77-140, Crane Fig. 93303-S, Jamesbury Fig. 351, or approved equal. Gate: Nibco T-113, Crane Fig. 1701, or approved equal. Globe: Crane 7TF or 17TF, Lunkenheimer 123 or 214, or approved equal. Swing Check: Crane 137, Lunkenheimer 230, or approved equal. Needle: Crane D71, Lunkenheimer 906, or approved equal. Pressure Regulating: See Section 40 05 72.
<u>(4" through 8")</u>	
Pipe:	Steel: ASTM A53, seamless, Grade B, black, with epoxy lining. Ref. Section 40 05 24. Connections: grooved, mech pipe coupling, or flanged. Fittings: malleable iron, ductile iron, or steel per Section 40 05 24; ends to match pipe. Pipe Insulation: Ref. Section 40 42 00
Valves:	Butterfly: with traveling nut, rack and pinion, or worm gear type operator per Section 40 05 64. Swing Check: spring loaded per Section 40 05 65.23.
<u>(10" and larger)</u>	

Pipe:	<p>Steel: same as 8", or AWWA C200, 1/4-inch thick, with epoxy lining. Ref. Section 40 05 24.</p> <p>Connections: mech pipe coupling, or flanged. See Remarks.</p> <p>Fittings: steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.</p>
Valves:	<p>Butterfly: ref. Section 40 05 64.</p> <p>Swing Check: spring loaded per Section 40 05 65.23.</p>
<u>Buried and Encased Pipes and Valves:</u>	[NOT USED]
<p>Remarks:</p> <ol style="list-style-type: none"> 1. Seal Water test pressure shall be 50 PSI more than maximum system pressure of the process fluid pumped by the pump requiring seal water, but no less than 150 PSI. 2. Manual air vents shall be provided at the high points and manual drains shall be provided at the low points of each reach of pipeline as specified in this Section and/or shown on the Drawings. 3. Piping installed over suspended ceilings shall be insulated for condensation control in accordance with Section 40 42 00. 4. See Section 40 06 22 for requirements for Seal Water valves. 	

3.08 PIPING SYSTEM 8

Piping Symbol/Service:	HRR – Heat Reservoir Return HRS – Heat Reservoir Supply HWS – Heating Water Supply HWR – Heating Water Return JW – Jacket Water PHW – Primary Heating Water SHW – Secondary Heating Water
<u>Test Requirements:</u>	
Medium:	Water. Ref. Section 40 05 01
Pressure:	75 PSI
Duration:	120 minutes
<u>Gasket Requirements:</u>	
Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
Push-on/Mech Cpl:	EPDM
<u>Exposed Pipes and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(2" or smaller)</u>	
Pipe:	Copper tube: ASTM B88, Type L, drawn. Ref. Section 40 05 17. Insulation per Section 40 42 00. Connections: solder type Fittings: wrought copper or bronze, ASME B16.22. Insulation per Section 40 42 00. (See Remarks)
Valves:	Ball: Jamesbury Fig. 351, Nibco T-580 or approved equal. Insulate. Globe: Crane 7TF or 17TF, Lunkenheimer 123 or 214 or approved equal. Insulate. Swing Check: Crane 137, Lunkenheimer 230 or approved equal. Insulate (See Remarks).
<u>(2 1/2" and larger)</u>	
Pipe:	Steel: ASTM A53, seamless, Grade B, Type E or S, no lining. Ref. Section 40 05 24. Insulation per Section 40 42 00. Connections: butt weld, grooved, mechanical joint coupling, or flanged. Insulate per Section 40 42 00. (See Remarks) Fittings: malleable iron, ductile iron, or steel per Section 40 05 24; ends to match pipe. Insulation per Section 40 42 00. (See Remarks) Coatings: Ref. Section 09 90 00, type B-1 or C-1 depending on exposure.
Valves:	Butterfly: ref. Section 40 05 64. Insulate. (See Remarks)
	Swing Check: spring loaded per Section 40 05 65.23. Insulation per Section 40 05 65.23. (See Remarks)
<u>Buried and Encased Pipe and Valves:</u>	(NOT USED)
Remarks:	

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in Section 40 05 47
2. For exposed HRWR and HRWS, insulation is not required.
3. Refer to Drawings for locations of expansion loops or joints. Refer to specification Section 40 05 44 for expansion joints.
4. Coat steel piping that is insulated, except for temporary jacket water piping, in accordance with Section 09 06 90.

3.08 PIPING SYSTEM 10

Piping Symbol/Service:	ECW – Emergency Cooling Water ECWD - Emergency Cooling Water Drain
<u>Test Requirements:</u>	
Medium:	Water. Ref. Section 40 05 01
Pressure:	175 PSI (ECW), 10 PSI (ECWD)
Duration:	120 minutes
<u>Gasket Requirements:</u>	
Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
<u>Exposed Pipes and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(2" and larger)</u>	
Pipe (ECW & ECWD):	PVC: ASTM D1784, Class 12454-B, ASTM D1785, Sch. 40. Ref. Section 40 05 31. Connections: solvent weld with flanged adapters for valves. Fittings: PVC, Sch. 40, socket weld. Ref. Section 40 05 31.
Pipe (ECW):	HDPE: High Density Polyethylene Pipe, Ref. Section 40 05 33. Connections and fittings as specified in Section 40 05 33.
Valves:	Ball (2" and smaller): ASTM D1784, Type I, Grade 1 PVC, double union; Nibco, Chemtrol Tru-Bloc; ASAHI/America, Type 21; Spears, or approved equal. True Union. Butterfly (larger than 2"): Ref. Section 40 05 64.
Remarks: 1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in Section 40 05 47.	

3.08 PIPING SYSTEM 11

Piping Symbol/Service:	MPG –Medium Pressure (Sludge) Gas [also called MSG] ASG – Auxiliary Sludge Gas [also called EGG] MPGV – Medium Pressure Gas Vent
<u>Testing Requirements:</u>	
Medium:	Air
Pressure:	15 PSIG for MPG (minimum in accordance with IFCG) and MPGV 120 PSIG for ASG (for operating at compressor MAWP of 80 psig)
Duration	120 minutes
Allowable leakage:	Zero. Reference this section for leakage testing requirements.
<u>Gasket Requirements:</u>	
Flanged:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push on/Mechanical Coupling:	N/A
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(2-1/2" and smaller)</u>	
Pipe:	Stainless Steel: ASTM A312, Type 316 Schedule 40S. Seamless. Ref. Section 40 05 23. Connections: butt weld, threaded (ASME B1.20.1) or flanged couplings where specified or indicated on the Drawings. See Remark 2. Threaded connections are prohibited on piping connected to hot water boilers. Flexible connections are required where boiler skid is connected to building. Fittings: ASTM A403, ends and wall thickness to match pipe.
Valves:	Ball: Nibco T-560-S6-R-66-FS-LL, or approved equal. Automatic Drain Trap: Shand & Jurs 97110-12, 5psi, 316 SST body, 2 quart capacity with neoprene gasket or approved equal. Isolate during LSG pipe testing.
<u>(3" and larger)</u>	
Pipe:	Stainless Steel: ASTM A312, Type 316L, Schedule 10S, Seamless. Ref. Section 40 05 23. Connections: butt weld or flanged couplings where specified or indicated on the drawings. Flexible connections are required where boiler skid is connected to building. See Remark 2. Fittings: ASTM A403, ends and wall thickness to match pipe.
Valves:	Butterfly: Ref. Section 40 05 64.

Remarks:

1. Lower test pressure at locations where noted.
2. Pipe joints shall be welded except where connections to valves or flanged appurtenances and as required by installation constraints.
3. Piping System 11 is classified as ASME B31.3 – Normal Piping category fluid service.
 - a) Do not install expansion joints during times of extreme temperature or in a fully compressed or fully expanded condition.
 - b) Align piping systems prior to installation of expansion joints, and do not use expansion joints to correct piping misalignment during installations.
 - c) Expansion joints shall be preset at the factory for rated axial compression and expansion. Install the expansion joints at the factory preset condition.

3.08 PIPING SYSTEM 12

Piping Symbol/Service:	PD – Pumped Drainage RS – Raw Sewage
<u>Test Requirements:</u>	
Medium:	Water. Ref. Section 40 05 01
Pressure:	175 PSI
Duration:	120 minutes
<u>Gasket Requirements:</u>	
Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
Push-on/Mech Cpl:	Nitrile or Neoprene.
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(2 1/2" thru 12")</u>	
Pipe:	Steel: ASTM A53 ERW, Grade B, Type E or S, epoxy lining. Ref. Section 40 05 24. Connections: grooved mech pipe coupling or flanged. Fittings: malleable iron, ductile iron, or steel per Section 40 05 24; ends to match pipe.
Valves:	Eccentric Plug: Per Section 40 05 62. Install valve with seat upstream. Swing Check: spring loaded per Section 40 05 65.23.
<u>(14" thru 36")</u>	
Pipe:	Steel: same as 12 inch, or AWWA C200, 1/2 inch thick, epoxy lined. Ref. Section 40 05 24 Connections: mech pipe coupling or flanged. See Remarks. Fittings: steel, ASTM A234, or fabricated steel, AWWA C208; lining and ends to match pipe.
Valves:	Eccentric Plug: ref. Section 40 05 62. Swing Check: spring loaded per Section 40 05 65.23.
<u>(54")</u>	
Pipe:	Steel: AWWA C200, 1/2 inch thick, lining per 09 06 90 (A-4) for new pipe, lining per 09 06 90 (A-4, A-5) for existing pipe. Ref. Section 40 05 24 Connections: grooved end couplings or flanged. Fittings: fabricated steel, AWWA C208; lining and ends to match pipe.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in Section 40 05 47.
2. Valves for tank drain lines shall be provided where indicated on the Drawings. Eccentric plugs, slide gates, or mud valves shall be as specified in Sections 40 05 62, 40 05 59.33, or 40 05 72, respectively. Testing for tank drains shall be in accordance with the Uniform Plumbing Code.
3. Grooved mechanical pipe couplings, 10 to 24 inch size, may be used with standard weight or heavier pipe. Grooved or shouldered mechanical pipe couplings are permitted with fabricated pipe if the rated working pressure of the coupling exceeds the specified test pressure. Butt weld connections are not permitted with lined pipe.

3.08 PIPING SYSTEM 18

Piping Symbol/Service:	LOR – Lube Oil Return LOS – Lube Oil Supply VP – Petroleum Vent
<u>Test Requirements:</u>	
Medium:	Lube oil and fuel oil (fuel piping, pressure piping, vents). Ref. spec Section 40 05 01.
Pressure:	150 PSI (fuel piping, pressure piping) 5 PSI (secondary containment piping, non-pressure piping)
Duration:	60 minutes
Allowable leakage:	Zero. Ref. spec Section 40 05 01.
<u>Gasket Requirements:</u>	
Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and nitrile binder.
Push-On/Mcl Cpl:	N/A
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
(2" and smaller)	
Pipe:	Steel: ASTM A106, seamless, Grade B, Sch. 40, pickled, oiled and capped. Ref. spec Section 40 05 24. Connections: threaded or socket end with threaded adapters for valves. Fittings: forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled and oiled. Unions: flat faced O-ring type with Buna-N O-ring
Valves:	Lubricated plug: cast iron, PTFE coated plug, Nordstrom Fig. 142, Walworth Fig. 1796, or approved equal. Lift check: Crane 27TF, Lunkenheimer 231, or approved equal. Thermal link actuated shut off valve: UL listed, for closure at 165 degrees F. Factory Mutual approved, carbon steel body, non-venting for fuel oil service, NPT connections. Morrison Bros. Co., Cashco, Inc., Essex Industries, Inc., or approved equal.
(2 1/2" thru 12")	
Pipe:	Steel: ASTM A53, seamless, Grade B, pickled, oiled and capped. Ref. spec Section 40 05 24. Connections: butt weld, flanged for valves. Fittings: steel, ASTM A234, seamless, ANSI B16.9, pickled; ends shall match pipe.
Valves:	Lubricated plug: cast iron with PTFE or molydisulfide coated plug; Rockwell Fig 143, Walworth Fig. 1797F, or approved equal, thru 5 inch. Rockwell Fig. 149, Walworth Fig. 1727F, or approved equal, with worm gear operator, 6 to 12 inches. Swing check: cast iron, flanged, Jenkins 1025-B2, Walworth 5344F, or approved equal.
<u>Buried and Encased Pipe and Valves:</u>	[NOT USED]

Remarks:

1. The cleaning (pickling) solution used shall comply with Mil-H-13528B. Immediately following pickling and rinsing procedures, steel pipe and fittings shall be coated inside and outside with a rust and corrosion preventative system, and the ends sealed to prevent the entry of dirt.
2. Low pressure air testing of approximately 5 PSI is allowed for testing the secondary containment piping. Test boots shall be installed at both ends of double containment pipe for testing, as shown on the Drawings.
3. Outdoor exposed piping, except FV piping, shall be insulated, heat traced and aluminum jacketed per Spec Section 40 42 00 and 40 41 00.
4. Install unions or flanges immediately downstream or upstream of the equipment and valves.

3.08 PIPING SYSTEM 24

Piping Symbol/Service:	D – Drain CD – Condensate Drain (see Remarks) STD – Storm Drain SD – Sanitary Drain RD – Roof Drain V – Vent
<u>Test Requirements:</u>	
Medium:	The applicable section of current Uniform Plumbing Code.
Pressure:	The applicable section of current Uniform Plumbing Code.
Duration:	The applicable section of current Uniform Plumbing Code.
<u>Gasket Requirements:</u>	
Flange:	Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder.
Push-on/Mech Cpl:	Nitrile or neoprene.
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
(1-1/2" thru 12")	
Pipe:	Cast iron soil pipe (CISP): ASTM A74. Connections: service hub and spigot compression type or hubless cast iron sanitary system per CISPI 301. Fittings: CISP, ASTM A74, joint options to match pipe. Coatings: Ref. Section 09 90 00, type B-1 or C-1 depending on exposure.
Valves:	None
<u>Encased Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
(12" and smaller)	
Pipe:	Cast iron soil pipe (CISP): same as exposed. Coating: Bituminous.
Valves:	None
Remarks:	1. HVAC equipment condensate drains shall be copper tube; ASTM B88, Type M, drawn. Fittings shall be wrought copper or bronze, ASME B16.22. Connections shall be solder type with threaded adapters for equipment connections where required. Products and fabrication shall be as specified in Section 40 05 17.

3.09 PIPING SYSTEM 24A

Piping Symbol/Service:	DR – Process Drain
<u>Test Requirements:</u>	
Medium:	The applicable section of current Uniform Plumbing Code.
Pressure:	The applicable section of current Uniform Plumbing Code.
Duration:	The applicable section of current Uniform Plumbing Code.
<u>Gasket Requirements:</u>	
Flange:	Rubber or Neoprene
Push-on/Mech Cpl:	Neoprene, ASTM F477
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(all sizes)</u>	
Pipe:	PVC Pressure Pipe: Schedule 40. Connections: solvent weld with chemical resistant primer/solvent. Fittings: Solvent welded socket type complying with ASTM D2466.
<u>(3" through 12")</u>	
Valves:	Ball: Ref. Section 40 05 72. Diaphragm: Ref. Section 40 05 72.

3.08 PIPING SYSTEM 31

Piping Symbol/Service:	EE – Engine Exhaust
<u>Test Requirements:</u>	No visible or detectable fumes or odors inside structures.
Medium:	Engine exhaust
Pressure:	None
Duration:	15 min (after full and stable operating temperature is reached)
<u>Gasket Requirements:</u>	
Flange:	Flat, full-face, graphoil suitable for temperatures to 1200 degrees F.
Push-on/Mech Cpl:	N/A
<u>Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(all sizes)</u>	
Pipe:	Stainless Steel: ASTM A312, Type 316L seamless, Schedule 10S. Connections: butt weld, flanged for equipment connections. Fittings: ASTM A403, material, thickness, and end connections to match pipe.
Remarks: <ol style="list-style-type: none">1. Pipe, fittings, and engine silencer shall be insulated with high temperature removable, flexible blanket type insulation per Section 40 42 00. Insulation at silencer access ports shall be designed for easy and more frequent removal.2. Welding shall be done in accordance with Part 3, Section 40 05 23.3. Testing shall be done prior to installation of insulation.4. Coat insulated portions of permanent engine exhaust piping for the standby generator engine in accordance with Section 09 06 90.	

3.08 PIPING SYSTEM 34

Piping Symbol/Service	SAM – Sample
<u>Test Requirements:</u>	
Medium:	Water. As specified in this Section.
Pressure:	150 PSI
Duration:	120 minutes
Allowable Leakage:	Zero
<u>Gasket Requirements:</u>	
Flange:	Rubber or Neoprene
<u>Indoor Exposed Pipe and Valves:</u>	(See Drawings for pipe size and valve type)
<u>(All sizes)</u>	
Pipe:	PVC Pressure Pipe: Schedule 80. Connections: solvent weld with chemical resistant primer/solvent. Fittings: Solvent welded socket type complying with ASTM D2466. Lining: none. Coating: Ref. Section 40 05 31.
Valves:	Ball: Ref. Section 40 05 72. Diaphragm: Ref. Section 40 05 72. Plug: Ref. Section 40 05 62. Swing Check: 40 05 65.23.

END OF SECTION

SECTION 40 05 17

COPPER PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies copper pipe, tubing, and fittings.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.22	Wrought-Copper and Copper-Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast-Copper Alloy Fittings for Flared Copper Tubes
ASME B1.20.1	Pipe Threads, General Purpose
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube
EPA SDWA Section 1417(d)	Reduction of Lead in Drinking Water Act Requirements, Amendments to Safe Drinking Water Act (SDWA), Effective January 4, 2014
NSF/ANSI Standard 61	Health effects criteria (Lead Content Compliance for water system components)
NSF/ANSI Standard 372	Lead Content Compliance Guideline for water system components

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's product data and catalog cuts.

PART 2 PRODUCTS

2.01 PIPE

- A. Seamless copper tubing, ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.
- B. All potable water system components shall utilize lead free materials in accordance with EPA's Safe Drinking Water Act Section 1417 Requirements, effect January 4, 2014. All produces shall meet NSF/ANSI Standard 61 or NSF/ANSI Standard 372. Refer to product listed in Annex G of NSF/ANSI Standard 61 or NSF/ANSI Standard 372.

2.02 CONNECTIONS

- A. Solder-type with taper threaded adapters for valves and other appurtenances. Taper threads shall comply with ASME B1.20.1
- B. Solder: 95-5 tin-antimony, ASTM B32, Grade 95TA. Do not use cored solder.

- C. Thread Lubricant and Seal:
 - 1. Compressed air: Teflon tape
 - 2. Water: Teflon tape.

2.03 COUPLINGS AND FITTINGS

- A. 1/2-inch and larger nominal diameter: wrought copper or bronze, solder joint pressure fittings, complying with ANSI B16.22.
- B. Piping reducers/enlargers shall be tapered. Bushing type adapters are not permitted.

2.04 DIELECTRIC WRAP

- A. 1/16-inch thick neoprene pad bonded to copper pipe; length of pipe support or shield, as applicable.

PART 3 EXECUTION

3.01 FABRICATION

- A. Solder Joints:
 - 1. Cut tubing square and remove burrs.
 - 2. Immediately before soldering, clean both inside of fittings and outside of tubing with steel wool until bright.
 - 3. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined prior to soldering.
 - 4. Apply solder and pass flame toward the center of the fitting until the solder disappears.
 - 5. Remove all excess solder while still plastic.
 - 6. Do not use acid flux or acid wipe in making solder joints.
 - 7. Take care to prevent overheating.
- B. Takedown Couplings: screw union type.
 - 1. Where piping passes through walls or floors, takedown couplings shall be provided on both sides of the wall or floor and within two feet of the wall or floor.
 - 2. A takedown coupling shall be provided within two feet of each threaded end valve or appurtenance.
- C. Dielectric Protection:
 - 1. Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location.
 - 2. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements.
 - 3. Wherever electrical contact is demonstrated by such tests, provide dielectric connection per Section 40 05 40.
 - 4. Where copper pipe is supported, insulate the pipe system from the hangers or support; or provide dielectric wrap per Section 40 05 41.

3.02 REPAIR

- A. Patching inserts, overlays, or pounding out of dents will not be permitted.
- B. Remove damaged ends as a cylinder and the section end properly prepared.

3.03 CLEANING

- A. Clean the interior of the pipe by swabbing.

3.04 TESTING

- A. As specified in Section 40 05 01.

END OF SECTION

SECTION 40 05 23

STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies stainless steel pipe, tubing, and fittings for ordinary service. High temperature stainless steel piping for engine exhaust is specified in PIPESPEC System 31 in Section 40 05 01.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI/ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded.
ASME BPVC Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A182	Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High-Temperature Service, or Both
ASTM A276	Stainless Steel Bars and Shapes
ASTM A312	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A380	Clearing, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems
ASTM A403	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
AWS D18.2	Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. The following information shall be provided:
1. Shop fabrication drawings showing: details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.
 2. Other data necessary to show conformance of the complete piping system to these specifications.
 3. Mill certificates.
 4. Certifications specified in the following documents:
 - a. ASTM A403.
 - b. ASTM A409.

5. Test results.
6. Performance qualification records, and current welder logs for proposed welders.
7. Welding data and weld inspection reports, as specified in Section 05 05 20.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 1. All shop fabricated stainless steel pipe and fittings shall be provided by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be provided. The pipe and fittings shall be shop-fabricated and field-installed in accordance with common industry wide practices and methods and shall comply with these specifications.
 2. Only welding procedures that have been qualified by the fabricator under ASME Boiler and Pressure Vessel Code Section IX and only welders who have successfully completed performance qualification tests per ASME Boiler and Pressure Vessel Code Section IX on these qualified procedures shall be utilized.
- B. Welding
 1. Use GTAW with inert purging gas for groove welds.
 2. Limit heat tint to No. 3 or less per AWS D18.2.
 3. Pipe welds shall be fully pickled inside and outside.
- C. Pickle all pipe and fittings in accordance with ASTM A380.

1.05 MARKING, SHIPPING, AND STORAGE

- A. All pipe, fittings, and fabrications shall be properly marked with type, gage, and heat number.
- B. All fabricated piping shall have openings plugged and flanges secured for storage and transport after fabrication.
- C. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart.
- D. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping.
- E. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

PART 2 PRODUCTS

2.01 PIPE

- A. 2-1/2-inches and smaller: ASTM A312 Type 316L, seamless, threaded joints conforming to ASME B1.1. Minimum wall thickness: Schedule 40S.
- B. 3-Inches and Larger: ASTM A312, Type 316L, seamless, 10S.

2.02 FITTINGS

- A. 2½-inches and Smaller: Stainless steel, ASTM A403, of the same material and pressure rating as the pipe, threaded long radius with dimensions conforming to ANSI/ASME B16.11.

- B. 3-Inches and Larger:
 - 1. Unless otherwise indicated, butt-weld type manufactured in accordance with ASTM A403 of the same material and in the same thicknesses as the pipe.
 - 2. Long radius elbows up to 24 inches in diameter shall be smooth flow. All short radius, special radius, and reducing elbows and long radius elbows greater than 24 inches in diameter shall be of mitered construction.
 - 3. Reducers shall be straight tapered, cone type.
 - 4. Tees, crosses, laterals, and wyes shall be shop-fabricated from pipe.

2.03 JOINTS

- A. General: Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-weld joints or flanges.
- B. Flanged Joints:
 - 1. Unless otherwise indicated, Van Stone joints made up of stainless steel slip-on type rolled-angle face rings and ductile iron back-up flanges fabricated to ASME B16.1, Class 125 standard.
 - 2. Angle face ring thickness: Equal to or greater than the wall of the pipe or fitting to which it is welded, and continuously welded on both sides to the pipe or fitting.
 - 3. Angle leg shall not interfere with the flange bolt holes.
 - 4. Back-up flanges:
 - a. Use for submerged joints.
 - b. Stainless steel plate flanges.

2.04 COUPLINGS

- A. General: Fabricated stainless steel piping shall be shop-prepared for pipe couplings where specified. Unless otherwise indicated, couplings shall be arched-band or grooved type.
- B. Sleeve Type:
 - 1. Where specified, 316 stainless steel construction as specified in Section 40 05 40.
 - 2. Pipe: Plain-end with external weld beads ground smooth to ensure proper gasket seating.
 - 3. Pressure pipe lines: Sleeve coupling joints shall be restrained by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs shall be welded to the pipe to receive the harness rods.
- C. Arched-Band Type:
 - 1. Stainless steel of the same material and wall thickness as the pipe.
 - 2. Fixed--FxF, Expansion--ExE, or Fixed by Expansion--FxE as specified or as required.
 - 3. Pipe: Plain-end with external weld beads ground smooth and with S.S. restraining rings shop-welded to the piping for fixed type couplings.
 - 4. Acceptable manufacturers:
 - a. Victaulic, Bolted Split-Sleeve Coupling.
 - b. Approved Equal.
- D. Grooved-End (Split) Type:
 - 1. Malleable iron or ductile iron as specified in Section 40 05 40 except that submerged couplings shall be the same material as the pipe.
 - 2. Pipe ends: Roll-grooved to the coupling manufacturer's specifications. Where roll grooving is impractical, the pipe shall have heavy-wall machine-grooved pipe nipples or machined ring collars fully welded to the pipe or fitting.
 - 3. Nipples: Taper-bored to the I.D. of the adjoining pipe to allow full-weld penetration, and made of the same alloy as the piping.
 - 4. Collars: Welded on both sides to the piping, and made of the same alloy as the piping.

- E. Expansion Type: Unless otherwise indicated, flanged rubber arch type as specified in Section 40 05 44. Provide pipe flanges for these couplings.

2.05 THREADED CONNECTIONS

- A. Threaded pipe, gage, or instrument connections: Made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276. Shop welded to the pipe at the locations specified.

2.06 GASKETS

- A. Unless otherwise indicated, as specified in the PIPESPECS.
- B. For air lines, gaskets shall be neoprene or EPDM suitable for use at temperatures to 240 degrees F.

2.07 BOLTS

- A. Bolts, nuts, and washers for stainless steel flange assemblies and stainless steel couplings: Same material, conforming to ASTM A320 for low-temperature service and ASTM A193 and ASTM A194 for high-temperature service.
- B. Bolts, nuts and washers for other couplings: As specified in referenced paragraphs for the couplings.

2.08 PIPE SUPPORT AND SEISMIC RESTRAINT SYSTEMS

- A. Unless otherwise indicated, all hangers, rods, structural attachments, and other components of support and seismic restraint systems for stainless steel pipe shall be of the same materials as the pipe and conform to Section 40 05 41 and 40 05 42.

2.09 FINISH

- A. After all shop operations have been completed, pipe and fittings shall be pickled and passivated in manufacturer's plant, and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed.
- B. Standard Finish:
 - 1. 16-gage through 8-gage material: No. 1 or 28 per ASTM A480.
 - 2. 3/16-inch and heavier plate material: No. 1 mill finish or better per ASTM A480.

2.10 SOURCE QUALITY CONTROL

- A. Factory Testing: Factory testing shall conform to the requirements of ASTM A312 or ASTM A403.
- B. Nondestructive Testing
 - 1. Comply with ASME B31.3 Normal Fluid Service Category, except that 10% of all CJP groove welds shall be 100% RT examined. Fillet welds shall be 10% PT examined.

PART 3 EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

- A. Pipe cutting, threading, and jointing shall conform to the requirements of ASME B31.3. Lubricate all pipe threads with Teflon tape.

3.02 WELDING

A. General:

1. Piping with wall thickness up to 11-gage (0.120-inch): Weld using TIG (GTAW) with inert purging gas.
2. Heavier walls: Unless otherwise indicated, properly bevel and root pass using TIG (GTAW) with inert purging gas, followed by subsequent passes with TIG (GTAW) or MIG (GMAW).
3. Use matching filler metals.
4. Make weld deposit smooth and evenly distributed and with a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices shall not be allowed.
5. Groove welds: Complete joint penetration. Provide inert gas shielding to the interior and exterior of the joint.
6. Remove, slag, spatter, and projections by grinding. Grind smooth welds on gasket surfaces.
7. Limit heat tint to No. 3 or less as defined by AWS D18.2.

B. Field Welding:

1. Use couplings and prefabrication of pipe systems at the factory to minimize field welding to the greatest extent possible. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with GTAW and inert purging and shielding gas, and that other applicable specified welding requirements are rigidly adhered to.
2. Remove all residue, oxide and heat tint from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by mechanical descaling and pickling in accordance with ASTM A380.

C. Preparation of Surfaces to be Welded:

1. Make surfaces of joints to be welded free from mill scale, slag, grease, oil, paint, rust, and other foreign material.
2. Wire brush joints to be welded with stainless steel wire brushes and precisely fit before welding.

D. Weather Conditions:

1. Perform welding only when the surfaces are completely free of any moisture.
2. Do not weld the pipe during periods of high winds or rain unless the areas being welded are properly shielded.

E. Tack Welds, Clips, and Other Attachments:

1. Repair nicks, gouges, notches, and depressions in the base metal in the area of the before the joint weld is made.
2. Remove tack welds, clips, and other attachments and repair defects, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed.
3. Grind those areas to be repaired down to clean metal and then repair by building up with weld metal. Grind the repaired areas smooth to form a plane surface with the base metal.

F. Defects and Repairs:

1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications, by chipping or grinding throughout their depth to clean base metal.
2. Do not perform calking or peening of welds to correct defects.
3. Enlarge welds found deficient in dimension but not in quality by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate.
4. Remove weld deposits, slag, weld spatter, and projections into the interior of the pipe by grinding.

G. Welded connections visual inspection and nondestructive weld testing:

1. As specified in Section 05 05 20 and ASME B31.3 for Normal Fluid Service Category.

3.03 FABRICATION AND INSTALLATION REQUIREMENTS

- A. The piping supplier during manufacturing, fabricating and handling stages, and the contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls.
- B. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only.
- C. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber-lined.
- D. Use nylon slings or straps for handling stainless steel piping.
- E. After installation, wash and rinse all foreign matter from the piping surface.
- F. Treat all welded joints with a pickling solution, brush with stainless steel wire brushes and rinse clean.
- G. If rusting of embedded iron occurs, pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes, and rinse clean.

3.04 COATINGS

- A. After installation, paint all steel or iron flanges, couplings, and appurtenances in accordance with Section 09 90 00.
- B. Painting of the stainless steel pipe is not required.
- C. Be responsible for supplying and installing the stainless steel piping with a consistently clean surface.
- D. Remove identifying spool piece marks with paint thinner or solvents and wash the entire stainless steel surface with detergent and hot water and rinse clean.

END OF SECTION

SECTION 40 05 24

STEEL PIPE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies steel pipe and fittings.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ASME B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ASME B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ASTM A36	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A197	Cupola Malleable Iron
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A536	Ductile Iron Castings
ASTM A572	High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement Mortar Protective Line and Coating For Steel Water Pipe 4 In (100Mm) and Larger Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C604	Installation of Buried Steel Water Pipe
AWWA M11	Steel Pipe--A Guide for Design and Installation
SSPC-SP10	Near-White Blast Cleaning

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's product data, catalog cuts, or shop drawings describing construction, dimensions, and materials. Indicate on the submittal each Piping System where the product will be used.
 2. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.
 3. Contractor's layout drawings as specified in Section 40 05 01.

4. Drawings showing cross-section of the pipe wall and joints for each size, pressure rating, and loading and drawings showing details, dimensions, and piece numbers of all fabricated fittings.
5. Calculations for fabricated fittings that indicate the adequacy of any required reinforcement. Calculations shall be in accordance with the procedures presented in AWWA M11.
6. Submit calculations and Drawings for proposed alternative thrust restraint or pipe anchorage.
7. Welding data and weld inspection reports, as specified in Section 05 05 20.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

- A. Provide steel pipe and fittings in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 05 01, Piping Systems.
 1. Steel for pipe fabrication to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36; ASTM A572, Grade 42; ASTM A516, Grade 70.

2.02 PIPE FABRICATION

- A. ASTM A53 and ASTM A106, Grade B Pipe:
 1. Type E or Type S, seamless pipe as indicated in Section 40 05 01.
 2. Minimum wall thickness: Schedule 40 for pipe 10-inch diameter and less and Std. weight for pipe 12 inch through 24-inch diameter.
- B. AWWA C200 Pipe:
 1. Straight or spiral seam.
 2. Minimum wall thickness:
 - a. 16-inch and smaller: 1/4 inch.
 - b. 18-inch - 48-inch: 3/8 inch.
 - c. 54-inch: 1/2 inch.
- C. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

- A. As specified in Section 40 05 01 and in conformance with Section 40 05 40.

2.04 FITTINGS AND APPURTENANCES

- A. Malleable Iron Threaded Fittings and Appurtenances: In conformance with the requirements of ASME B16.3 and either ASTM A47 or ASTM A197.
- B. Steel Fittings and Appurtenances:
 1. Unless otherwise indicated, in conformance with the requirements of ASTM A234, ASTM A105, or ASME B16.11.
 2. Fabricated steel fittings and appurtenances: In conformance with AWWA C208.
- C. Fittings for Grooved-End Piping Systems:
 1. Full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings.
 2. Cast fittings: Cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47.
 3. Standard steel fittings, including large size elbows: Forged steel conforming to ASTM A106.
 4. Standard segmentally welded fittings: Fabricated of Schedule 40 carbon steel pipe.
- D. Unless otherwise indicated, all fittings shall be rated for pressure and loadings equal to the pipe.

- E. Pipes cut for groove coupling shall be as specified in the Section 40 05 40.

2.05 PIPE LINING

- A. Epoxy:
 - 1. Unless otherwise indicated, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:
 - a. No coal tar products shall be incorporated in the liquid epoxy.
 - b. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.
 - 2. The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.
- B. Cement Mortar:
 - 1. Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205.
 - 2. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2-inch by 4-inch by 13-gage self-furring wire mesh reinforcement for hand-applied lining.
- C. High Temperature Service Epoxy:
 - 1. Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F.
 - 2. Surfaces shall be prepared in accordance with SSPC-SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.
 - 3. Acceptable Manufacturer:
 - a. 3M, Scotchkote 306.
 - b. Porter, MCR 65 High Solids Epoxy.
 - c. Approved Equal.

2.06 PIPE COATING

- A. Epoxy: Apply in accordance with Section 09 06 90.
- B. Polyethylene Tape:
 - 1. Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214.
 - 2. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3.
 - 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

2.07 FUSION EPOXY COATING AND LINING

- A. Where specified, steel pipe and fittings shall be fusion epoxy coated and lined.
- B. Application Method: Fluidized bed method, attaining 12 mils minimum dry film thickness.
- C. Surface Preparation: in accordance with SSPC-SP 10 Near White Blast Cleaning.
- D. Acceptable Manufacturer:
 - 1. 3M Scotchkote 206N.
 - 2. Dupont Nap-Guard 7-2500.
 - 3. Approved Equal.

- E. Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with a 2-part epoxy compound from the same manufacturer as the coating.
Acceptable Manufacturer:
 - 1. 3M Scotchkote 306.
 - 2. Dupont Nap-Guard 7-1847.
 - 3. Approved Equal.

2.08 JOINT GASKETS

- A. Joint gaskets shall be as specified in Section 40 05 40.

2.09 CORROSION PROTECTION (NOT USED)

2.10 SOURCE QUALITY CONTROL

- A. Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.
- B. Nondestructive weld examination:
 - 1. All welds: 100% VT by Fabricator's AWS QC1 CWI.
 - 2. Butt joint groove welds: 5% RT. Acceptance criteria shall comply with ASME BPVC Section VIII, Div. 1, UW-52.
 - 3. Groove welds at tees and outlets, and all other groove welds: 100% UT in accordance with ASME BPVC Section VIII, Div. 1, UW-53.
 - 4. Fillet welds: 100% MT or PT in accordance with ASME BPVC Section VIII, Div. 1, Appendix 6.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install pipe in accordance with AWWA M11. Weld joints in accordance with AWWA C206 and Section 40 05 40. Tie rods shall be used where required for thrust restraint.
 - 2. Provide sleeve-type mechanical pipe couplings in accordance with AWWA M11 and Section 40 05 40.
 - 3. Apply pipe lining and coatings at field joints per Section 40 05 24.
- B. Anchorage:
 - 1. All couplings and fittings shall be restrained.
 - 2. Provide concrete thrust blocks only where specified on the Drawings.
 - 3. Submit calculations and drawings for proposed alternative thrust restraint or pipe anchorage in accordance with Section 40 05 24.

3.02 TESTING

- A. Hydrostatic testing shall be in accordance with Section 4 of AWWA C604 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.
- B. Welded connections visual inspection and nondestructive weld testing:
 - 1. As specified in Section 05 05 20.

END OF SECTION

SECTION 40 05 31

PLASTIC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies polyvinylchloride (PVC), chlorinated polyvinylchloride (CPVC), and polypropylene (PP) pipe and fittings.
- B. Use in conjunction with the Piping System Specification Sheets (PIPESPEC) in Section 40 05 01.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM D1784	Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F402	Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's certificates of compliance with the specified standards.
 - 2. Product data for weld primer and solvent.

PART 2 PRODUCTS

2.01 PVC PIPE

- A. Pressure Pipe and Fittings:
 - 1. Material for pipes and fittings: ASTM D1784, Class 12454-B.
 - 2. Pipe and fittings requirements: Either ASTM D1785 or ASTM D2241 for standard dimension ratios.
 - 3. 160-psi pipe--SDR 26; 200-psi pipe--SDR 21; 250-psi--SDR 17, as specified.
 - 4. Neoprene gaskets with push-on joints: ASTM F477.
 - 5. Schedule 80 PVC socket-type fittings: ASTM D2467.
 - 6. Schedule 40 PVC fittings: ASTM D2466.

7. Schedule 80 PVC threaded fittings: ASTM D2464.

B. Non-pressure Pipe:

1. Material for pipe and fittings: ASTM D1784, Class 12454-B.
2. Pipe and fittings requirements: ASTM D3034 for SDR 35.
3. Neoprene gaskets with push-on joints: ASTM F477.

C. Solvent cement:

1. ASTM D 2564 formulated and labeled for PVC. Universal plastic pipe solvents and adhesives are not acceptable.
2. Formulated and labeled for use in the size and pressure rating of the pipe
3. Manufacturers:
 - a. IPS Weld-On.
 - b. Oatey.
 - c. Approved Equal.

D. Primer:

1. Formulated and labeled for PVC.
2. Same manufacturer as the solvent cement.
3. The primer shall be colored to contrast with the pipe color and contrast with the solvent cement color. Where clear pipe is used, primer shall also be clear.
4. Prior to joining, clean joints of all loose debris and prime.
5. Manufacturers:
 - a. IPS Weld-On.
 - b. Oatey.
 - c. Approved Equal.

2.02 DOUBLE CONTAINMENT PVC PIPE [NOT USED]

2.03 CPVC PIPE [NOT USED]

2.04 POLYPROPYLENE PIPE [NOT USED]

PART 3 EXECUTION

3.01 INSTALLATION

A. PVC pipe and fittings 3 inches in diameter and smaller:

1. Join by means of socket fittings and solvent welding in conformance with ASTM F402.
2. Make solvent-cemented joints in strict compliance with the manufacturer's/supplier's instructions and recommended procedures.

B. PVC pipe and fittings 4 inches in diameter and greater:

1. Unless otherwise indicated, join by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings.
2. Line fittings: Line and coat as specified in Section 40 05 24 or 40 05 19.
3. Unless otherwise indicated, paint PVC piping exposed to sunlight with UV resistant coating system as specified in Section 09 90 00.

C. Polypropylene pipe and fittings: [NOT USED]

D. Connections:

1. Connect to different types of pipe by means of flanges, specified adapters or transition fittings.

2. Where sleeve type couplings are used, uniformly torque both in accordance with pipe manufacturer's recommendation.
3. Foreign material shall be removed from the pipe interior prior to assembly.

3.02 TESTING

- A. Per Section 40 05 01.

END OF SECTION

SECTION 40 05 33

HIGH-DENSITY POLYETHYLENE PROCESS PIPE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies high-density polyethylene (HDPE) pipe, fittings, and appurtenances for piping 4 inches to 63 inches in nominal diameter. The designation HDPE is used in the piping system specification sheets (PIPESPEC) in Section 40 05 01 and in this Section.
- B. Performance Requirements: Conform to:
 - 1. Dimension Ration (DR): As Specified.
 - 2. Pressure Class: AWWA C906 - 125 psi or as otherwise specified.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution
ASTM D2321	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2657	Heat Joining Polyolefin Pipe and Fittings
ASTM D3261	Butt Heat Fusion PE Fittings for PE Pipe and Tubing
ASTM D3350	PE Plastics Pipe and Fittings Materials

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Welder certification.
- C. Items to be Submitted for this Specification:
 - 1. Product data and deviations noted.
 - 2. Detail drawings which show the type and location of all fittings, joints, and connections to structures and manholes.

1.04 QUALITY ASSURANCE

- A. Affidavit of Compliance:
 - 1. The manufacturer shall furnish an affidavit of compliance conforming to the requirements of AWWA C906 affirming that the piping components comply with the requirements of AWWA C906 and this Section.
 - 2. The affidavit shall be signed under penalty of perjury by an officer of the pipe manufacturer's company.

- B. Factory Tests: All HDPE materials, pipe and fittings shall be inspected and tested in accordance with the requirements of AWWA C906.
- C. Shipment and Storage:
 - 1. The Contractor shall use care in handling and storage of the pipe. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe shall be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.
 - 2. Sections of pipe with cuts, gouges, or scratches on the outside diameter (OD) surface that exceed 10 percent of the wall thickness of the pipe shall be removed completely and the ends of the pipeline rejoined. The inside diameter (ID) surface shall be free of cuts, gouges, and/or scratches.
- D. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the ASPA inspector.

PART 2 PRODUCTS

2.01 MATERIALS

- A. HDPE piping components shall be manufactured from materials that meet or exceed the requirements of the Plastic Piping Institute designation PE4710 and that conform to the requirements of ASTM D3350 for a cell classification of PE 445574C.
- B. Flanges: The polyethylene flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe.
- C. Bolts and nuts: ASTM A726 Type 316 stainless steel specified in Section 26 05 00.

2.02 FEATURES

- A. Pipe: Pipe shall have the nominal dimensions shown on the Drawings with an IPS outside diameter basis and the dimensions and tolerances specified in AWWA C906. DR rating and pressure class shall be as specified in this Section.
- B. Fittings:
 - 1. Fittings shall conform to the applicable requirements of AWWA C906 for the joining methods specified in this Section.
 - 2. Pipe bends 14 inches and smaller: Where long radius bends are specified for the piping system in Section 40 05 01, provide Arc™ sweep bends manufactured by Pipestar International, or approved equal. Bend radius shall be three times the pipe diameter, measured to the center line of the bend for long-radius bends.
 - 3. Pipe bends larger than 14-inch diameter in size shall be mitered type with the following characteristics:

Degree of Bend	Minimum Number of Miter Segments
22.5	2
45	3
67.5	4
90	5

- C. Connections: Flange Type VR 955

- D. Pipe Supports for Exposed Applications:
1. Pipe supports shall conform to the applicable requirements of Section 40 05 41.
 2. Pipe shall be properly supported, thermal expansion and contraction movement shall be accommodated, and supports shall be spaced to limit vertical deflection between supports.
 3. Pipe supports shall conform with the following additional requirements:
 - a. Supports shall cradle the bottom 120 degrees of the pipe.
 - b. Supports shall have a width at least one half of pipe diameter.
 - c. Edges of the supports shall be rounded or rolled to prevent cutting into the pipe.
 - d. Commercial pipe supports such as u-bolts, narrow strap-type hangers, and roller type supports are unsuitable unless modified for width and cradling.
- E. Pipe Markings: Pipe marking shall conform to the requirements of AWWA C906.

PART 3 EXECUTION

3.01 INSTALLATION – BURIED APPLICATIONS [NOT USED]

3.02 INSTALLATION – EXPOSED APPLICATIONS

- A. General: Unless otherwise specified, the piping system shall be installed in accordance with ASTM D2321, AWWA C906 and the manufacturer's recommendations.
- B. Joining:
1. Pipe and fittings shall be joined into continuous lengths on the job site. Unless otherwise specified, joining shall be by the butt-fusion method performed in accordance with the pipe manufacturer's recommendations and ASTM D2657. Socket fusion, extrusion welding and hot gas welding shall not be used for field connections.
 2. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by butt-fusion of HDPE pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe.
 3. Flanged joining, or other mechanical joining methods specified, may be used to make connections to differing piping materials, to equipment, valves and other appurtenances, and where specified.
 4. Victaulic Style 995 couplings shall be installed where specified on the Drawings for pipeline disassembly for maintenance.

3.03 FIELD TESTING

- A. System Test Phase: Following the preoperational, and component test phases specified in Section 01 75 20, perform the following field tests during the system test phase.
1. Hydrostatic Pressure Testing:
 - a. Buried pipelines shall be tested prior to backfilling the piping. Cover the pipe at intervals and/or at curves if necessary to hold the pipe in place during testing. Connections shall be left exposed for visual leak inspection.
 - b. After all free air is removed from the test section, the pressure in the pipe shall be raised at a steady rate to the required pressure. The pressure in the section shall be measured at the lowest point of the test section. Test pressure shall be as specified in Section 40 05 01. The initial pressure shall be applied and allowed to stand without makeup pressure for 2 to 3 hours to allow for diametric expansion or pipe stretching to stabilize. After the equilibrium period, the test section shall be returned to the required test pressure and held for 3 hours. Amounts of makeup water allowable for expansion during the pressure test shall be as listed in the Plastic Pipe Institute PE Pipe Handbook Chapter 2. No visual leaks or pressure drops shall be observed during the final test period.
 2. Deflection Testing for Buried applications:[NOT USED]

END OF SECTION

SECTION 40 05 40

PIPING CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, dielectric unions, and welding.
- B. Contractor shall be responsible for the scheduling and planning investigation of compatibility, providing and testing all connections, including coordinating rating, sizes, diameters, bolt sizes and drill circle, gasket and flange facing and material, plus the use of dielectric insulation for dissimilar metals including connecting to existing facilities and equipment.
- C. Unless otherwise specified, connections of piping at equipment shall comply with the requirements of this Section.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain End Pipe
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's catalog data showing piping connection details for each piping system.
 - 2. Details for installation for each type of piping connection.
 - 3. Welder performance qualification records, welding procedures and CWI credentials.
 - 4. Welding data and weld inspection reports, as specified in Section 05 05 20.
 - 5. Statement by the supplier for each type of item that the materials provided are normally recommended for the liquid and piping materials and pressures as well as the installation situation and environment.

1.04 QUALITY ASSURANCE

- A. Welding:
 - 1. Welding shall conform to the requirements of ASME B31.3, Normal Fluid Service Category or AWWA C206.
 - 2. Welding procedures shall be qualified by testing in accordance with ASME Section IX or AWS D1.1 requirements.
 - 3. Welders shall be qualified by the Contractor or Fabricator in accordance with ASME Section IX or AWS D1.1.
 - 4. Contractor's shop and field welding inspectors shall hold current AWS QC1 CWI certification.
 - 5. Each welder's certificate shall be provided to the Project Representative prior to that welder working on the job.

PART 2 PRODUCTS

2.01 GENERAL

- A. Pipe connections (joint and fitting) options for a particular piping system shall be as specified on the particular system PIPESPEC sheet in Section 40 05 01.
- B. Takedown Couplings: provide for all piping systems in accordance with this section; provide both around equipment and at standard pipe lengths for all straight runs of pipe.
- C. Continuous welding for straight runs of pipe is acceptable only where the individual PIPESPEC sheet allows welding as a connection option. Where connections are shown, then the connections shall be specifically where shown, however, if several connection options are allowed for the particular piping system on the PIPESPEC sheet, then any option may be consistently used, i.e., if flanged or rigid grooved connections are acceptable and grooved are shown, then flanged may be substituted. Integrity of rigid, non-rotating connections shall be maintained at all valves and other equipment.

2.02 FLANGE ASSEMBLIES

- A. Flanges:
 - 1. General:
 - a. Flanges shall either be flat-faced flanges or convoluted ring flanges as specified in the following paragraphs.
 - b. Flat-faced flanges shall not be bolted to raised-face flanges.
 - 2. Flat-Faced Flanges:
 - a. Ductile and Cast iron flanges: Faced in accordance with ASME B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face.
 - b. Class 150 and Class 300 forged steel flanges: Raised face conforming to ASME B16.5.

- c. Lightweight slip-on flanges: Plain face conforming to AWWA C207, Class B and ASME B16.5.
 - d. Steel flanges: Unless otherwise specified, ASME B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi.
- 3. Convoluted Ring Flanges:
 - a. Ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe.
 - b. Flange joints: Rated for not less than 150 percent of the test pressures listed in Section 40 05 01 and in conformance with the requirements of ASME B 16.5 and AWWA C207.
 - c. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.
- B. Gaskets:
 - 1. Material: As specified in this section and Section 40 05 01.
 - 2. For plain faced flanges:
 - a. Full face type.
 - b. Thickness:
 - 1) Pipe 10 inches and less in diameter: 1/16 inch.
 - 2) Pipe 12 inches and larger in diameter: 1/8 inch.
 - 3. For raised face flanges:
 - a. Unless otherwise indicated, shall match the raised face.
 - b. Thickness:
 - 1) Pipe 3½ inches and less in diameter: 1/16 inch.
 - 2) Pipe 4 inches and larger: 1/8 inch.
- C. Bolts, Washers and Nuts:
 - 1. ASME B18.2.1 standard square or hexagon head bolts with ASME B18.2.2 standard hexagon nuts.
 - 2. Threads: ASME B1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B.
 - 3. Length: In conformance with ASME B16.5.
 - 4. Unless otherwise specified, carbon steel machined bolts with hot pressed hexagon nuts.
 - 5. Bolts, nuts, and washers:
 - a. For submerged service, over open basins, and in tank headspaces: Made of Type 316 stainless steel in conformance with ASTM F593 and ASTM F594, markings F593F and F594F. Use anti-seize compound for installation. Nuts for submerged service can be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100 or C65500, designation H04.
 - b. For buried service, including for use in vaults: Made of noncorrosive high-strength, low-alloy steel having the characteristics specified in AWWA C111, regardless of any other protective coating. Provide factory applied fluoropolymer coating: FluoroKote#1, Xylan 1424, or Approved Equal.

2.03 MECHANICAL COUPLINGS

- A. Sleeve-Type Couplings:
 - 1. Unless otherwise specified, use model as recommended by the manufacturer for the application.
 - 2. Acceptable manufacturer:
 - a. Dresser.
 - b. Romac.
 - c. Smith-Blair.
 - d. Approved Equal.
 - 3. Bolts, nuts, and washers:
 - a. For submerged service: Made of Type 316 stainless steel in conformance with ASTM F593 and ASTM F594, markings F593F and F594F. Use anti-seize compound for installation. Nuts for submerged service can be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100 or C65500, designation H04.
 - b. For buried service: Made of noncorrosive high-strength, low-alloy steel having the characteristics specified in AWWA C111, regardless of any other protective coating. Provide factory applied fluoropolymer coating: FluoroKote#1, Xylan 1424, or Approved Equal.

- B. Grooved End (Split Ring) Couplings:
1. Couplings shall conform to AWWA C606.
 2. Unless otherwise specified, use model as recommended by the manufacturer for the application
 3. Flexible-type couplings: all piping greater than 12 inches in diameter; pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less: rigid-type couplings.
 4. Cut grooves are not permitted on fabricated or light wall pipe. Note that Ductile Iron pipe shall meet minimum wall thickness for use of grooving, per AWWA C606.
 5. Housing: Ductile iron, ASTM A563.
 6. Gasket: flush seal type designed for ductile iron or steel pipe.
 7. Bolts, nuts, and washers:
 - a. Per AWWA C606. Bolts: ASTM A449 and ASTM A183. Nuts: ASTM A563.
 - b. For submerged service: Type 316 stainless steel in conformance with ASTM F593 and ASTM F594, markings F593F and F594F.
 - c. For buried service: [NOT USED]
 8. Unless otherwise specified, use model as recommended by the manufacturer for the application
 9. Grooved end flexible-type couplings:
 - a. Gruvlok Fig 7001.
 - b. Victaulic 77/W77.
 - c. Approved Equal.
 10. Grooved end rigid-type couplings:
 - a. Gruvlok Fig 7401.
 - b. Victaulic 07/W07.
 - c. Approved Equal.
 11. Grooved end couplings for RS (RSP discharge piping and FSI/Pump fronthead connection):
 - a. Victaulic Type D Vic-ring Adapter with Style 44 Coupling.
 - b. Approved Equal.

2.04 GASKETS

- A. Materials:
1. EPDM: Ethylene-propylene-diene-terpolymer.
 2. Neoprene
 3. Nitrile (Buna N).
 4. Viton.
- B. Properties:
1. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).
 2. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).
 3. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).
 4. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).
 5. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).
 6. TFE: Noncreeping tetrafluoroethylene (TFE) with insert filler.
 7. TFE bonded EPDM: TFE bonded to EPDM in full-face gasket having concentric-convex molded rings.

2.05 THREAD

- A. Pipe thread dimensions and size limits shall conform to ASME B1.20.1.

2.06 UNIONS

- A. 2 inches and smaller: Ground joint screwed pattern unions.

- B. 2½ inches and larger: Ground joint flange unions.
- C. Dielectric unions: Match the pipe material except bronze may be used with copper piping. EPCO, Capitol Manufacturing, or approved equal.
- D. Hydraulic power and petroleum conveying piping shall use flat-faced O-ring style unions, for both regular and dielectric unions. O-ring material shall be suitable for piped fluid.

2.07 COATINGS

- A. Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated as specified in Section 09 90 00.

PART 3 EXECUTION

3.01 PIPE CUTTING, THREADING AND JOINTING

- A. Pipe cutting, threading and jointing shall conform to the requirements of ASME B31.3.

3.02 GROOVE COUPLING

- A. Groove coupling pipe cuts or roll shall be per the pipe manufacturer's recommendations.
- B. All pipe groove cuts shall be implemented from outside surface of the pipe. No pipe groove cutting equipment shall touch interior finish surface of pipes neither for alignment or support. No damages to the original interior surface of the pipes during groove coupling cuts or rolls.

3.03 PIPE WELDING

- A. Welders shall be qualified by the Contractor in accordance with ASME Section IX or AWS D1.1, as applicable.
- B. Make welds in accordance with the requirements of ASME B31.3 Normal Fluid Service Category for piping Systems 8, 20, 26, and 28 specified in Section 40 05 01.
- C. All welding shall be done in accordance with the requirements of the applicable, individual steel pipe specifications. Welds for piping systems not specified above shall be in accordance with AWWA C206 and AWS D1.1.
- D. Welded connections visual inspection and nondestructive weld testing:
 - 1. As specified in Section 05 05 20.

3.04 TAKEDOWN COUPLINGS AND DISMANTLING CONNECTIONS

- A. Screw unions, flanged, or grooved end mechanical coupling type joints and provided as specified.
- B. Where piping passes through walls, provide takedown couplings within 3 feet of the wall.
- C. Provide a union or flanged connection within 2 feet of each threaded end valve.
- D. Provide Restrained Sleeve Coupling or Equipment Connection Fitting for suction and discharge of all pumps.
- E. Provide Flexible Vibration reduction couplings on the suction and discharge of all air compressors and blowers, restrained.

3.05 FLEXIBILITY

- A. Where required for resistance to pressure, restrain mechanical couplings in accordance with AWWA M11.
- B. Restrain all flexible joints used on pressurized ductile iron pipe. Lugs for restraint on ductile iron pipe to be factory installed.

3.06 DIELECTRIC CONNECTIONS

- A. Provide dielectric unions or an insulating section of rubber or plastic pipe where a copper pipe is connected to steel or cast iron pipe. The insulating section shall have a minimum length of 12 pipe diameters.

END OF SECTION

SECTION 40 05 41

PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies hangers and supports for all piping systems specified in Section 40 05 01.
- B. This Section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
MFMA	Metal Framing Manufacturer's Association
MSS SP-58	Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
AISC 325	Steel Construction Manual
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SPC	Seattle Plumbing Code

1.03 OPERATING CONDITIONS:

- A. The hangers and supports specified in this Section are provided to resist gravity and operating loads.
- B. For the purpose of pipe hanger and support selection, this Section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
 - 1. Hot Systems:
 - a. 120 degrees F to 450 degrees F.
 - b. 451 degrees F to 750 degrees F.
 - c. Over 750 degrees F.
 - 2. Ambient Systems:
 - a. 60 degrees F to 119 degrees F.
 - 3. Cold Systems:
 - a. 33 degrees F to 59 degrees F.
 - b. 20 degrees F to 32 degrees F.
- C. For the purpose of material selection, spaces are classified as:
 - 1. Dry Service Environment including offices, pipe galleries.
 - 2. Wet/Corrosive Service Environment including Wet wells, Pump Rooms, Odor Control Spaces, Chemical storage, storage and handling, battery rooms.

1.04 HANGER AND SUPPORT SELECTION

- A. Design:
 - 1. The Contractor shall be responsible for design of hanger and support systems. The pipe support system drawings shall show the hanger and support locations. The pipe support design drawings

and calculations shall be prepared and signed by a Professional Engineer licensed in the state of Washington.

2. Supports and other piping system mounting elements for piping 30-inch diameter and less are generally not shown on the Drawings. Where a specific support, hanger, guide, structural attachment, anchor, or joint detail for pipe 30-inch diameter or less is shown, it shall be to indicate the general arrangement to be developed by the Contractor's design professional.
 3. Design, select, locate, and provide piping supports, pipe guides, and anchors required for final piping layout. The Drawings include King County's applicable typical details for piping system mounting elements.
- B. Select pipe hangers and supports in accordance with this specification. Selections shall be based upon the pipe support classifications specified in this Section and the piping insulation thickness specified in Section 40 42 00, and any special requirements which may be specified. Materials will be based on the service environment.
 - C. Review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the support to be used at each hanger point.
 - D. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.
 - E. Where there is horizontal movement at a suspended type hanger location, hanger components shall be allowed for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.
 - F. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.
 - G. Unless otherwise indicated, existing pipes and supports shall not be used to support new piping.
 - H. Stock hanger and support components shall be used wherever practical and be compatible with any existing hanger hardware for system standardization.

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 1. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
 2. Calculations for each type of pipe support, attachment, and anchor.
 3. Fabrication drawings for fabricated components.
 4. Revisions to support systems resulting from changes in related piping system layout.
 5. Welding data and weld inspection reports, as specified in Section 05 05 20.

PART 2 PRODUCTS

2.01 GENERAL

- A. Pipe support shall conform to the requirements of MSS SP-58.
- B. Metal framing system components shall conform to the Metal Framing Manufacturer's Association standard MFMA.
- C. For system compatibility, support clips and attachments shall be compatible with Unistrut or B-Line.

- D. Insulated pipe shall be provided with insulation shield at the supports.
- E. Copper pipe shall be provided with dielectric wrap (see Section 40 05 17). Where provided with insulation shield, the dielectric wrap may be omitted.
- F. Acceptable manufacturers:
 - 1. B-Line.
 - 2. Unistrut.
 - 3. Approved Equal.

2.02 MATERIALS

- A. Service Environment: Pipe hangers and supports, structural attachments, fittings and accessories:
 - 1. Dry Service Environment: Zinc plated or mechanically galvanized after fabrication. Nuts, bolts, and washers: galvanized or zinc-plated.
 - 2. Wet or Corrosive Environment: type 304 or 316 stainless steel nuts, bolts, and washers.
- B. Pipe Hangers and Supports:
 - 1. Type 1 – Clevis Pipe Hanger:
 - a. Carbon steel with configuration and components equivalent to MSS Type 1.
 - b. Steel pipe (uninsulated):
 - 1) B-Line B3100.
 - 2) Grinnell Fig. 260.
 - 3) Approved Equal.
 - c. Cast and ductile iron pipe:
 - 1) B-Line B3102.
 - 2) Grinnell Fig. 590.
 - 3) Approved Equal.
 - d. Copper pipe (uninsulated):
 - 1) B-Line B3104 CT.
 - 2) Grinnell Fig. CT-65.
 - 3) Approved Equal.
 - e. Plastic pipe:
 - 1) B-Line B3100 C.
 - 2) Carpenter & Patterson Fig. 100PVC.
 - 3) Approved Equal.
 - 2. Type 2 - "J" Pipe Hanger:
 - a. Carbon steel with configuration and components equivalent to MSS Type 5.
 - b. Use only on uninsulated pipe.
 - c. Steel pipe (uninsulated):
 - 1) B-Line B3690.
 - 2) Grinnell Fig. 67.
 - 3) Michigan model 418.
 - 4) Approved Equal.
 - d. Copper and plastic pipe:
 - 1) Michigan model 419.
 - 2) Unistrut J 1205N series.
 - 3) Approved Equal.
 - 3. Type 3 – Double Bolt Pipe Clamp:
 - a. Carbon steel, with configuration and components equivalent to MSS Type 3.
 - b. Steel pipe (uninsulated):
 - 1) B-Line B3144.
 - 2) Grinnell Fig. 295.
 - 3) Approved Equal.
 - c. Steel pipe (insulated):

- 1) Double bolt pipe clamp shall be as specified in Section 40 05 41, with insulation shield.
Insulation shield is optional for hot and ambient systems.
4. Type 4 – Adjustable Roller Hanger:
 - a. Rollers shall be cast iron.
 - b. Yoke and cross bolt shall be carbon steel.
 - c. Configuration and components shall be equivalent to MSS Type 43.
 - d. Steel pipe (uninsulated):
 - 1) B-Line B3110.
 - 2) Grinnell Fig. 181.
 - 3) Approved Equal.
 - e. Plastic pipe:
 - 1) B-Line B3110.
 - 2) Grinnell Fig. 181.
 - 3) Approved Equal.
5. Type 5 – Single Pipe Roll:
 - a. Rollers and sockets shall be cast iron.
 - b. Cross rod shall be steel.
 - c. Configuration and components shall be equivalent to MSS Type 41.
 - d. Steel pipe (uninsulated):
 - 1) B-Line B3114.
 - 2) Grinnell Fig. 171.
 - 3) Approved Equal.
 - e. Plastic pipe:
 - 1) B-Line B3114.
 - 2) Grinnell Fig. 171.
 - 3) Approved Equal.
6. Type 6 – Framing Channel Pipe Clamp:
 - a. Pipe clamps shall be steel with galvanized finish.
 - b. Steel pipe (uninsulated):
 - 1) Material thickness:

Pipe size	Material thickness
3/8 inch and 1/2 inch	16 gage
3/4 inch through 1¼ inches	14 gage
1½ inches through 3 inches	12 gage
3½ inches through 5 inches	11 gage
6 inches and 8 inches	10 gage

- 2) Acceptable manufacturer:
 - a) Michigan model 431.
 - b) Powerstrut PS 1100.
 - c) Unistrut P 1109 series.
 - d) Approved Equal.
- c. Copper (uninsulated) and plastic pipe:
 - 1) Material thickness:

Pipe size	Material thickness
3/8 inch and 1 inch	16 gage
1¼ inches and 1½ inches	14 gage
2 inches through 3 inches	12 gage
4 inches	11 gage

- 2) Clamp shall be copper-plated, plastic coated or lined with dielectric material.
- 3) Acceptable manufacturers:
 - a) Michigan model 432.

- b) Powerstrut PS 1200.
 - c) Unistrut P 2024C and P 2024PC series.
 - d) Approved Equal.
- 7. Type 7 - U-Bolt:
 - a. Carbon steel with configuration equivalent to MSS Type 24.
 - b. Steel pipe (uninsulated):
 - 1) Grinnell Fig. 137.
 - 2) B-Line B3188.
 - 3) Approved Equal.
 - c. Cast and ductile iron pipe:
 - 1) Grinnell Fig. 137.
 - 2) B-Line B3188.
 - 3) Approved Equal.
 - d. Copper pipe (uninsulated):
 - 1) Carpenter & Patterson Fig. 222 CT.
 - 2) B-Line B3501 CT.
 - 3) Grinnell Fig. 137C.
 - 4) Approved Equal.
 - e. Plastic pipe:
 - 1) Grinnell Fig. 137C.
 - 2) Michigan model 151.
 - 3) B-Line B3188 C.
 - 4) Approved Equal.
- 8. Type 8 – Adjustable Pipe Roll Support:
 - a. Rollers and sockets shall be cast iron.
 - b. Cross rod and support rods shall be carbon steel.
 - c. Steel pipe (uninsulated):
 - 1) B-Line B3122.
 - 2) Grinnell Fig. 177.
 - 3) Approved Equal.
 - d. Plastic pipe:
 - 1) B-Line B3122.
 - 2) Grinnell Fig. 177.
 - 3) Approved Equal.
- 9. Type 9 – Welded Pipe Stanchion:
 - a. Minimum material thickness shall be standard schedule carbon steel pipe, cut to match contour of the pipe elbow.
 - b. Use of this support shall be limited to ambient systems only.
- 10. Type 10 – Pipe Stanchion Saddle:
 - a. Saddles and yokes shall be carbon steel and comply with MSS Type 37.
 - b. Steel pipe (uninsulated):
 - 1) Carpenter & Patterson Fig. 125.
 - 2) B-Line B3090.
 - 3) Approved Equal.
 - c. Cast and ductile iron pipe:
 - 1) Carpenter & Patterson Fig. 125.
 - 2) B-Line B3090 NS.
 - 3) Approved Equal.
 - d. Plastic pipe:
 - 1) Carpenter & Patterson Fig. 125.
 - 2) B-Line B3090.
 - 3) Approved Equal.
- 11. Type 11 – Offset Pipe Clamp:
 - a. Carbon steel with configuration and components as specified.
 - b. Be of standard design manufactured by a pipe hanger component manufacturer.
 - c. Steel pipe (uninsulated):

- 1) B-Line B3148.
- 2) Grinnell Fig. 103.
- 3) Approved Equal.
- d. Cast and ductile iron pipe:
 - 1) B-Line B3148 NS.
 - 2) Grinnell Fig. 103.
 - 3) Approved Equal.
- e. Plastic pipe:
 - 1) B-Line B3148.
 - 2) Grinnell Fig. 103.
 - 3) Approved Equal.
- 12. Type 12 – Riser Clamp:
 - a. Carbon steel with configuration and components equivalent to MSS Type 8.
 - b. Steel pipe (insulated):
 - 1) B-Line B3373.
 - 2) Grinnell Fig. 261.
 - 3) Approved Equal.
 - c. Steel pipe (uninsulated):
 - 1) B-Line B3373.
 - 2) Grinnell Fig. 261.
 - 3) Approved Equal.
 - d. Cast and ductile iron pipe:
 - 1) B-Line B3373.
 - 2) Grinnell Fig. 261.
 - 3) Approved Equal.
 - e. Copper pipe (insulated):
 - 1) B-Line B3373 CT.
 - 2) Grinnell Fig. CT-121.
 - 3) Michigan model 511.
 - 4) Approved Equal.
 - f. Copper pipe (uninsulated) :
 - 1) B-Line B3373 CT.
 - 2) Grinnell Fig. CT-121.
 - 3) Michigan model 511.
 - 4) Approved Equal.
 - g. Plastic pipe:
 - 1) B-Line B3373.
 - 2) Grinnell Fig. 261c.
 - 3) Approved Equal.
- 13. Type 13 – Framing Channel Pipe
 - a. Carbon steel, with configuration equivalent to MSS Type 26.
 - b. Steel pipe (uninsulated):
 - 1) Superstrut No. C-708-U.
 - 2) Powerstrut PS 3126.
 - 3) Kin-Line No. 477.
 - 4) Approved Equal.
 - c. Plastic pipe:
 - 1) Superstrut No. C-708-U.
 - 2) Powerstrut PS 3126.
 - 3) Kin-Line No. 477.
 - 4) Approved Equal.

C. Rack and Trapeze Supports:

- 1. General: Unless otherwise indicated, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, or a minimum fiberglass thickness of 0.200 inch, with a maximum deflection 1/240 of the span.

2. Type 20 – Trapeze Pipe Support:
 - a. Trapeze pipe support cross members shall be framing channel, or fiberglass where specified.
 - b. Flat plate fittings shall be 1-5/8 inch square carbon steel of standard design manufactured by framing channel manufacturer.
 - c. Acceptable manufacturer:
 - 1) Unistrut P2471.
 - 2) B-Line B202-2.
 - 3) Aickinstrut 2000 series.
 - 4) Approved Equal.
 3. Types 21 and 22 – Pipe Rack Supports:
 - a. Post and cross members shall be framing channel.
 - b. Pipe rack fittings shall be carbon steel, of standard design manufactured by framing channel manufacturer.
 - c. Ninety-degree fittings shall be gusseted.
 - d. Post base fittings shall be as specified in Section 40 05 41.
 - e. Acceptable manufacturer:
 - 1) Unistrut P2484.
 - 2) B-Line B844.
 - 3) Approved Equal.
- D. Structural Attachments:
1. Type A – Malleable Iron Concrete Insert:
 - a. Concrete inserts shall be malleable iron and comply with MSS Type 18.
 - b. Acceptable manufacturers:
 - 1) Grinnell Fig. 282.
 - 2) Carpenter & Patterson Fig. 108.
 - 3) Approved Equal.
 2. Type B – Side Beam Bracket:
 - a. Bracket shall be malleable iron and comply with MSS Type 34.
 - b. Acceptable manufacturers:
 - 1) Grinnell Fig. 202.
 - 2) B-Line B3062.
 - 3) Approved Equal.
 3. Type C – Malleable Beam Clamp with Extension Piece:
 - a. Clamp and extension piece shall be malleable iron. Tie rod shall be steel. Beam clamp shall comply with MSS Type 30.
 - b. Acceptable manufacturers:
 - 1) Grinnell Fig. 218 with Fig. 157 extension piece.
 - 2) B-Line B3054.
 - 3) Approved Equal.
 4. Type D – Steel Beam Clamp with Eye Nut:
 - a. Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS Type 28.
 - b. Acceptable manufacturers:
 - 1) Grinnell Fig. 292.
 - 2) Carpenter & Patterson Fig. 297.
 - 3) Approved Equal.
 5. Type E – Framing Channel Post Base:
 - a. Post bases shall be carbon steel, and of standard design manufactured by framing channel manufacturer.
 - b. Single channels:
 - 1) Unistrut P 2072A.
 - 2) B-Line B280.
 - 3) Approved Equal.
 - c. Double channels:
 - 1) Unistrut P 2073A.

- 2) B-Line B281.
- 3) Approved Equal.
- 6. Type F – Welded Beam Attachment:
 - a. Beam attachment shall be carbon steel and comply with MSS Type 22.
 - b. Acceptable manufacturer:
 - 1) B-Line B3083.
 - 2) Grinnell Fig. 66.
 - 3) Approved Equal.
- 7. Type G – Welded Steel Bracket:
 - a. Bracket shall be carbon steel.
 - b. Medium welded bracket shall comply with MSS Type 32.
 - c. Heavy welded bracket shall comply with MSS Type 33.
- 8. Type H – Cast Iron Bracket:
 - a. Acceptable manufacturers:
 - 1) Carpenter & Patterson Fig. 340.
 - 2) Grinnell.
 - 3) Approved Equal.
- 9. Type J - Adjustable Beam Attachment:
 - a. Beam attachment shall be carbon steel.
 - b. Acceptable manufacturers:
 - 1) Carpenter & Patterson Fig. 151.
 - 2) B-Line B3082.
 - 3) Approved Equal.
- 10. Type K – double channel bracket:
 - a. Wall channel shall be single framing channel, or fiberglass where specified.
 - b. Cantilever bracket shall be a carbon steel, double framing channel assembly.
 - 1) Acceptable manufacturers:
 - a) Unistrut P2542 through P2546.
 - b) B-Line B297-12 through B297-36.
 - c) Aickinstrut 2000 series.
 - d) Approved Equal.
- 11. Type L – Single Channel Bracket:
 - a. Wall channel shall be single framing channel, or fiberglass where specified.
 - b. Cantilever bracket shall be a carbon steel single framing channel assembly.
 - 1) Acceptable manufacturers:
 - a) Unistrut P2231 through P2234.
 - b) B-Line B198-6, B198-12, B196-18 and B196-24.
 - c) Aickinstrut 2000 series.
 - d) Approved Equal.
- 12. Type M – Wall Mounted Channel:
 - a. Wall channel shall be single framing channel, or fiberglass where specified.
- 13. Type N – Pipe Stanchion Floor Attachment:
 - a. Baseplate shall be carbon steel with 1/2 inch minimum thickness.
 - b. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter.
 - c. The space between the baseplate and the floor shall be filled with non-shrink grout.

E. Accessories:

- 1. Hanger Rods:
 - a. Rods shall be carbon steel or as specified on the Drawings, threaded on both ends or continuous threaded and sized as specified.
- 2. Weldless Eye Nut:
 - a. Eye nut shall be forged steel and shall comply with MSS Type 17.
 - b. Acceptable manufacturers:
 - 1) Grinnell Fig. 290.
 - 2) B-Line B3200.
 - 3) Approved Equal.

3. Welded Eye Rod:
 - a. Eye rod shall be carbon steel or as specified on the Drawings with eye welded closed.
 - b. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter.
 - c. Acceptable manufacturers:
 - 1) Grinnell Fig. 278.
 - 2) B-Line B3211.
 - 3) Approved Equal.
4. Turnbuckle:
 - a. Turnbuckle shall be forged steel or as specified on the Drawings and shall comply with MSS Type 15.
 - b. Acceptable manufacturers:
 - 1) Grinnell Fig. 230.
 - 2) B-Line B3202.
 - 3) Approved Equal.
5. Framing Channel:
 - a. Framing channel shall be 1-5/8 inches square, roll formed, 12-gage carbon steel or as specified on the Drawings.
 - b. Channel shall have a continuous slot along one side with in-turned clamping ridges.
 - 1) Single channel:
 - a) Unistrut P 1000.
 - b) B-Line B22.
 - c) Approved Equal.
 - 2) Double channel:
 - a) Unistrut P 1001.
 - b) B-Line B22A.
 - c) Approved Equal.
 - 3) Triple channel:
 - a) Unistrut P 1004A.
 - b) B-Line B22X.
 - c) Approved Equal.
 - c. Provide end caps or end anchors as recommended by the manufacturer.
 - 1) Embedded concrete insert framing channel:
 - a) Unistrut P 3200 series.
 - b) B-Line B32I series.
 - c) Approved Equal.
 - 2) End caps or end anchors:
 - a) Unistrut P 3280 or P 3704.
 - b) B-Line B206 or B3332.
 - c) Approved Equal.

2.03 THERMAL PIPE HANGER SHIELD

- A. General:
 1. Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation.
 2. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer.
 3. The thermal shield shall be the same thickness as the piping system insulation specified in Section 40 42 00.
 4. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems.
 5. Stainless steel band clamps shall be used to ensure against slippage between the pipe wall and the thermal shield.
- B. Standard Shield:

1. Insulation:
 - a. Hydrous calcium silicate, high density, waterproof.
 - b. Compressive strength: 100 psi average.
 - c. Flexural strength: 75 psi average.
 - d. K factor: 0.38 at 100 degrees F mean.
 - e. Temperature range: 20 degrees F to 500 degrees F.
 2. Steel Jacket:
 - a. Galvanized steel.
 - b. Gage shall be the manufacturer's standard supplied for the given pipe size.
 3. Connection:
 - a. Shield shall have butt connection to pipe insulation.
 - b. Steel jacket and insulation shall be flush with end.
- C. Vapor Barrier Shield:
1. Insulation:
 - a. Hydrous calcium silicate, high density, waterproof.
 - b. Compressive strength: 100 psi average.
 - c. Flexural strength: 75 psi average.
 - d. K factor: 0.38 at 100 degrees F mean.
 - e. Temperature range: 20 degrees F to 500 degrees F.
 2. Steel Jacket:
 - a. Galvanized steel.
 - b. Gage shall be the manufacturer's standard supplied for the given pipe size.
 3. Connection:
 - a. Shield shall have butt connection to pipe insulation.
 - b. Insulation shall extend 1 inch each side of steel jacket for vapor-tight connection to pipe insulation vapor barrier.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

- A. Locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the Drawings to support continuous pipeline runs unaffected by concentrated loads.
- B. Locate at least one hanger or support within 2 feet from a pipe change in direction.
- C. For any valve 6 inches in size and greater, locate at least one hanger or support within 2 feet in either direction of the valve.
- D. Locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.
- E. Provide pipe supports at spacings in compliance with applicable SMACNA and SPC requirements.
- F. Where piping is connected to equipment, a valve, piping assembly, etc., which will require removal for maintenance, the piping shall be supported in such a manner that temporary supports are not necessary for this procedure.
- G. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

- A. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC 325. Unless otherwise indicated, do not drill or burn holes in the building structural steel.
- B. Do not use hanger components for purposes other than that for which they were designed. Do not use them for rigging and erection purposes.
- C. Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Make butt joint connections to pipe insulation at the time of insulation installation in accordance with the manufacturer's recommendations.
- D. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.
- E. Rollers shall roll freely without binding.
- F. Prior to grouting, rough finished floor beneath Type N structural attachments and framing channel post bases. Grout between base plate and floor shall be free of voids and foreign material.
- G. Cut and drill baseplates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.
- H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 FIELD QUALITY CONTROL

- A. Welded connections visual inspection and nondestructive weld testing:
 - 1. As specified in Section 05 05 20.

3.04 ADJUSTMENTS

- A. Adjust hangers and supports to obtain required pipe slope and elevation.
- B. Shims made of material that is compatible with the piping material may be used.
- C. Adjust stanchions prior to grouting their baseplates.

3.05 ANCHOR BOLTS

- A. Anchor bolt material and installation requirements shall conform to Specification Sections 05 05 19 and 05 05 23.

END OF SECTION

SECTION 40 05 42

SEISMIC RESTRAINTS FOR PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies seismic restraints for bracing all piping systems specified in Section 40 05 01. This Section does not include seismic restraints for fire sprinkler systems.

1.02 DEFINITIONS

- A. Longitudinal direction: direction parallel to the pipe axis.
- B. Lateral direction: direction perpendicular to the pipe axis.

1.03 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASCE 7	Minimum Design Loads for Buildings and Other Structures
AISC 360	American Institute of Steel Construction, Steel Construction Manual
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures
MFMA	Metal Framing Manufacturer's Association
MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
SMACNA	Seismic Restraints Manual

1.04 OPERATING CONDITIONS

- A. The seismic restraints specified in this Section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event in accordance with the Drawings.
- B. Unless otherwise specified, all piping shall have bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity.
- C. Seismic loading criteria: Section 01 73 00.
1. Unless noted otherwise, all piping shall have a Seismic Importance Factor, $I_p = 1.0$.

1.05 RESTRAINT SELECTION

- A. Unless otherwise specified, the Contractor shall select, locate and provide seismic restraints for piping.
- B. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
- C. Seismic bracing and anchoring shall be provided for all piping as described in Section 01 73 00.

- D. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
- E. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
- F. There shall be no contact between a pipe and restraint component of dissimilar metals. The Contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
- G. Branch lines shall not be used to brace main lines.
- H. Seismic bracing shall not limit the expansion and contraction of the piping system.

1.06 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's catalog data on pipe attachments, restraints, braces, fittings and accessories including load capacities. Drawings showing location and type of seismic bracing to be installed.
 - 2. Provide seismic bracing and anchorage design as required by Section 01 73 00.
 - 3. A legend to the piping layout drawings required by Section 40 05 01 that gives load information and restraint component selection at each restraint location.
 - 4. Fabrication drawings for fabricated components.
 - 5. Welding data and weld inspection reports, as specified in Section 05 05 20.

PART 2 PRODUCTS

2.01 GENERAL

- A. Acceptable Manufacturer:
 - 1. Carpenter & Patterson.
 - 2. B-Line.
 - 3. Kin-Line.
 - 4. ITT Grinnell.
 - 5. Michigan.
 - 6. Pipe Shields Incorporated.
 - 7. Superstrut.
 - 8. Unistrut.
 - 9. Approved Equal.
- B. Pipe restraint components shall conform to the requirements of MSS SP-58 and MFMA.
- C. Copper pipe shall be provided with dielectric wrap (see Section 40 05 17).

2.02 MATERIALS

- A. Service Environment: Pipe hangers and supports, structural attachments, fittings and accessories:
 - 1. Dry Service Environment: Zinc plated or mechanically galvanized after fabrication. Nuts, bolts and washers: galvanized or zinc-plated.
 - 2. Wet or Corrosive Environment: type 304 or 316 stainless steel, nuts, bolts and washers stainless.

2.03 PIPE ATTACHMENTS

- A. Type 1s: Clevis Restraint Attachment:
 - 1. Type 1, clevis pipe hanger, as specified in Section 40 05 41.
- B. Type 3s: Double Bolt Restraint Clamp:
 - 1. Type 3, double bolt pipe clamp, as specified in Section 40 05 41.
- C. Type 4s: Roller Restraint Attachment:
 - 1. Type 4, adjustable roller hanger, as specified in Section 40 05 41.
 - 2. Hold down strap shall be carbon steel and sized as follows:

Pipe size (in.)	Hold down strap (in.)	Hold down strap thickness (in.)
1 to 2	1	1/8
2½ to 4	1¼	3/16
6	2	3/16
8	2½	3/16
10 to 16	2½	1/4
20	3	1/4
24	3	3/8

- D. Type 7s: U-Bolt Restraint:
 - 1. Type 7, U-bolt, as specified in Section 40 05 41.
- E. Type 13s: Framing Channel Strap Restraint:
 - 1. Type 13, framing channel pipe strap, as specified in Section 40 05 41.
- F. Type 14s: Pipe Clamp Restraint:
 - 1. Carbon steel, with configuration and components equivalent to MSS Type 4.
 - 2. Rod attachment and longitudinal brace connection stud shall be carbon steel, fabricated and welded by the manufacturer.
 - 3. Steel pipe (uninsulated):
 - a. Superstrut No. S-720.
 - b. Kin-Line No. S475.
 - c. Approved Equal.

2.04 TRAPEZE RESTRAINTS

- A. General: Unless otherwise indicated, trapeze members shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.
- B. Pipe attachments shall be Type 7s or 13s as specified in this Section.
- C. Rod stiffeners, longitudinal and lateral braces shall be as specified in this Section.
- D. Type 20s: Single Channel Lateral Restraint:
 - 1. Cross member shall be 1-5/8 inch square carbon steel framing channel.
 - 2. Acceptable manufacturer:
 - a. Unistrut P1000.
 - b. B-Line B22.
 - c. Superstrut A-1200.
 - d. Approved Equal.
- E. Type 21s: Double Channel Lateral Restraint:

1. Cross member shall be double channel manufactured assembly.
2. Acceptable manufacturer:
 - a. Unistrut P1001.
 - b. B-Line B22A.
 - c. Superstrut A-1202.
 - d. Approved Equal.

F. Type 22s: Double Channel Longitudinal Restraint:

1. Cross member shall be a double channel manufactured assembly.
2. Acceptable manufacturer:
 - a. Unistrut P1001.
 - b. B-Line B22A.
 - c. Superstrut A-1202.
 - d. Approved Equal.

2.05 BRACES AND FITTINGS

A. Seismic Brace Fitting:

1. Manufactured for use with industry standard framing channel.
2. Carbon steel, welded construction, two-piece linked fitting.
3. Provide a means to reduce noise and vibration transmission between the linked fitting parts.
4. Acceptable manufacturer:
 - a. Superstrut C-749N series seismic brace.
 - b. Kin-Line No. 633 seismic connector fitting.
 - c. Approved Equal.

B. Hanger Rod Stiffener Assembly:

1. Rod stiffener channel shall be 1-5/8 inch square carbon steel framing channel.
2. Rod stiffener channel shall be:
 - a. Unistrut P1000.
 - b. B-Line B-22.
 - c. Superstrut A-1200.
 - d. Approved Equal.
3. Rod stiffener clamps shall be complete with channel nut.
4. Rod stiffener clamps shall be:
 - a. Superstrut ES-142.
 - b. Kin-Line No. 635.
 - c. Approved Equal.

C. Type A1 Seismic Brace:

1. Shall be 1-5/8 inch square carbon steel framing channel.
2. Acceptable manufacturer:
 - a. Unistrut P1000.
 - b. B-Line B22.
 - c. Superstrut A-1200.
 - d. Kin-Line No. 4112.
 - e. Approved Equal.

D. Type A2 Seismic Brace:

1. Shall be 1-5/8 inch wide by 3-1/4 inch deep carbon steel framing channel.
2. Acceptable manufacturer:
 - a. Unistrut P 5000.
 - b. B-Line B-11.
 - c. Superstrut H-1200.
 - d. Kin-Line No. 8212.
 - e. Approved Equal.

2.06 STRUCTURAL ATTACHMENTS

- A. General:
 - 1. Unless otherwise indicated, hanger rod structural attachments shall be as specified in Section 40 05 41.
 - 2. Structural attachments for longitudinal and lateral seismic braces shall be as specified in this Section.
- B. Type SA-1 Attachment:
 - 1. Brace fitting shall be as specified in this Section.
 - 2. Concrete anchors shall be as specified in Section 05 05 23 with embedment and location dimensions as specified.
- C. Type SA-2 Attachment:
 - 1. Brace fitting shall be as specified in this Section.
 - 2. Concrete anchors shall be as specified in Section 05 05 23 with embedment and location dimensions as specified.
 - 3. Framing channel shall be as specified in this Section.
- D. Type SA-3 Attachment:
 - 1. Brace fitting shall be as specified in this Section.
 - 2. Cap screw, lockwasher and hex nut materials and finish shall be compatible with structural steel material.
- E. Type SA-4 Attachment:
 - 1. Brace fitting shall be as specified in this Section.
- F. Type SA-5 Attachment:
 - 1. Brace fitting shall be as specified in this Section.
 - 2. Four-inch x 3-inch x 3/8-inch angle shall be carbon steel.

2.07 ACCESSORIES

- A. Hanger Rods:
 - 1. Carbon steel, threaded on both ends or continuous threaded and sized as specified.
- B. Framing Channel:
 - 1. Shall conform to MFMA standard.
 - 2. Roll formed, 12-gage carbon steel.
 - 3. Continuous slot along one side with in-turned clamping ridges.
 - 4. Acceptable manufacturer:
 - a. Unistrut P1000 series.
 - b. B-Line B22 series.
 - c. Superstrut A-1200 series.
 - d. Approved Equal.
- C. Rod Coupling:
 - 1. Carbon steel, with sight hole in center of coupling body.
 - 2. Acceptable manufacturer:
 - a. Grinnell Fig. 135.
 - b. Superstrut H-119.
 - c. Approved Equal.
- D. Thermal Pipe Hanger Shield:

1. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in Section 40 05 41.
2. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

PART 3 EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

- A. Locate the first seismic restraint on a piping system not more than 10 feet from the main riser, from an entrance to a building, or from a piece of equipment.
- B. Brace cast iron pipe on each side of a change in direction of 90 degrees or more. Brace or stabilize joints in risers between floors.
- C. Brace no-hub and bell and spigot cast iron soil pipe longitudinally every 20 feet and laterally every 10 feet.
- D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.
- E. Seismic restraint locations and components shall be indicated on the piping layout drawings required by Section 40 05 01.

3.02 INSTALLATION

- A. Use rod stiffener assemblies at seismic restraints for hanger rods over 6 inches in length. Use a minimum of two rod stiffener clamps on any rod stiffener assembly.
- B. Install lateral and longitudinal bracing between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.
- C. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC 325. Do not drill or burn holes in the building structural steel without approval of the Project Representative.
- D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in areas below water surface or normally subject to submerging.
- E. Install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Make butt joint connections to pipe insulation at the time of insulation installation in accordance with the manufacturer's recommendations.
- F. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.
- G. Rollers shall roll freely without binding.
- H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 8 feet above the floor.

3.03 FIELD QUALITY CONTROL

- A. Welded connections visual inspection and nondestructive weld testing:
 1. As specified in Section 05 05 20.

END OF SECTION

SECTION 40 05 44

EXPANSION JOINTS AND FLEXIBLE METAL HOSE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies piping expansion joints and flexible metal hose.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
EJMA	Standards of Expansion Joint Manufacturers' Association

1.03 PERFORMANCE AND SERVICE CONDITIONS

- A. Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in PIPESPEC.
- B. Flexible metal hose shall be suitable for a line pressure equal to the test pressure listed in the PIPESPEC.
- C. Design Requirements:
1. Flexible Metal Hose: Live lengths for flexible metal hose shall be based upon the service conditions listed in this Section and have a design life of 1,000,000 full displacement cycles.
 2. Expansion Joints: Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's catalog data, including dimensions, materials of construction and allowable deflection.
 2. Product data.
 3. Design and construction details of formed metal bellows type expansion joints.
 4. Pressure thrust force and spring rate data for formed bellows expansion joints.
 5. Details for installation of all expansion joints.
 6. Certificate from manufacture for sewer application (where expansion joint or flexible hose is used for raw sewage).

PART 2 PRODUCTS

2.01 EXPANSION JOINTS

- A. Metal Construction:
1. Formed Bellows Type:

- a. Medium Temperature (up to 800 degrees F):
 - 1) Having 300 series stainless steel multi-ply bellows rated for the specified design temperature and pressure.
 - 2) Test pressures: Specified in Section 40 05 01. Each expansion joint shall be factory tested at the test pressure.
 - 3) Piping expansion joints: Expansion joints at hot water piping shall be rated at no less than one-and-a-half times boiler relief pressure.
 - 4) Design: Determined by the amount and kind of movement specified (axial, lateral, angular).
 - 5) End connections: Unless otherwise specified, flanged.
 - 6) Acceptable manufacturers:
 - a) Flexonics, Inc.
 - b) Hyspan Precision Products, Inc.
 - c) American BOA Inc.
 - d) Approved Equal.
- b. High Temperature (up to 2000 degrees F):
 - 1) Engine and gas turbine exhaust expansion joints: Multi-ply bellows type designed for 15 psig.
 - 2) Bellows: Constructed of 300 series stainless steel.
 - 3) End connections: Unless otherwise specified, either the fixed flange or Vanstone flange configuration.
 - 4) Flange material: Carbon steel for temperatures up to 1000 degrees F and stainless steel for temperatures above 1000 degrees F. Vanstone materials and flow liners, where specified, shall be the same as bellows material.
 - 5) Acceptable manufacturers:
 - a) GT Exhaust System.
 - b) Flexonics DEX Series.
 - c) Hyspan Series 2500.
 - d) American BOA Series 025E
 - e) Approved Equal.
2. Steel Expansion Compensator Type:
 - a. Having 2-ply stainless steel bellows and carbon steel shroud and end fittings.
 - b. Rated for 175 psi maximum working pressure and 750 degrees F.
 - c. Acceptable manufacturers:
 - 1) Flexonics Model H Expansion Compensator.
 - 2) Hyspan Series 8500.
 - 3) Keflex 7Q.
 - 4) Approved Equal.
3. Bronze Expansion Compensator Type:
 - a. Having multi-ply phosphor bronze or stainless steel bellows and copper tube end fittings.
 - b. Rated for 150 psi maximum working pressure and 400 degrees F.
 - c. Acceptable manufacturers:
 - 1) Flexonics Model HB Expansion Compensator.
 - 2) Hyspan Series 8500.
 - 3) Keflex 70.
 - 4) American BOA Inc.
 - 5) Approved Equal.

B. Elastomer and Fabric Construction:

1. General:
 - a. Standard spool arch type or the precision molded spherical design type as indicated or specified.
 - b. Expansion joint connectors: Having control units (restraints) to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer.
 - c. Single arch and sphere type expansion joints: Unless otherwise indicated, have 6-inch face-to-face dimension for pipe up to 8 inches and 8-inch face-to-face dimension for pipe 10 and 12

- inches. For use with larger diameters, Contractor shall obtain approval from the Project Representative.
- d. Cover elastomer: Chlorobutyl, neoprene, or EPDM.
 - e. Tube elastomer: For temperatures between 180 and 240 degrees F, chlorobutyl or EPDM. Neoprene or Buna N liners are acceptable for temperatures to 180 degrees F.
 - f. For raw sewer system the expansion joints material shall be compatible for sewer application. Provide certificate from the manufacturer for sewer application.
2. Spool Type:
- a. Resilient arch type and standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.
 - b. Constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body.
 - c. Retaining rings or backup rings:
 - 1) Provide for standard arch type expansion joints suitable for the specified temperature and pressure.
 - 2) 3/8-inch thick steel, split, either galvanized, zinc shield coated, or as specified on the Drawings.
 - d. Filled arch type shall be used on all piping systems carrying fluids containing solids.
 - e. Acceptable manufacturers:
 - 1) Single, multiple, or filled arch:
 - a) Mason Style EJBN.
 - b) Garlock Style 204.
 - c) Mercer Style 500.
 - d) Goodall Style E-1462.
 - e) General Style 1025.
 - f) Approved Equal.
 - 2) High pressure couplings suitable for 240 degree F operating temperatures:
 - a) Mason Style EJBN-HD.
 - b) Mercer Style 510.
 - c) Garlock Style 204-HP.
 - d) Goodall Style E-1489.
 - e) General Style 1015.
 - f) Approved Equal.
3. Spherical Molded Type:
- a. Precision molded of multiple plies of nylon tire cord fabric and elastomer suitable for specified temperature and pressure.
 - b. Having steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid.
 - c. Acceptable manufacturer (single sphere molded connectors):
 - 1) Mason Type MFNC.
 - 2) Mercer Type 5500.
 - 3) Goodall Type E-611.
 - 4) General Type 1010.
 - 5) Garlock Style 8100.
 - 6) Approved Equal.
 - d. Double sphere or triple sphere connectors shall be provided where required to provide for the specified movement.

2.02 FLEXIBLE METAL HOSE

- A. General:
1. Unless otherwise indicated, corrugated type 321 stainless steel with stainless steel fittings and provided with stainless steel single braid.
 2. End connections: Attached by the heliarc welding process using stainless steel welding rod.
 3. Bronze flexible metal hose shall be provided for copper and brass systems.

- B. Braided Type:
 - 1. Type A:
 - a. Acceptable manufacturers:
 - 1) Flexonics Series 401M/402M.
 - 2) Flexweld USFWSS-31/32.
 - 3) American BOA Series B.
 - 4) Approved Equal.
 - 2. Type B:
 - a. Acceptable manufacturers:
 - 1) Flexonics Series 301.
 - 2) Flexweld USFWB-31.
 - 3) American BOA Series B.
 - 4) Approved Equal.

2.03 TEFLON FLEXIBLE CONNECTORS [NOT USED]

PART 3 EXECUTION

3.01 INSTALLATION

- A. Locate expansion joints and anchors as specified. Location and number of guides shall be determined from EJMA Standards.
- B. Do not install expansion joints during times of extreme temperature or in a fully compressed or fully expanded condition.
- C. Thrust control shackles/rods shall be required for expansion joints 4 inches and larger to control distortion from pressure expansion.

3.02 ALIGNMENT

- A. Align piping systems prior to installation of expansion joints.
- B. Do not use expansion joints to correct piping misalignment during installations.
- C. Expansion joints shall be preset at the factory for rated axial compression and expansion. Install the expansion joints at the factory preset condition.

3.03 EXPANSION JOINT AND CONNECTOR SERVICE AND USE

- A. The piping systems expansion joints shall be installed as shown on the Drawings and/or as required for isolation vibration system Section 43 05 51.
- B. The expansion joints shall be provided to meet the piping system and equipment installation requirements and design criteria, including temperature, pressure and movement for each joint, are specified on the Drawings.
- C. Expansion joints and/or flexible metal hose connectors provided for specific equipment items or piping systems are specified on the following table:

TYPE OF EXPANSION JOINT CONNECTOR	TYPE OF SERVICE/USE
Metal Construction Formed Bellows Type; Medium temperature (2.01A1a)	Hot and chilled water, jacket water, steam, high pressure air, and gas and steel pipe lines subjected to ambient temperature differentials sufficient to require expansion joints.

TYPE OF EXPANSION JOINT CONNECTOR	TYPE OF SERVICE/USE
Metal Construction Formed Bellows Type; High temperature (2.01A1b)	Engine and gas turbine exhaust to meet the engine temperature and sufficient for the required vibration and expansion.
Metal Construction Steel Expansion Compensator Type (2.01A2)	Same type service/use as for "Formed Metal Bellow Type medium Temperature expansion joint" except size of piping is limited to 3-inch diameter or less.
Metal Construction Bronze Expansion Compensator Type (2.01A3)	Medium temperature copper piping
Elastomer and Fabric Construction Spool arch Type (2.01B2)	Pump/blower connectors and expansion joints for piping 14 inch diameter and larger. Except for steam and chemical lines.
Elastomer and Fabric Construction Elastomer Spherical Molded Type (2.01B3)	Pump/blower connectors and expansion joints for piping 12 inch diameter and less. Except for steam and chemical lines.
PVC Construction (2.01C1)	PVC piping.
Flexible Metal Hose Stainless Steel Braided Hose (2.02)	Air and gas compressor discharge connections.
Flexible Metal Hose Bronze Braided Hose (2.02)	Air compressor discharge and pump connectors for copper lines.

END OF SECTION

SECTION 40 05 47

PIPING APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies flow and level gages, pressure devices, strainers, sight glasses, vents, and drains.

1.02 REFERENCE STANDARDS [NOT USED]

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Appurtenances shall be located on the piping layout drawings by plant area submitted in accordance with Section 40 05 01.
 - 2. Manufacturer's product data
 - 3. A list of any deviations or substitutions.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise specified or shown on the Drawings:
 - 1. All equipment shall be the same size as the adjoining pipe.
 - 2. Body material of equipment shall match pipeline material.
 - 3. Pressure rating of equipment shall be no less than 150 PSI.
 - 4. Electrical housings shall be NEMA 4.
- B. All units shall have the name of the manufacturer and the size of the unit cast on the body or shown on a permanently attached plate in raised letters.
- C. All equipment provided shall be equipped with flanges, integral unions, or other functional take-a-parts.

2.02 PIPELINE THERMOMETERS [NOT USED]

2.03 FLOW AND LEVEL GAGES

- A. Rotameters:
 - 1. Purge Rotameters (Seal Water):
 - a. General:
 - 1) Variable area type.
 - 2) Factory assemblies with integral needle valve and flow controller.
 - 3) Elastomers: Buna-N, EPDM.
 - 4) Range: 2 - 20 gpm
 - 5) 200 psi working pressure.
 - b. Flow control valve shall be pressure compensated to maintain set flow rate with constant upstream pressure and variable downstream pressure.
 - c. Rotameters for standard service:
 - 1) Materials:

- a) Meter tube: glass.
 - b) Body, frame, float: 316 stainless steel.
- 2) Acceptable manufacturers:
 - a) Brooks: Sho-Rate.
 - b) Approved Equal.

B. Sight Gages:

- 1. Type and material: automatic water gage complete with Pyrex gage glass and gage glass protector.
- 2. Overall length of gages, type of mounting, and orientation of set shall be as specified.
- 3. Acceptable manufacturers:
 - a. 3/4-inch Penberthy 205 Series.
 - b. Lunkenheimer Fig. 589.
 - c. Approved Equal.

C. Flow Indicators:

- 1. Flow indicators shall be provided where specified.
- 2. Fabrication: bronze body with threaded ends and a sight glass with rotary wheel.
- 3. Pressure ratings for flow indicators shall match pipe pressure ratings.
- 4. Acceptable manufacturers:
 - a. Jacoby-Tarbox.
 - b. Schutte & Koerting.
 - c. Eugene Ernst Products.
 - d. Approved Equal.

2.04 PRESSURE DEVICES

A. Gage Cocks:

- 1. The exposed threads of each gage cock shall be protected by a brass plug.
- 2. Unless otherwise indicated, acceptable manufacturers:
 - a. Robertshaw 1303.
 - b. Ashcroft 1095.
 - c. Approved Equal.

B. Pressure Gages:

- 1. Unless otherwise indicated, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale.
- 2. Diameter: 4½ inch.
- 3. Movement: 270 degrees.
- 4. Accuracy: 0.5 percent.
- 5. Case: non-metallic case with a 1/2-inch NPT bottom connection.
- 6. Type: premium grade, heavy duty Type 316 stainless steel bourdon tube units with plastic bushings and pinion, and stainless steel sector. Internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill; snubbers or orifices are not acceptable.
- 7. All gauges shall be vertically oriented.
- 8. Bleed-off valves shall be bronze gage cocks pressure rated for 150 psi.
- 9. Acceptable manufacturers:
 - a. Ashcroft Duragage 1279.
 - b. Ametek 198 IL.
 - c. Approved Equal.

C. Diaphragm Seals:

- 1. Type 1:
 - a. Body and diaphragm material: Type 316 or Type 316L stainless steel.
 - b. Flushing connection: 1/4-inch.
 - c. Process connection: 1/2-inch.

- d. Unless otherwise indicated, fill fluid shall be Silicone DC200.
 - e. Acceptable manufacturers:
 - 1) Ashcroft Type 101.
 - 2) Ametek.
 - 3) Approved Equal.
 - 2. Type 2:
 - a. Type: flexible sleeve type.
 - b. Size: 1-inch, unless otherwise indicated.
 - c. Unless otherwise indicated, sleeve shall be Buna-N.
 - d. Acceptable manufacturers:
 - 1) Red Valve Series 742.
 - 2) Ashcroft Type 85.
 - 3) Approved Equal.
- D. Flexible Sleeve Pressure Sensors:
- 1. Type: in-line full stream captive sensing liquid type.
 - 2. Materials:
 - a. Metal parts, wetted: 316 stainless steel.
 - b. Sleeve: Buna-N, unless otherwise indicated.
 - c. Capillary tubing: armored stainless steel.
 - 3. Seals:
 - a. Rated for 200 psi with 5-inch SC hysteresis.
 - b. Acceptable manufacturer:
 - 1) Ronningen-Petter.
 - 2) Red Valve.
 - 3) Approved Equal.
 - 4. Fill fluid shall be rated for a temperature range of -20 degrees F to 200 degrees F.
 - 5. Vacuum filling: Fittings shall be provided for vacuum filling of system. Systems that are not factory filled shall be vacuum filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.05 STRAINERS

- A. Air and Gas Strainers:
- 1. Unless otherwise indicated, air and gas line strainers shall be Y-pattern with 40 mesh Monel screens packed with Everdur wool.
 - 2. Bronze bodies shall be provided with copper piping. Cast iron bodies shall be provided with steel piping. Strainer bodies connected to gas piping at boiler gas train shall be 316 stainless steel.
 - 3. Airline strainers shall be fitted with a brass blow-off ball valve.
 - 4. Acceptable manufacturers:
 - a. Mueller.
 - b. Armstrong.
 - c. Approved Equal.
- B. Water Strainers:
- 1. Unless otherwise indicated, water strainers shall be Y-pattern.
 - 2. Bronze bodies shall be provided with copper piping. Cast iron bodies shall be provided with steel piping.
 - 3. Strainers shall have 304 stainless steel screens and tapped and plugged blowoff connections.
 - 4. Screen perforations shall be 0.040 inch or less.
 - 5. Acceptable manufacturers:
 - a. Mueller.
 - b. Armstrong.
 - c. Approved Equal.

2.06 QUICK CONNECT FITTINGS

- A. Air and water utility station quick connect fittings: Section 40 05 80.
 - 1. Acceptable manufacturers:
 - a. Dixon Air King.
 - b. Chicago Pneumatic.
 - c. Approved Equal.
- B. All other quick connect fittings:
 - 1. Type: Coupler type, with cam arms. Capable of connecting to a hose adapter without the use of tools.
 - 2. Size: The same size as the pipeline.
 - 3. Materials: PVDF with Teflon gaskets.
 - 4. Acceptable manufacturers:
 - a. Kamlock.
 - b. Chicago Pneumatic.
 - c. Approved Equal.

PART 3 EXECUTION

3.01 GAGE TAPS

- A. Provide gage taps on the suction and discharge of pumps, fans, compressors, vacuum pumps and blowers.
- B. Gage taps shall consist of a ¼-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.02 VENTS AND DRAINS

- A. Vents:
 - 1. Provide manual air vents at the high points of each reach of pipeline shown on the Drawings, and provide additional manual drains as required and specified by the Project Representative after completion of piping installation.
 - 2. Air vents shall be 1-inch and shall consist of full port ball valve and copper tubing return.
 - 3. Air vents shall be taken to the nearest floor with ball valve mounted 4 feet above the floor.
 - 4. Fit vents in piping systems for fluids containing solids with quick couplers.
- B. Drains:
 - 1. Pipe each drain to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor.
 - 2. Drain valves in piping systems for fluids containing solids shall be threaded end full port plug valves of the size specified, fitted with quick couplers. All other drain valves shall be threaded end gate valves of the size specified, fitted with quick couplers.
 - 3. When a drain cannot be run to a collection point, route the drain to a point of easy access and install a valve, of the type and size specified, fitted with a male threaded nipple suitable for connection to a hose.

END OF SECTION

SECTION 40 05 48

WALL PENETRATION SEALS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies standard wall penetration seals for above grade pipe penetrations, and watertight wall penetration seals for below grade pipe penetrations.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail

Reference	Title
ASTM E814	Fire Tests of Penetration Firestop Systems

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. The following information shall be provided in accordance with Section 01 33 00:
 - 1. Manufacturer's product data including descriptive literature about the material and installation procedures.

PART 2 PRODUCTS

2.01 STANDARD WALL PENETRATION

- A. Fire Stop Wrap:
 - 1. As specified in 07 84 00, Firestopping.
- B. Firestop Sealant:
 - 1. As specified in 07 84 00, Firestopping.
- C. Metal sleeve: 20-gage galvanized steel.
- D. Chrome-plated escutcheon plates shall be 1 inch larger in diameter than wall opening.

2.02 WATERTIGHT WALL PENETRATION MECHANICAL SEAL

- A. Acceptable Manufacturer:
 - 1. Thunderline Link-Seal.
 - 2. Approved Equal.
- B. Materials:
 - 1. Modular mechanical type, interlocking synthetic rubber links, sized to fill annulus between pipe and wall opening.
 - 2. Rubber links expanded to form watertight seal with Type 304 or 316 stainless steel bolts and hardware.

- C. Fabrication:
 - 1. Cast-in-place anchor and waterstop or core drilled.
 - 2. Size as recommended by the manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Standard Wall Seal:
 - 1. Concrete structure and masonry walls.
 - 2. Minimum of 2 inches larger than outside diameter of pipe.
 - 3. Wrap strip around pipe and caulk around piping with caulking full length of sleeve.
 - 4. Caulk evenly to outside of sleeve.
 - 5. Follow manufacturer's installation recommendations.
 - 6. Pipe penetrations through walls above grade cored 1 inch larger than pipe.
 - 7. Provide wall escutcheon plates when piping is installed in finished areas.
- B. Watertight Wall Seal: Install at locations as shown on the Drawings and at wall penetrations below finish floor elevation and tighten seal as recommended by the manufacturer.

END OF SECTION

SECTION 40 05 57

ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies manual actuator for valves and gates.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AWWA C500	Metal-Seated Gate Valves for Water Supply Service

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Affidavits of compliance, as required by AWWA C500.
 2. Materials of construction.
 3. Operations and maintenance manuals as specified in Section 01 78 23.
 4. Catalog cuts of all furnished components and equipment, including dimensions and weight.
 5. Field test schedule and procedure including test forms.
 6. Test reports.
 7. Bill of Materials, including Form 01 78 45-A.

PART 2 PRODUCTS

2.01 OPERATORS

- A. General:
1. Actuator to be factory-mounted on the valve or gate and provided as a unit.
 2. Each valve body or actuator shall have cast thereon the word OPEN, an arrow indicating the direction to open, and flow direction arrows.
 3. Materials of construction shall be suitable for the installed environment.

2.02 MANUAL ACTUATORS

- A. General:
1. Manual operators shall have operating torques less than 80 foot-pounds.
 2. Unless otherwise indicated, each manual operator shall be provided with an operating wheel.
 3. Unless otherwise indicated, the direction of rotation of the operator shall be counterclockwise for opening.
 4. Provide lever actuators for plug valves, butterfly valves, and ball valves 3-inch diameter and smaller.
 - a. Lever actuators for butterfly valves shall have a minimum of 5 intermediate lock positions between full open and full close.
 - b. Provide a minimum of (2) levers for each type and size of valve furnished.

5. Wrench nuts: Wrench nuts shall comply with AWWA C500. A minimum of 2 operating keys, but no less than 1 key per every 10 valves, shall be provided for operation of the wrench nut operated valves.
6. Gear actuators required for plug valves, butterfly valves, and ball valves 4-inch diameter and larger.
 - a. Gear actuators are to be totally enclosed, permanently lubricated with sealed bearings.
 - b. For plug-type valves 8 inches and larger, the actuator shall be provided with a hammer blow wheel.
7. Chain wheels:
 - a. Chain wheels for interior locations shall be ductile iron, unless otherwise specified or required by the manufacturer to be suitable for the installed environment.
 - b. Operating chains for interior locations shall be galvanized.
 - c. Chain wheels and operating chains for exterior locations shall be 304 stainless steel. Chain wheels and operating chains for corrosive locations shall be 316 stainless steel.
8. Provide chain wheel actuators for any valve over 7 feet above the floor or deck.

PART 3 EXECUTION

3.01 GENERAL

- A. Manual Actuators:
 1. General: Unless otherwise indicated, valves and gates shall be provided with manual actuators. Manual actuators shall be positioned so that they can be readily operated.
 2. Wrench nuts: Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.
 3. Chain wheels: Unless otherwise indicated, valves with centerlines more than 6 ft above the specified operating level shall be provided with chain wheels and operating chains:
 - a. Chain wheel operated valves shall be provided with a chain guide.
 - b. Operating chains shall be looped to extend within 4 feet of the specified operating level below the valve.
 - c. Hooks on adjacent piping shall be provided for chain storage where chain hangs in foot traffic.
- B. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 FIELD QUALITY CONTROL

- A. Field Tests
 1. Section 01 75 20. Include testing to the manufacturers' testing requirements.
 2. Each valve, after installation and connection to the piping system, shall be cycled three times manually to demonstrate proper operation.
 3. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 05 59.33

CAST IRON SLIDE GATES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies cast iron slide gates used for drainage of wastewater from the RSP wetwell influent channel.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.	POWERED OPERATOR?
Influent Channel Drainage Slide Gate, RSP #1 Drain Gate	704-SG35GT011	No
Influent Channel Drainage Slide Gate, RSP #2 Drain Gate	704-SG35GT013	No
Influent Channel Drainage Slide Gate, RSP #3 Drain Gate	704-SG35GT014	No
Influent Channel Drainage Slide Gate, RSP #4 Drain Gate	704-SG35GT016	No
Influent Channel Drainage Slide Gate, RSP Wetwell East Drain Gate	704-SG35GT015	No
Influent Channel Drainage Slide Gate, RSP Wetwell West Drain Gate	704-SG35GT012	No

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A126	Gray Iron Casting for Valves, Flanges and Pipe Fittings
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM B103	Phosphor Bronze Plate, Sheet, Strip and Roller Bar
ASTM B139	Phosphor Bronze Rod, Bar and Shapes
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWWA C560	Cast Iron Slide Gates

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Perform measurements and verification of existing conditions of the components of the influent channel drainage slide gates and coordinate replacement with Formed Suction Inlet Planning and Execution Activities per Section 05 58 01.

2. Existing wall thimbles, gate stem pipe sleeves embedded in concrete wall, and floor boxes embedded in floor slab shall be reused unless determined to be unacceptable during FSI replacement planning activities inspection specified in Section 05 58 01.
3. The gates listed below were determined to not be functional when using existing operating nut and are therefore assumed to require replacement of the cover slide, frame, stem, and operating nut assembly:

Equipment	Equipment No.
Influent Channel Drainage Slide Gate, RSP Wetwell East Drain Gate	704-SG35GT015
Influent Channel Drainage Slide Gate, RSP Wetwell West Drain Gate	704-SG35GT012

4. The gates listed below were determined to be functional when using the existing operating nut and it is therefore assumed the existing gate stem and operating nut assembly can be reused if compatible with the new slide gate. Provide new cover slide and frame for the gates. Provide new gate stem and operating nut assembly if the existing gate stem and operating nut assembly are not compatible with new cover slide and frame:

Equipment	Equipment No.
Influent Channel Drainage Slide Gate, RSP #1 Drain Gate	704-SG35GT011
Influent Channel Drainage Slide Gate, RSP #2 Drain Gate	704-SG35GT013
Influent Channel Drainage Slide Gate, RSP #3 Drain Gate	704-SG35GT014
Influent Channel Drainage Slide Gate, RSP #4 Drain Gate	704-SG35GT016

5. Operating forces used for determining the strength of gate components comprised of frames, cover slides, stems, cover slide nut pockets, and other load-bearing members shall be based on the sum of the guide friction force (computed using an opening breakaway friction factor of 0.70) and the weight of cover slide and stem.
6. When the gate is in motion, the operating forces shall be based on the sum of the frictional force (using a guide friction factor of 0.35) and the weight of cover slide and stem.
7. Gates shall meet the following requirements, unless the inspection specified in Section 05 58 01 reveals conditions that require the Contractor to propose an alternative configuration:

Equipment No.	704-SG35GT011 - 704-SG35GT016
Size (inches)	6
Gate Type ^d	FM
Opening Direction ^a	U
Bottom seating ^b	FB
Frame Type ^c	S or SC (as proposed and required)
Design Seating Head, ft	20
Unseating Head, ft	25
Operator Type ^e	Type II

Notes:

^a U = upward opening.

^b FB = flush bottom.,

^c S = standard; SC = self-contained (yoke type).

^d FM = face-mounted.

^e As specified below.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Proposed gate assembly details and dimensional information to verify compatibility with existing components that are specified to remain and be reused.
 - 2. Product information, calculations, charts or graphs.
 - 3. Calculations: include breakaway lift and thrust forces, clearly showing the weight of the cover slide, weight of stem, coefficient of friction and design head.
 - 4. Dimensioned drawings of gates, mounting components and operators.
 - 5. Dimensioned drawings, plans, cross section, and details showing assembled gates with mounting and operators.
 - 6. Details of refurbishment required of existing mounting surfaces at each gate necessary to provide acceptable surface for proposed replacement gates.
 - 7. Shop test procedures.
 - 8. Results of the shop seat clearance check and the leakage tests as specified in AWWA C560.
 - 9. Manufacturer's installation instructions.
 - 10. Operations and Maintenance information: Section 01 78 23.

1.05 QUALITY ASSURANCE

- A. Slide gates and all components shall meet the requirements of AWWA C560.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturer
 - 1. Rodney Hunt/JASH.
 - 2. Waterman.
 - 3. Hydro Gate.
 - 4. Approved Equal.

2.02 GENERAL

- A. Cover slides shall be one-piece construction with integrally cast vertical and horizontal reinforcing ribs. The maximum allowable clearance between the cover slide and the slide guides shall be 1/16-inch. A thrust-nut pocket shall be reinforced by ribs.
- B. Frames shall be one-piece integral casting compatible with existing mounting surface refurbished as necessary for mounting of frame.
- C. Use existing wall thimbles. Refurbish mounting surface as necessary for mounting of frame.
- D. Single non-rising stems.

- E. Stems and stem guides, where required, shall be in accordance with AWWA C560.
- F. Stem couplings, where required, shall be of the stem material.
- G. Stem guides, where required, shall be of the split, bronze bushed, adjustable type.

2.03 MATERIALS

- A. Slide Gate:
 - 1. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
 - 2. Materials of construction:

Component	Material
Frame and cover slide	ASTM A126, Class B, cast iron
Seating faces	ASTM B98, B103 or B139, bronze
Wall thimbles	existing – refurbish as necessary
Stems (if replaced)	ASTM A276, stainless steel, Type 304
Wedges, thrust nut	ASTM B584, bronze, CA872 stem couplings
Fasteners and adjusting hardware	ASTM A276, stainless steel, Type 304 or ASTM F593 and F594, stainless steel, group 1 or group 2
Yoke (if proposed)	ASTM A126, Class B, cast iron
Flush bottom seal	Neoprene
Flush bottom retainer	ASTM A276, stainless steel, Type 304 bar

2.04 OPERATORS

- A. Type II: Manual T-wrench operated nut:
 - 1. General:
 - a. T-wrench: 4 feet long, aluminum, with socket to match the operating nut.
 - 2. Floor box:
 - a. Use existing floor boxes unless determined to be unacceptable during FSI replacement planning activities inspection specified in Section 05 58 01.
 - b. If replacement required, provide fabricated steel, with galvanized steel hinged cover and embedded in the floor similar to existing.
 - c. If replacement required, depth shall be such that the gate stem and operating nut do not protrude above the floor under any condition.
 - 3. Thrust bearings if applicable: Roller or ball bearing type, replaceable and protected by seals.
 - 4. Accessible pressure type grease fittings: Provide for bearing lubrication.
 - 5. Operating nuts: AWWA standard 2-inch square head nuts.

2.05 FINISHES

- A. Shop coated with coating system A1 per Section 09 90 00.

2.06 SOURCE QUALITY CONTROL

- A. Factory Tests: Shop seat clearance and operating tests per AWWA C560.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.
- B. Coordinate installation with requirement Section 05 58 01.
- C. Refurbish existing mounting surfaces to provide acceptable surface for proposed replacement gates.
- D. Clean gate stem pipe sleeves embedded in concrete wall.

3.02 TESTING

- A. Field operating and leakage tests: AWWA C560.

END OF SECTION

SECTION 40 05 62

ECCENTRIC PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies eccentric plug valves.
- B. Valve List:

VALVE	VALVE NO.	POWERED OPERATOR?
RSP Sampler Feed Pump 1 Inlet Plug Valve	704-PLV240381	No
RSP Sampler Feed Pump 2 Inlet Plug Valve	704-PLV240391	No
RSP Sampler Feed Pump 1 Discharge Plug Valve	704-PLV240383	No
RSP Sampler Feed Pump 2 Discharge Plug Valve	704-PLV240393	No
RSP Pump Room Sump Pump 1 Discharge Plug Valve	704-PLV350405	No
RSP Pump Room Sump Pump 1 Discharge Plug Valve	704-PLV350407	No
Stand-by Generator Propane Isolation Valve 1	704-PLV160415	No

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	Ductile Iron Castings
AWWA C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
AWWA C606	Grooved and Shouldered Joints

1.03 VALVE DESCRIPTION

- A. Design Requirements:
1. Unless otherwise indicated, valves shall have the following minimum pressure ratings:

Valve Size	Working Pressure
12 inches and smaller	175 psi

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's product data, catalog cuts, and shop drawings detailing materials of fabrication, assembly, dimensions, and flow capacity.
 - 2. Manufacturer's installation instructions.
 - 3. Proof of design tests.
 - 4. Certified C_v value test results from an approved laboratory for all valve sizes.
 - 5. Certified drawings for spherical solid passage.

1.05 QUALITY ASSURANCE

- A. Design Tests:
 - 1. Three certified copies of a report from an independent testing laboratory certifying successful completion of proof-of-design testing conducted in accordance with AWWA C517. In lieu of testing the valves at an independent testing laboratory, proof-of-design testing may be performed at the valve manufacturer's laboratory, and witnessed by a representative of a qualified independent testing laboratory.
 - 2. All test reports shall be certified by the laboratory representative.
 - 3. Perform proof-of-design testing on at least one valve of each size and class, with all test units demonstrating full compliance with the test standards.
 - 4. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Dezurik PEC / PEF.
 - 2. Milliken Millcentric.
 - 3. Pratt Ballcentric.
 - 4. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Body	Cast Iron, ASTM A126, Class B; or Ductile Iron, ASTM A536, Grade 65-45-12
Plug	
3" – 20"	Ductile iron, ASTM A536
24" and larger	Cast Iron, ASTM A126, Class B; or Ductile Iron, ASTM A536, Grade 65-45-12
Plug facing	Buna-N
Body seats	
Less than 3 inches	Epoxy coated cast iron, ASTM A126, Class B
3 inches and larger	Welded-in overlay of not less than 90 percent nickel
Packing	Buna or PTFE

Component	Material
Bearings	
Less than 20 inches	Permanently lubricated (oil impregnated) stainless steel
24 inches and larger	Permanently lubricated (oil impregnated) bronze

2.03 VALVE FEATURES AND COMPONENTS

A. General:

1. Straight-flow, non-lubricated, resilient plug type suitable for drip-tight, bi-directional shutoff at the specified valve design pressure.
2. Unless otherwise indicated, port areas for valves shall be at least 80 percent of the adjacent full pipe area.
3. Port area shall be round for valve sizes 14 inches and smaller; rectangular ports are not acceptable. Rectangular ports are acceptable for 16 inches and above.
4. Valves shall be capable of passing spherical solids which are at least 85 percent of the pipe size for valves 12 inches and smaller and at least 50 percent the pipe size for valves 14 inches and larger.
5. Valve body seats consisting of nickel for valves 3 inches and larger shall be fabricated of a welded-in overlay of not less than 90 percent pure nickel.
6. For valves 20 inches and smaller, upper and lower bearings shall be replaceable sleeve type, permanently.
7. For valves 24 inches and larger, upper and lower journal shall be replaceable, sleeve-type, permanently lubricated bronze. Aluminum bronze bearings are not acceptable.
8. Each valve body shall be plainly marked to indicate seat end.
9. Bearings shall be protected at both the top and bottom with PTFE grit seals.
10. Shaft seals shall be self-adjusting chevron type packing, or "U" cup with "O" ring, replaceable without removing the plug.

B. End Connections:

1. Valves 3 inches and smaller: threaded ends.
2. Valve 4 inches and larger: flanged, ASME B16.1, Class 125.
3. Grooved-end per AWWA C606 valves may be provided with grooved-end piping systems.

C. Lay Length: Flanged valves and grooved end valves equipped with manufacturer's standard flange adapters shall conform to ASME B16.10 Table 1, for short pattern Class 125 cast iron plug valves

D. Manual Operators:

1. Valves 4 inches and smaller: lever type manual operator.
2. Valves larger than 4 inches: totally enclosed worm gear operator sized for bidirectional shutoff at design pressure in accordance with AWWA C517 or 40 05 01, whichever is greater.
3. Where indicated, manual operators shall have an adjustable stop.
4. Comply with applicable portions of Section 40 05 57.

2.04 LIMIT SWITCHES

A. When required, valves shall be equipped with limit switches:

1. Limit switches shall be designed and installed to determine if the valve plug is fully closed and not fully closed.
2. Limit switches shall be heavy-duty, snap action, over-center switch mechanisms contained in a die cast metallic NEMA 4 enclosure with chemical resistant Viton gaskets and seals.
3. Switches shall include one normally-open and one normally-closed fine silver contacts rated NEMA A600, 120 VAC, 10 amp continuous with wiping action operation.
4. Contacts shall be replaceable without disconnecting the external wiring.
5. Wiring terminals shall accommodate AWG #22-12 stranded copper wire and shall be identified on a permanently attached nameplate.

- B. Limit switches shall be securely installed to the valve as required to determine valve position.

2.05 FINISHES

- A. Interior and exterior: per AWWA C550.

2.06 SOURCE QUALITY CONTROL

- A. Hydrostatic Test: per AWWA C517.
- B. Cycle Test: per AWWA C517.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as indicated on the Drawings.
- B. Unless otherwise indicated, install valves with the seat upstream into flow.
- C. Install valves at tank connections with seat away from tank.
- D. Install valves on pump discharge lines with seat adjacent to the pump.
- E. Install horizontal valves with shaft horizontal and plug opening up into body of valve.

3.02 FIELD QUALITY CONTROL

- A. After installation and connection to the piping system, each valve shall be
 1. Cycled three times manually or utilizing the manual override to demonstrate proper operation.
 2. Cycled to fully demonstrate proper operation and confirm that operating times are as specified under both normal operating and emergency closure conditions.
- B. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 05 64
BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies butterfly valves.

B. Valve List:

VALVE	VALVE NO.	POWERED OPERATOR?
Temporary Radiator No. 1 Isolation Valve No. 1	704-BTV030357	No
Temporary Radiator No. 1 Isolation Valve No. 2	704- BTV030358	No
Temporary Radiator No. 1 Isolation Valve No. 3	704- BTV030359	No
Temporary Radiator No. 1 Isolation Valve No. 4	704- BTV030360	No
Temporary Radiator No. 2 Isolation Valve No. 1	704-BTV030365	No
Temporary Radiator No. 2 Isolation Valve No. 2	704-BTV030366	No
Temporary Radiator No. 2 Isolation Valve No. 3	704- BTV030367	
Temporary Radiator No. 2 Isolation Valve No. 4	704- BTV030368	
MSG Isolation Butterfly Valve to Boiler 4	705-BTV193703	No
MSG Isolation Butterfly Valve to Boiler 3	705-BTV193704	No
Boiler 1 Circulation Pump Isolation Valve 1	705-BTV193755	No
Boiler 1 Circulation Pump Isolation Valve 2	705-BTV193756	No
Boiler 2 Isolation Valve	705-BTV193763	No
Boiler 2 Magnetic Filter Isolation Valve 1	705-BTV193773	No
Boiler 2 Magnetic Filter Isolation Valve 2	705-BTV193774	No
Boiler 4 Isolation Valve 1	705-BTV193782	No
Boiler 4 Isolation Valve 2	705-BTV193783	No
Boiler 4 Isolation Valve 3	705-BTV193784	No
Boiler 4 Magnetic Filter Isolation Valve 1	705-BTV193799	No
Boiler 4 Magnetic Filter Isolation Valve 2	705-BTV193800	No
Siloxane Bypass Isolation Valve 1	708-BTV163168	No
Siloxane Bypass Isolation Valve 2	708-BTV163169	No

C. Powered Operators: Section 40 05 57.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings ASTM A48-83 Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber-Seated Butterfly Valves

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Operation and maintenance information as specified in Section 01 78 23.
- C. Shop drawings, illustrating valve component configuration, dimensions, material specifications (list ASTM designations) with certified leakage test results in accordance with AWWA C504, pressure drop characteristics, and operator torque requirements.
- D. Affidavits of compliance with AWWA C504 for Type A valves.

1.04 TYPE USAGE:

- A. Type A:
1. System 7 and 7A.
 2. System 8.
- B. Type B:
1. System 5.
- C. Type C: [NOT USED]
- D. Type D:
1. System 10.
- E. Type F:
1. System 11.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Type A: Specified according to size as follows.

1. Type A, Size 3 Through 24 Inches:

Component	Material
Body	Cast iron, ASTM A126, Class B
Shaft	Stainless steel, ASTM A276, Type 304
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A436, type 1 (Ni-Resist); or ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 316, mounted in body or on disc edge; or Ni-Chrome on the disc edge
Seat sealing surface	Neoprene or Buna N (nitrile)

2. Acceptable Manufacturers Type A:
- Pratt; Model 2FII or Triton XR-70.
 - DeZurik; AWWA Valve.
 - Homestead; Series 820.
 - Approved Equal.
3. Type A, Size 30 Through 72 Inches:

Component	Material
Body	Cast iron, ASTM A126, Class B
Shaft	Stainless steel, ASTM A276, Type 304
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A48, Class 40
Seat mating surface	Stainless steel, ASTM A276, Type 316, mounted in body or on disc edge
Seat sealing surface	Neoprene or Buna N (nitrile)

4. Acceptable Manufacturers Type A:
- Pratt; Model Triton XR-70.
 - DeZurik; AWWA Valve.
 - Homestead; Series 840.
 - Approved Equal.

B. Type B:

Component	Material
Body	Cast iron, ASTM A126, Class B
Shaft	Stainless steel, ASTM A276, Type 316
Disc	Aluminum bronze, 316 stainless steel, or nylon 11 coated ductile iron
Seat sealing surface	Buna N (nitrile), FKM (Viton) --air and gas services

1. Acceptable Manufacturers Type B:
- Bray Controls; Series 31.
 - Tyco/Keystone; Model AR2.
 - Approved Equal.

C. Type C: [NOT USED]

D. Type D:

1. Type D, Size 2 Through 10 Inches:

Component	Material
Shaft	Stainless steel ASTM A276, Type 304
Disc	PVC or Polypropylene
Body	Rigid Polyvinyl Chloride (PVC)
Seat	EPT

2. Acceptable Manufacturers Type D:
 - a. ASAHI/America, Type 57
 - b. Spears
 - c. Approved Equal.

E. Type F:

Component	Material
Body	Stainless steel, ASTM A276, Type 316
Shaft	Stainless steel, ASTM A276, Type 316, 17-4PH, or XM-19
Disc and trim	Stainless steel, ASTM A276, Type 316 or 317
Seat mating surface	Stainless steel, ASTM A276, Type 316
Seat sealing surface	RTFE / stainless steel

1. Acceptable Manufacturers Type F:
 - a. Crane Flowseal.
 - b. Pratt HP Series.
 - c. Keystone K-LOK High Performance Figure 362-116.
 - d. Approved Equal.

2.02 FABRICATION

A. General:

1. Valves shall be the stub or through shaft design.
2. Valves shall be lug style, flanged, or grooved end.
3. Unless otherwise indicated, valve flange drilling shall be per ANSI B16.1, Class 125.

B. Type A:

1. Designed in accordance with AWWA C504 with 150 psig pressure rating.
2. Shafts shall be turned, ground and polished.
3. Shaft dimensions and operator torque shall be chosen for the test pressure specified in Section 40 05 01 and Class B as specified in AWWA C504.
4. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.
5. Valve seats:
 - a. Type A valves, size 3 through 72 inches, shall have valve seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.
 - b. Type A valves, size 30 through 72 inches, shall have valve seats that are field adjustable and field replaceable. Discs for valves shall be of the flow-through type with a 360-degree seating design.

C. Type B:

1. Valves shall be rated at 175 psig and provide driptight shutoff up to the full valve rating on dead-end or isolation service.
2. Seat shall be held in place mechanically and shall be field replaceable.
3. Valve ends shall be as specified in Section 40 05 01.
4. Valve seats:
 - a. Type B valves, size 2 through 20 inches, shall have seats that are bonded to a rigid reinforcing ring.
 - b. Type B valves, size 24 through 36 inches, shall have adjustable seats bonded to a bronze or stainless steel retention ring that is held in place by Type 304 stainless steel retaining screws.

- D. Type C (Size 2 through 20 Inches): [NOT USED]
- E. Type D:
 - 1. Size 2 through 10 inches:
 - a. Valve shall have a molded PVC body.
 - b. The disc shall be polypropylene with an encapsulated metal reinforcing insert.
- F. Type F:
 - 1. Sizes 2 through 20 inches for digester gas service.
 - 2. Designed in accordance with API 607.
 - 3. Soft-seated with metal backup seat that retains valve seal during and after a fire.
 - 4. Valve design shall be high-performance type with double eccentric mounted disc.
 - 5. Valves shall be lugged design compatible for use with ANSI B16.5, Class 150 flanges.
 - 6. Valves shall be suitable for dead end service.

2.03 MANUAL OPERATORS

- A. General: Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.
- B. Type A:
 - 1. Manual operators for Type A valves shall be of the traveling nut, rack and pinion, or worm gear type.
 - 2. Operators shall be equipped with adjustable mechanical stop-limiting devices to prevent overtravel of the disc in the open and closed positions and shall be self-locking and designed to hold the valve in any intermediate position between full open and full closed.
 - 3. Valve operator components shall withstand an input torque of 300 ft-lbs at the extreme operator positions without damage.
 - 4. Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig.
 - 5. Operators for exposed service shall include a handwheel and be gasketed for weatherproof service.
- C. Types B and D:
 - 1. Operators for valves 6 inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.
 - 2. Operators for valves 8 inches in diameter and larger shall be the traveling nut or worm gear type. Operators for exposed service shall be gasketed for weatherproof service. A handwheel or chain wheel shall be provided for each operator per Section 40 05 57

2.04 OPERATORS

- A. Powered valve operators shall be as specified in Section 40 05 57.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 FIELD TESTS

- A. Each valve, after installation and connection to the piping system, shall be cycled three times manually or utilizing the manual override to demonstrate proper operation.

- B. Each valve, upon completion of installation of the piping system, shall be cycled to fully demonstrate proper operation and confirm that operating times, under both normal operating, and emergency closure conditions, are as specified.
- C. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 05 65.23

SPRING-LOADED SWING CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies spring-loaded swing check valves. Valves shall be field convertible to counterweighted oil-cushioned style without the use of special tools.
- B. Valve List:

VALVE	VALVE NO.
RSP Sampler Feed Pump 1 Discharge Check Valve	704-BVC240382
RSP Sampler Feed Pump 2 Discharge Check Valve	704-BVC240392
RSP Pump Room Sump Pump 1 Discharge Check Valve	704-CHV350404
RSP Pump Room Sump Pump 1 Discharge Check Valve	704-CHV350406
Boiler 4 Gas Train – MSG Check Valve	705-CHV193737
Boiler 4 Gas Train – Propane Check Valve	705-CHV193743
RSP Control Room Air Handler Pump 1 Check Valve	704-CHV253186
RSP Control Room Air Handler Pump 2 Check Valve	704-CHV253187
RSP Crane Hall Supply Air Handler Pump 1 Check Valve	704-CHV253189
RSP Crane Hall Supply Air Handler Pump 2 Check Valve	704-CHV253190
RSP Screen Room Air Handler Pump 1 Check Valve	704-CHV253194
RSP Screen Room Air Handler Pump 2 Check Valve	704-CHV253195
RSP Gallery Air Handler Pump 1 Check Valve	704-CHV253199
RSP Gallery Air Handler Pump 1 Check Valve	704-CHV253200

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless Steel Bars and Shapes
ASTM A536	Ductile Iron Castings

Reference	Title
ASTM A564	Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A582	Free-Machining Stainless Steel Bars
ASTM B62	Composition Bronze or Ounce Metal Castings
AWWA C508	Swing Check Valves for Waterworks Service, 2-In. Through 48-In.

1.03 VALVE DESCRIPTION

A. Design Requirements

1. Unless otherwise indicated, valves shall have the following minimum pressure ratings:

Valve Size	Working Pressure	Hydrostatic Test Pressure
12 inches and smaller	175 psi	350 psi
14 inches and larger	150 psi	300 psi

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Provide the following submittals:

1. Manufacturer's product data detailing materials, construction, and flow capacity.
2. Manufacturer's product data detailing limit switch system, materials, and wiring diagram.
3. Operation and maintenance information in accordance with Section 01 78 23.

1.05 QUALITY ASSURANCE

A. Check valves shall comply with AWWA C508.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:

1. APCO CVS-6000.
2. Pratt 9001.
3. Valmatic 7900.
4. Approved Equal.

2.02 MATERIALS

A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.

B. Materials of construction shall be as follows:

Component	Material
Body and Cover	Cast iron, ASTM A126, Class B; or Ductile Iron ASTM A536, Grade 65-45-12
Disc arm and disc	Ductile Iron ASTM A536, Grade 65-45-12
Body Seat	Stainless Steel, Type 316, ASTM A276.
Disc Seat, Cover Gasket, and other elastomers	Buna N, EPDM
Pivot / Hinge Shaft	Stainless Steel, Type 303 ASTM A582; or Type 17-4 PH, ASTM A564

Component	Material
Hinge Shaft Bushing	Bronze, ASTM B62
Seat Pins, Seat Rings and Lock Screws	Stainless Steel
Spring Tensioner	Stainless Steel

2.03 VALVE FEATURES AND COMPONENTS

- A. General:
 - 1. Valves shall be drip-tight shutoff.
 - 2. Provide tapped and plugged drain and vent holes in valve body and cover.
 - 3. All internal components shall be field replaceable without use of special tools.
- B. End Connections:
 - 1. Valve 4 inches and larger: flanged, ASME B16.1, Class 125.
- C. Valve Disk:
 - 1. Double clevis mounted to arm.
 - 2. Suspended from non-corrosive shaft extending through both sides of the body.
 - 3. O-ring type shaft seals.

2.04 FINISHES

- A. Interior and exterior: per AWWA C550 and NSF 61 certified.

2.05 SOURCE QUALITY CONTROL

- A. Hydrostatic Test: per AWWA C508.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 FIELD QUALITY CONTROL

- A. After installation and connection to the piping system, each valve shall be:
 - 1. Cycled three times manually or utilizing the manual override to demonstrate proper operation.
 - 2. Cycled to fully demonstrate proper operation and confirm that operating times are as specified under both normal operating and emergency closure conditions.
- B. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 05 72

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's product data detailing materials, construction, flow capacity, performance charts or tables and pressure loss curves.
 2. Installation shop drawings.

PART 2 PRODUCTS

2.01 SAFETY VALVES

- A. ASME certified.
- B. Size and pressure settings: As specified or as required for the service intended.
- C. Acceptable manufacturer:
1. Lunkenheimer Figure 1226 or 1227.
 2. Crane 2550 or 2551.
 3. Approved Equal.
- D. Safety and pressure relief valves for cold and hot water: Acceptable manufacturer:
1. Crane 2606.
 2. McDonnell and Miller 230.
 3. Approved Equal.

2.02 HOSE VALVES

- A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, with threaded nipple adapter for hose connection.
- B. Acceptable manufacturers:
1. Crane 17.
 2. Lunkenheimer 214.
 3. Powell 151.

4. Approved Equal.

2.03 QUICK DISCONNECTS

- A. Universal quick-acting twist-lock claw coupling per Section 40 05 80.
- B. Shall not be disconnectable under pressure.
- C. Air service:
 1. Shall be ½-inch, unless otherwise specified.
 2. Acceptable manufacturers:
 - a. Swagelok.
 - b. Tomco.
 - c. Approved Equal.
- D. Water service:
 1. Shall be 1-inch, unless specified otherwise.
 2. Acceptable manufacturers:
 - a. EverTite Part B.
 - b. Gate Part B.
 - c. Approved Equal.

2.04 FLUSHING COCKS

- A. Unless otherwise indicated: 1-inch full port valve with stainless steel ball and stem.
- B. Body material: match pipe material.
- C. Neoprene-faced eccentric plug valve with a hose nipple adapter, if required.
- D. Acceptable manufacturers:
 1. DeZurik 159/118-S.
 2. Keystone Fig 541.
 3. Approved Equal.

2.05 STOP AND DRAIN VALVES [NOT USED]

2.06 DIAPHRAGM VALVES

- A. 125 psi at 100 Degrees F.
- B. Design Requirements:
 1. True Union or flanged.
 2. Handwheel operator.
- C. Materials of construction shall be as follows:

Component	Material
Body	PVC Type 1, Grade 1
Diaphragm	Teflon with a PVDF vapor barrier
Seal	PTFE (Teflon)

- D. Acceptable manufacturers:
 1. Chemtrol.
 2. Hayward.

3. Approved Equal.

2.07 PLASTIC BALL VALVES (1/2 TO 4 IN)

- A. 150 psi at 75 Degrees F.
- B. Design Requirements:
 1. Double or true union design.
 2. Blocks both directions, upstream and downstream.
 3. Union nut capable of compensating for seat wear.

- C. Materials of construction shall be as follows:

Component	Material
Body, stem, ball, handle, end connectors	CPVC
Seat	Teflon
O-rings	Viton

- D. Acceptable Manufacturers:
 1. Chemtrol/NIBCO.
 2. ASAHI/America.
 3. Approved Equal.

2.08 BALL CHECK VALVES (1/2 TO 4 IN)

- A. 150 psi at 73 Degrees F.
- B. Design requirements: Connectors shall be double union.

- C. Materials of construction shall be as follows:

Component	Material
Body and trim	CPVC
Ball	Glass filled or polypropylene
Seals	Viton or EPDM

- D. Acceptable manufacturers:
 1. R&G Sloane.
 2. Corr Tech.
 3. Approved Equal.

2.09 PRESSURE REGULATING VALVES (2 IN AND SMALLER)

- A. Design requirements:
 1. Direct-acting, spring operated type.
 2. Provide upstream strainers in accordance with Section 40 05 47.
 3. Provide downstream pressure gauges in accordance with Section 40 05 47.
- B. Acceptable manufacturers:
 1. Wilkins 500.
 2. Mueller H-9310.
 3. Approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 FIELD TESTS

- A. Each valve, after installation and connection to the piping system, shall be cycled three times manually or utilizing the manual override to demonstrate proper operation.
- B. Each valve, upon completion of installation of the piping system, shall be cycled to fully demonstrate proper operation and confirm that operating times, under both normal operating, and emergency closure conditions, are as specified.
- C. Perform all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 05 80

HOSES AND NOZZLES FOR UTILITY STATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies hoses, connectors and nozzles for utility stations.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM F1546	Standard Specification for Fire Hose Nozzles

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's product data.

PART 2 PRODUCTS

2.01 HOSE

- A. Reinforced rubber plies pressure rated for a minimum working pressure of 200 psig.
- B. Resistant to heat, sunlight, ozone and weathering. Meet or exceed RMA Class C medium oil resistance. Temperature range: -40 degrees F to 212 degrees F.
- C. Suitable for both air and water service.
- D. Color: Red.
- E. Acceptable Manufacturer:
1. Parker/Dayco Series 7092 GST II.
 2. Gates.
 3. Approved Equal.

2.02 NOZZLES

- A. Chrome-plated brass.
- B. Plain fire hose type, 8 inches long.
- C. Meet ASTM F1546.

2.03 QUICK CONNECTIONS

- A. Malleable Iron.

- B. Provide quick connect couplings at each end of hose and on the nozzle.
- C. Not be disconnectable under pressure.
- D. Acceptable Manufacturer:
 - 1. Dixon Air King.
 - 2. Chicago Pneumatic.
 - 3. Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. At locations shown on the Drawings.
- B. Provide at each utility station:
 - 1. One 30-foot length of 1-inch hose.
 - 2. One nozzle.
 - 3. Quick connection couplings at each end of hose, on the utility station valve, and on the nozzle.
 - 4. Equip nozzle with a ball valve.

END OF SECTION

SECTION 40 05 82

SOLENOID VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies 2- and 3-way solenoid valves, direct or pilot operated type, for control of process fluids. Valves for air cylinder pilot duty are specified in Section 40 05 57.
- B. Valve List:

VALVE	VALVE NO.
RSP-Pump 1 Seal Water Solenoid Valve	704-SV03DC011
RSP-Pump 2 Seal Water Solenoid Valve	704-SV03DC012
RSP-Pump 3 Seal Water Solenoid Valve	704-SV03DC013
RSP-Pump 4 Seal Water Solenoid Valve	704-SV03DC014
RSP Temporary C2 Solenoid Flow Valve 1	704-FCV03AW011
RSP Temporary C2 Solenoid Flow Valve 2	704-FCV03AW021

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM A48	Gray Iron Castings
UL 429	Electrically Operated Valves
UL 1002	Electrically Operated Valves for Use in Hazardous Locations Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G

1.03 VALVE DESCRIPTION

- A. Types
- Valves with piping connections less than 1½ inches in diameter shall be direct-acting type.
 - Valves with piping connections 1½ inches in diameter and greater shall be pilot operated globe body type.
- B. Design Requirements:
- Unless otherwise specified, solenoid valves shall be designed to seal the pressurized (supply) port upon de-energization.
 - The minimum acceptable operating pressure differential for pilot operated valves shall be 5 psi.
- C. Performance Requirements:

Valve number	Service ^a	Line size, inches	Valve size, inches	Operating pressure, psig, maximum ^b	Operating temperature, degrees F, maximum	Unpowered position ^c
704-SV03DC011	SW	3/4	3/4	150	140	NO
704-SV03DC012	SW	3/4	3/4	150	140	NO
704-SV03DC013	SW	3/4	3/4	150	140	NO
704-SV03DC014	SW	3/4	3/4	150	140	NO
704-FCV03AW011	C2	1	1	150	80	NC
704-FCV03AW021	C2	1	1	150	80	NC

^a See Section 40 05 01.

^b Operating pressure: The test pressure for the service as listed on the PIPESPEC sheets in Section 40 05 01 which shall be considered the pressure drop across each valve for the purpose of actuator sizing.

^c NC: Normally Closed. NO: Normally Open.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's product data and capacity information.
 - 2. Manufacturer's certificates of compliance with the specified standards.

1.05 QUALITY ASSURANCE

- A. Valves shall be listed by Underwriters Laboratories Inc. in accordance with UL 429 and UL 1002.
- B. Solenoid valves for gas service shall be approved by Factory Mutual Engineering Corporation.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturer:
 - 1. Direct Acting Type:
 - a. Automatic Switch Company.
 - b. Honeywell-Skinner.
 - c. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction shall be as follows:
 - 1. Direct Acting Type:

Component	Material
Body	Brass or stainless steel, Type 304
Seal	Teflon or Buna-N
Disc	Teflon or Buna-N

2.03 FABRICATION

- A. General:
 - 1. Unless otherwise indicated, solenoid valves shall be rated for continuous duty at 120 volts AC.
 - 2. Valves shall be threaded for sizes 2-inch and smaller and flanged for sizes 2½ inch and larger.
- B. Direct Acting Type:
 - 1. Valves shall have enclosures compatible with area classifications per Section 26 05 00.
 - 2. Solenoids shall have fully encapsulated Class H coils.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 FIELD TESTS

- A. Each valve, after installation and connection to the piping system, shall be cycled three times manually or utilizing the manual override to demonstrate proper operation.
- B. Each valve, upon completion of installation of the piping system, shall be cycled to fully demonstrate proper operation and confirm that operating times, under both normal operating, and emergency closure conditions, are as specified.
- C. Verify operation and response to automatic control and interlocks.
- D. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 05 93

ELECTRIC MOTORS FOR PROCESS EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies low-voltage alternating current induction motors, 250 horsepower or less. This Section does not specify specialty motors such as hoist motors, valve operator motors or torque rated motors.
- B. Equipment List: Motors are part of the equipment and listed in the individual equipment Sections.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
IEEE 112 Method B	Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE 841	Standard for Petroleum and Chemical Industry – Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors – Up to and including 370 kW (500 hp)
NEMA MG 1	Motors and Generators
IBC	International Building Code
UL 674	Motors and Generators, Electric, for Use in Hazardous Locations, Class I, Groups C and D, Class II, Groups E, F and G
UL 1004	Motors, Electric
WAC 51-11	Washington State Energy Code
WAC 296-46B-430	Electrical Safety Standards, Administration, and Installation – Motors, Motor Circuits and Controllers
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. The submittals for Section 40 05 93 and the submittal for the driven unit: combined into one submittal. Failure to provide and combine both submittals shall result in rejection of the submittals without further review.
- C. Provide the following submittals:
 - 1. Motor Data Form No. 40 05 93-A in Section 01 33 10. Separate the motor data for each motor of 1/2-horsepower and greater.
 - 2. Motor outline, dimensions and weight.
 - 3. Manufacturer's general descriptive information relative to motor features.
 - 4. For VFD driven equipment, provide a letter of certification from both the VFD and motor manufacturer that the specific application has been reviewed and that the motor and VFD are compatible and that the motor and VFD combination will satisfy the requirements under all conditions of operation without adverse impacts on either the motor or VFD.
 - 5. Motor Part Load Efficiency Curve or Table.

6. Bill of Materials, including Form 01 78 45-A.

1.04 QUALITY ASSURANCE

- A. All motors:
 1. Built in accordance with NEMA MG 1, UL 674, UL 1004, and to the requirements specified. Listed and labeled for the purpose for which they are used by Underwriters Laboratories (UL) or equivalent nationally recognized testing laboratory acceptable to the Washington State Department of Labor and Industry and to the local administrative authority.
 2. Where one of these listings is required but not available, obtain written permission for a variance from King County.
 3. This requirement supersedes the listing and labeling requirements of Division 26.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise indicated, motors: factory-mounted to the equipment as practicable.
- B. Motors shall, as a minimum, comply with the requirements of this Section and the manufacturer's standard industrial product. Additional or better features which are not specifically prohibited by the specifications, but which are a part of the manufacturer's standard industrial product are to be included in the motor being furnished. A standard industrial product is a product that has been or will be sold on the market through advertisement or manufacturer's catalogs, or brochures, and represents the latest production model(s).
- C. All equipment: designed and built for industrial service and capable of delivering rated horsepower under the following applicable conditions:
 1. 100 degrees F maximum ambient temperature.
 2. 100 percent relative humidity.
 3. Voltage variations to ± 10 percent of nameplate rating.
 4. Frequency variations to ± 5 percent of nameplate rating.
 5. Combined voltage and frequency variations to ± 10 percent total, as long as frequency does not exceed ± 5 percent.
- D. Motor enclosures will be identified as follows:
 1. ODP: Open Drip-Proof; NEMA MG1.25.1.
 2. WP: Weather Protected, Type I and II; NEMA MG1.25.8.1.
 3. TENV: Totally Enclosed, Nonventilated; NEMA MG1.26.1.
 4. TEFC: Totally Enclosed, Fan Cooled; NEMA MG1.26.2.
 5. EP: Explosion-Proof; NEMA MG1.26.3.
- E. Unless otherwise indicated, electrical requirements shall be as follows:
 1. Service factor:
 - a. Single-phase motors: 1.0.
 - b. Three-phase motors: 1.15.
 2. Time rating: All motors shall have continuous time ratings in conformance with NEMA MG 1-10.35.
 3. Torques: Motors shall meet, or exceed, the locked rotor and breakdown torques specified for NEMA Design B.
 4. Currents: Locked rotor currents shall not exceed the values for NEMA Design B.
 5. Protection: Current density and heating characteristics to be such that the motors will not burn out if subjected to a maximum of 20-second stall at 6 times full-load current.
 6. Rating: Motors shall not be submitted or provided that are required to operate at greater than their nameplate horsepower. Use of the service factor will not be allowed under conditions of rated voltage and frequency.

7. Insulation: Unless otherwise specified, all motors shall have non-hygroscopic insulation systems conforming to the requirements for NEMA Class B or higher.
 8. Conduit box: One size larger than standard.
 9. Motor efficiencies for all motors to comply with WAC 51-11, Chapters 14 and 15. Determine efficiency by the dynamometer test method, IEEE 112, Method B.
- F. Unless otherwise indicated, mechanical requirements shall be as follows:
1. Frame sizes: Conforming to latest NEMA Standard MG1-11.31 for "T" frames, and all dimensions meeting NEMA Standards insofar as they apply.
 2. Shafts:
 - a. In accordance with NEMA "T" or "TS" dimensions.
 - b. Long shafts: Suitable for belt, chain, or gear drive, within limits established by good industrial practice and documented by NEMA Standards MG1-14.42 and MG1-14.07.
 - c. Short shafts: Used for direct connection.
 3. Connection diagrams: Permanently attached to the motor, either inside the conduit box or on the motor frame, in a location readable from the conduit box side.
 4. External finish: Corrosion resistant for outdoor operation.
 5. All bolts, screws, and other external hardware: treated for resistance to corrosion.
- G. Nameplates:
1. Of corrosion resistant metal such as stainless steel or brass.
 2. Engraved or stamped and: permanently fastened to the motor frame with screws or drive pins of the same material.
 3. Nameplates shall indicate clearly all the items of information enumerated in NEMA MG1.
 4. The Contractor shall coordinate the motor nameplate location so it is readily visible for inspection in the completed machine.
- H. Construction: All motors provided under this specification shall have the following features of construction:
1. Frames:
 - a. Cast iron frames for motors ½ horsepower and larger.
 - b. Steel frames for motors smaller than ½ horsepower.
 - c. Aluminum frame motors will not be permitted.
 2. Cast metal fan blades and shrouds.
 3. Stainless steel hardware.
 4. Nonhygroscopic leads.
 5. Class B temperature rise above 40 degrees C ambient.
 6. NEMA design B unless otherwise specified.
- I. Protective Coating: Before shipment, coat the shaft extension and any other external bare exposed metal parts of each motor with an easily removable rust preventive.
- J. Packaging: All loose motors: packed in Styrofoam or securely fastened to a hardwood skid or pallet for fork-truck handling and: covered for protection against dirt and moisture during transit and for short-time outdoor storage.

2.02 MOTORS LESS THAN 1/2 HORSEPOWER

- A. General:
1. Unless otherwise indicated, motors less than 1/2 horsepower: single-phase, squirrel cage, capacitor start induction run type designed for 115 volt, 60 Hz operation.
 2. Dual voltage (115/230) rated motors are acceptable if all leads are brought out to the conduit box.
- B. Enclosures:
1. Unless otherwise indicated, motors shall have open drip-proof enclosures.
 2. Explosion-proof motors: where specified.

3. UL label for Class I, Division 1, Group D hazardous locations. An over-temperature device in the enclosure: provided to detect and automatically de-energize the motor if the enclosure surface temperature exceeds 280 degrees C.
4. The nameplate: marked with the UL frame temperature code T2A.

2.03 MOTORS 1/2-HORSEPOWER THROUGH 250 HORSEPOWER

- A. General:
 1. Motors 1/2-horsepower through 250 horsepower: 3-phase, squirrel cage, induction motors designed for 460-volt, 60-Hz operation, unless otherwise indicated on Drawings.
 2. Dual voltage (230/460) rated motors are acceptable if all leads are brought out to the conduit box.
 3. Motor enclosure, rpm, horsepower, and modifications (if any) are specified in the specific equipment specification section.
 4. Two speed motors: single winding.
- B. Drip-Proof Motors: Unless otherwise indicated, drip-proof motors shall have a Class B insulation with a service factor of 1.15.
- C. Totally Enclosed Fan Cooled Motors (TEFC):
 1. General:
 - a. With frame sizes 182 and larger: Having cast-iron frames and end shields.
 - b. Smaller frames:
 - 1) Constructed of rolled steel with cast-metal end shields.
 - 2) Provided with condensation drain holes.
 - 3) Frame sizes 286 and larger: Having an automatic breather/drain device provided in the drain hole.
 2. General duty motor: Having Class B insulation with a service factor of 1.15.
 3. Severe duty motor:
 - a. Having a Class F insulation with a service factor of 1.15.
 - b. Internal surfaces coated with a corrosion-resistant epoxy paint.
 - c. Acceptable manufacturer:
 - 1) ABB (Baldor-Reliance) SXT-XT.
 - 2) TECO-Westinghouse MAX-E1.
 - 3) Approved Equal.
 4. Energy Efficient, Severe Duty TEFC Motor:
 - a. Identical to the severe duty motor except that it will be designed to comply with the minimum nameplate efficiency in Table A. The preferred motor is 4-pole 1800 RPM.

Table A, Minimum Nameplate Efficiency NEMA MG-1 Table 12-12 and 20-B

Horsepower	Speed, RPM		
	1200	1800	3600
	6-Pole	4-Pole	2-Pole
1/2	84.0	84.0	80.0
3/4	84.0	86.5	86.5
1	82.5	85.5	77.0
1.5	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7.5	91.0	91.7	89.5
10	91.0	91.7	90.2
15	91.7	92.4	91.0
20	91.7	93.0	91.0

Table A, Minimum Nameplate Efficiency NEMA MG-1 Table 12-12 and 20-B

Horsepower	Speed, RPM		
	1200	1800	3600
	6-Pole	4-Pole	2-Pole
25	93.0	93.6	91.7
30	93.0	93.6	91.7
40	94.1	94.1	92.4
50	94.1	94.5	93.0
60	94.5	95.0	93.6
75	94.5	95.4	93.6
100	95.0	95.4	94.1
125	95.0	95.4	95.0
150	95.8	95.8	95.0
200	95.8	96.2	95.4
250	95.8	96.2	95.8

- b. The efficiency: as determined by the dynamometer test method, IEEE 112, Method B.
- c. Acceptable manufacturer:
 - 1) ABB (Baldor-Reliance) Super-E.
 - 2) TECO-Westinghouse MAX-E2.
 - 3) Approved Equal.
- 5. Explosion-Proof Motor:
 - a. UL-listed for Class I, Division 1, Group D hazardous atmospheres.
 - b. Having a Class B insulation with a service factor of 1.15.
 - c. UL-approved breather/drain device provided in the motor drain hole.
 - d. Frame temperature thermostat which:
 - 1) Meets the UL frame temperature limit code T2A (280 degrees C).
 - 2) Automatically reset, normally closed contact rated 2 amperes at 115V AC.
 - 3) Nameplate marked with the UL temperature limit code T2A.
 - e. Acceptable manufacturer:
 - 1) Marathon Electric.
 - 2) ABB (Baldor-Reliance).
 - 3) Approved Equal.
- 6. Submersible Motors: Submersible pump motors shall meet the following requirements unless otherwise specified in the individual equipment specification section.
 - a. UL-approved for explosion-proof atmospheres in accordance with 2.03.C.4 of this Section.
 - b. Mechanical seals:
 - 1) Two mechanical seals.
 - 2) The lower seal is outside the motor and protecting the upper seal.
 - 3) Upper seal is in an oil-filled chamber.
 - c. Moisture detector probes in the oil-filled seal chamber: provided to indicate the presence of moisture in the seal chamber.
 - d. A normally closed NEMA Class B150 contact from the moisture detector shall open to deactivate the motor control circuit in the event of moisture detection.
 - e. Relays or solid state controls which are required: provided in an enclosure on or near the motor.
 - f. Provide winding temperature detectors, this Section.
- 7. Energy efficient, explosion-proof motor: Identical to the explosion-proof motor except that the efficiency shall comply with Table A of this Section.
- 8. Inverter Duty Motors:
 - a. The motors controlled by variable frequency drives (VFD): rated for inverter duty and shall include a stainless steel nameplate showing "Inverter Duty Motor."

- b. Nameplate shall also show that motor is suitable for variable torque operation on VFD power from 6 to 60 Hz, and show rated torque in lb-ft on inverter power in addition to the standard nameplate data specified in NEMA standards.
- c. Supply certification with submittals that the motors meet all requirements of NEMA MG1-2004, Part 31.
 - 1) Inverter duty motors: specifically certified by the motor manufacturer to be compatible with the adjustable frequency controller to be used with the motor.
 - 2) Motor to be designed to operate over the speed or frequency range specified.
 - 3) Equip inverter duty motors with two RTDs – 100 ohm platinum temperature detectors mounted on the DE and ODE bearings of the motor in a manner that is suitable for detecting bearing temperature and provides ready access for maintenance purposes.
- d. Motors shall include an 'inverter grade' insulation system using not less than triple insulation layer wire and other features necessary to meet the voltage spike specifications of NEMA MG1-2004. Complete insulation of the slot, cell, and phase groups is required. The system: rated for Class F temperature rise or better at a service factor of 1.0.
- e. Inverter duty motors shall include a normally closed winding over-temperature thermostat suitable to be wired to the VFD panel for drive shutdown.
- f. Equip inverter duty motors with a shaft grounding unit mounted on the fan housing with stub shaft extended from the motor shaft. Grounding unit: equipped with two brushes, totally enclosed and sealed against environmental contamination.
- g. The maximum permissible noise level for inverter duty motors not to exceed 85 dBA at 3 feet.
- h. Field test inverter duty motors for sound output when running with their designated VFD.
- i. Provide inverter duty motors with a thrust bearing housing that includes a suitable mounting boss for the vibration sensor if specified.
- j. Acceptable manufacturer:
 - 1) Wolong (General Electric).
 - 2) ABB (Baldor-Reliance).
 - 3) Nidec (US Motors).
 - 4) Approved Equal.

D. Vertical Motor:

- 1. Solid-shaft specifically designed for vertical installation.
- 2. Unless otherwise indicated, full voltage with a Type P base.
- 3. The type of enclosure, service factor, type of shaft and thrust bearing as specified in the specific equipment Section.

E. Conduit Boxes:

- 1. Provided with threaded hubs.
- 2. Motors provided with neoprene gaskets at the base of the conduit box and between the halves of the conduit box.
- 3. Motors having a grounding lug located within the box for the raceway ground connection.

F. Temperature Sensing and Protection:

- 1. Motors 10 horsepower through but not including 20 horsepower:
 - a. Containing a bi-metal disc thermostat to sense winding over-temperature.
 - b. Thermostat: Automatic reset, normally closed contact, rated at 2 amperes at 115V AC.
 - c. Motor nameplate: Marked "OVER TEMP PROT 2" in accordance with NEMA MG 1-12.53.
- 2. Motors 20 horsepower and above:
 - a. Having a temperature sensing device embedded in the motor winding which is sensitive to both over-temperature and rate of temperature rise.
 - b. Sensor: Wired to a NEMA 4 temperature monitor box located near or on the motor.
 - c. Temperature sensing system: Automatic reset, normally closed contact, rated 2 amperes at 115V AC.
 - d. Motor nameplate: Marked "OVER TEMP PROT 1" in accordance with NEMA MG 1-12.53.

G. Rotors:

1. Die cast aluminum or brazed copper construction, epoxy protected corrosion on external surfaces.
2. Free from inherent axial thrust and be balanced to within NEMA Standard MG 1-12.05 vibration limits.
3. If balancing weights are required they: permanently secured by welding or other approved method.

H. Space heaters:

1. Provided for all motors over 99 horsepower.
2. Heaters for 480 VAC motors: 120 VAC, single phase and 1,000 watts or less.

I. Constant Torque Motors:

1. Certain motors shall provide constant torque over their speed range when used with variable frequency type variable speed controllers.
2. The most common application is variable speed pumping of positive displacement pumps.
3. Motors: suitable for these applications; specifically, the submittal data for each such motor shall include a letter of certification from the variable frequency supplier that the motor is suitable for the application and compatible with the variable frequency controller.

PART 3 EXECUTION

3.01 TESTING

A. Insulation Check:

1. King County may test the insulation resistance of the motor at any time after delivery of the motor to the jobsite or at any time during the warranty period.
2. Tests for acceptability will be made using a 1,000-volt megohm meter (megger).
3. Interpretations of test results for minimum acceptable values of insulation resistance will be made in accordance with IEEE No. 43.
4. All deficiencies: corrected by the Contractor at no cost to King County.

B. Load Testing:

1. King County may test a motor at any time after delivery of the motor to the jobsite or at any time during the warranty period to determine its ability to operate at nameplate current or less and meet the load test requirements.
2. All deficiencies: corrected by the Contractor at no cost to King County.

END OF SECTION

SECTION 40 05 94

ELECTRIC MOTORS – LARGE LOW VOLTAGE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies squirrel cage induction motors, 500 hp and larger, less than 600 V, for vertical application with centrifugal type pumps.
- B. Equipment Number:

Equipment Number	Description	HP	Nominal RPM	Voltage	Mounting Position	Shaft type
704-MTR03DC011	RSP – Pump 1 Motor	900	240	480	Vertical	Intermediate Drive
704-MTR03DC021	RSP – Pump 2 Motor	900	240	480	Vertical	Intermediate Drive
704-MTR03DC031	RSP – Pump 3 Motor	900	240	480	Vertical	Intermediate Drive
704-MTR03DC041	RSP – Pump 4 Motor	900	240	480	Vertical	Intermediate Drive

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASME B30.1	Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries
IEEE 43	Recommended Practice for testing Insulation Resistance of Rotating Machinery
IEEE 112	IEEE Standard Test Procedure for Polyphase Induction Motors and Generators
ISO 1940/1	Balance Quality Requirements of Rigid Rotors
NEMA MG-1	National Electrical Manufacturers Association, Motors and Generators

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the submittals from this Section with the submittals for Section 43 23 04 and Section 26 29 23 to allow evaluation as a unit responsibility system. Provide unit responsibility as specified in Section 43 05 01 for the variable speed non-clog end suction centrifugal pump system with the required compatible components listed in Section 43 05 01 including the motors specified in this Section.
- C. Provide the following submittals:
1. Torque, current, and power factor vs. speed curves at 80 and 100 percent rated voltage.
 2. Estimated acceleration time curves at 80 and 100 percent rated voltage.
 3. Maximum number of successive cold and hot starts.
 4. Motor Thermal Performance: Hot and cold start curves.
 5. Locked rotor kVA/HP code letter.

6. Locked rotor current and power factor at 80 and 100 percent rated voltage.
7. Locked rotor withstand time, with the motor at ambient temperature and at its maximum rated operating temperature, at 70, 80, 90, and 100 percent of rated voltage.
8. Locked-rotor inrush in percent of full-load current.
9. Locked rotor, pull-up, breakdown, and full-load torque.
10. Guaranteed power factor and efficiencies at 1/2, 3/4, and full load. State method used for determining rotor resistance and stray load loss for IEEE 112, Method F calculations.
11. Motor nameplate data. including but not limited to:
 - a. Motor Type and model.
 - b. Rated motor horsepower.
 - c. Voltage, phase and frequency ratings.
 - d. Design full load current at rated horsepower for utilization (motor) voltage.
 - e. Number of poles and full-load speed.
 - f. Winding Insulation class and temperature rise class.
 - g. Service factor.
 - h. Duty Rating.
 - i. Power factor.
 - j. Frame size.
 - k. Nominal efficiency.
 - l. Enclosure type.
12. Sound pressure level.
13. Bearing Data:
 - a. Identify type and manufacturer.
 - b. Specify proposed bearing insulation materials and methods and recommended bearing lubricant(s).
 - c. Bearing protection data.
 - d. Recommended alarm and trip settings in degrees Celsius for the stator winding and bearing temperature detectors.
 - e. Recommended alarm and trip settings for the vibration detectors.
14. Complete motor and motor accessory schematic and connection diagrams.
15. Catalog data sheets for motor and motor accessory equipment. Provide detailed catalog information indicating complete model number derivation and wiring diagrams.
16. Dimensional outline, detail, and cross-sectional drawings. Drawings shall include a detailed scaled diagram of each terminal box including terminal provisions and conduit entry.
17. Assembly clearances, including but not limited to diametrical bearing clearances, air gap, and coupling interference fit to shaft.
18. Motor component weights.
19. Anticipated maximum maintenance weights for rotors and removable housing elements.
20. Shaft radial and axial runout tolerances at various lateral locations.
21. Shaft mass elastic diagram.
22. Sufficient information to confirm adequate foundation design including loading diagrams, motor net and erection weights, anchor bolt placement, and location of the center of gravity. As required by Section 01 73 00.
23. Installation, maintenance, and operating instructions, as required by Section 01 78 23.
24. Bill of Materials, including Form 01 78 45-A.
25. Itemized list of special tools required.
26. Statement of guarantee and warranty.
27. Factory provisions and test forms for Factory Testing and Final Certified Factory Test Reports.
28. Motor rotor inertia (wk^2), and load inertia (wk^2), as obtained from driven machinery manufacturer.
29. Certification from motor manufacturer that lifting lugs have been designed to accommodate the motor and motor support assembly as one unit.
30. Completed Motor Data form provided in Section 01 33 10.
31. Quality Assurance certifications.
32. Motor anchorage calculations including all operating loads including the unbalanced force resulting from the motor operation.
33. Motor seismic anchorage calculations in accordance with 01 73 00

34. Finite element analysis results in accordance with this Section.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Company specializing in motors for similar applications with 5 years documented experience.
- B. Factory Tests: Test complete system at factory and calibrate prior to shipment, include full-load test at rated power factor.
- C. Provide the Work in accordance with NFPA 70 (National Electric Code - NEC). Where required by authority having jurisdiction (AHJ), material and equipment shall be listed and labeled by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the above listed agency.
- D. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.
- E. Material and equipment shall be listed and labeled for its intended purpose, environment, or application, especially when used in extreme climate areas.
- F. Supply certification with submittals that the motors meet all applicable requirements of NEMA MG1 including, but not limited to, compliance with VFD requirements. The certification document shall demonstrate compliance to the performance standards specified in NEMA MG-1, Part 31, for inverter-fed polyphase motors.
- G. Provide letters of certification signed by officers of manufacturer and the VFD manufacturer that the specific application has been reviewed and that the motor and drive combination are compatible and will satisfy operating requirements under all conditions of operation without adverse impacts on either the motor or VFD. Coordinate the submittal of these letters through the Contractor's Unit Responsibility Engineer for equipment included in a unit responsibility system.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00 and 26 05 00.

1.06 ENVIRONMENTAL CONDITION

- A. Environmental condition: Section 01 17 00 and 26 05 00.
- B. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - 1. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.

1.07 WARRANTY

- A. Refer to Contract General Terms and Conditions and Section 01 78 36.
- B. Shall include repair parts, labor, and travel expense necessary for repairs at the jobsite, and during the course of repair.
- C. Guaranteed Performance: If equipment fails to meet the performance requirements specified herein, the County may, at the County's option and at no additional cost, require the equipment to be modified

or replaced with equipment that does meet the specified requirements. All changes necessary to meet the specified performance requirements shall be made at no cost to the County.

1.08 DEFINITIONS

- A. IPS RMS: Inches Per Second, Root Mean Squared.
- B. PIV: Peak Inverse Voltage.
- C. RTD: Resistance temperature detector.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. ABB Motors, Inc.
 - 2. General Electric.
 - 3. WEG.
 - 4. Approved Equal.

2.02 GENERAL

- A. Motors shall be high efficiency, adequate for severe duty, squirrel cage induction type with the design, construction, and performance characteristics described in this Specification.
- B. The motor manufacturer shall coordinate with pump manufacturer and supplier of pump's drive shaft equipment and verify that all requirements for the application and installation are included. The motor's temperature rating shall be adequate for running with quality of power source from variable frequency drives. A signed certificate of the require coordination from the motor manufacturer shall be provided with motor shop drawings.
- C. Electric motors driving identical machines shall be identical.

2.03 BASIC MOTOR DESIGN DATA

- A. Motors shall be designed for both continuous operation and long periods of inactivity.
- B. Motor voltage ratings shall be designed for 460 volts, three-phase, 20 Hz, for use on a 480-volt (nominal), three-phase, 60-Hz system, in accordance with the voltage and frequency variations dictated by NEMA MG-1. The motor's rated frequency shall be adjusted per manufacturers standards to match drive system operational speeds without increased number of poles.
- C. Nameplate horsepower and synchronous rpm shall be as indicated in the Drawings and in the individual driven equipment specifications.
- D. Service factor shall be 1.00 when driven by variable frequency drive (VFD). If output beyond a 1.0 service factor is required, the next higher motor rating shall be selected.
- E. Form windings, including leads and connections to the windings, shall be epoxy based, vacuum-pressure-impregnated (VPI), and non-hygroscopic. Insulation shall be Class F.
- F. Temperature rise shall be limited to 80 degrees Celsius (Class B rise) above 50 degrees C ambient at rated full load and service factor as determined by the RTD method.

- G. Motors shall be designed to tolerate the maximum overspeed dictated by NEMA MG-1 without permanent mechanical deformation to the rotor.
- H. Motors shall be suitable for operation from a pulse width modulated (PWM) variable frequency drive (VFD) system in accordance to NEMA MG1, Part 31.
 - 1. The motors controlled by variable frequency drives (VFD) shall be rated for inverter duty and shall include a stainless steel nameplate showing "Inverter Duty Motor."
 - 2. Nameplate shall also show that motor is suitable for variable torque operation on VFD power from 2 Hz to motor rated frequency, and show rated torque in lb-ft on inverter power in addition to the standard nameplate data specified in NEMA standards.
 - 3. Motors shall include an "inverter grade" insulation system using not less than triple insulation layer wire and other features necessary to meet the voltage spike specifications of NEMA MG1-2004. Complete insulation of the slot, cell, and phase groups is required. The system shall be rated for Class F temperature rise or better at a service factor of 1.0.
- I. Motor dimensions shall conform to the following:
 - 1. Height shall be a maximum of 126 inches.
 - 2. Weight shall be a maximum of 36,000 pounds.
 - 3. Regardless of the limits on motor dimensions specified herein, all vertical motors and appurtenances shall be configured such that a minimum of 6 feet of horizontal clearance is provided to any adjacent motor or motor appurtenance.
- J. Efficiency and Power Factor:
 - 1. The Guaranteed Efficiency:
 - a. The motor(s), at rated voltage and frequency, shall meet the minimum Nameplate Efficiency of 94.5% determined in accordance with NEMA MG-1.
 - b. Nameplate shall be stamped with tested efficiency in accordance with IEEE 112.
 - 2. The Guaranteed Power Factor:
 - a. The motors, at rated voltage and frequency, shall not be less than 67 percent at full load, 62 percent at 3/4 load, and 50 percent at 1/2 load.
- K. The motor shall be capable of operating at 120 percent of full-speed in reverse rotation direction, with no power applied to motor.
- L. Inertia (wk^2):
 - 1. Motors shall be capable of accelerating driven equipment without excessive temperature rises.
 - 2. Coordinate total load wk^2 of the combined driver/load with the driver manufacturer per Section 43 23 04.

2.04 ELECTRICAL SYSTEM CONDITIONS

- A. Details regarding the plant electrical system and provisions for motor control are indicated on the Drawings.
- B. Coordinate with entity performing short-circuit study to obtain the maximum 1/2 cycle RMS short-circuit amperes at the motor bus that can be delivered by the power system. Alternatively, the maximum supply switchgear circuit breaker RMS short-circuit ampere rating can be used. This information shall be coordinated with switchgear vendor.
- C. Coordinate with entity performing short-circuit study to obtain minimum RMS short-circuit amperes and X/R ratio at the motor terminals.

2.05 MOTOR STARTING

- A. Torque characteristics shall be as required by the driven load and shall be coordinated with the driven equipment manufacturer:
 - 1. Motor manufacturer shall review start-up load curve for driven equipment to determine minimum motor capabilities for locked-rotor torque, pull-up torque, and breakdown torque.
 - 2. Motor speed-torque curve shall exceed driven equipment speed-torque curve by a minimum margin of 10 percent at all points from zero speed to pull-up speed.
- B. When operating at speeds between minimum and 100 percent of rated speed, the motor shall maintain sufficient self-cooling such that rated temperature rise will not be exceeded when driving the pump at that speed and supplying all the required driving torque.
- C. Each motor shall be capable of two successive cold starts or one hot start according to NEMA MG 1.

2.06 MOUNTING

- A. Coordinate with the motor manufacturer such that all required mounting plates, jackscrews, shims, bolts, fasteners, lifting lugs, grouting, coatings, and all other items necessary for frame installation are provided.
- B. Design, fabricate and install motor supports:
 - 1. Motor anchorage calculations shall include all operating loads including the unbalanced force resulting from the motor operation.
 - a. The unbalanced force shall be determined in accordance with ISO 1940/1 using the rotor mass and G number (balance quality grade) furnished by the motor manufacturer.
- C. Conduct a Finite element analysis demonstrating that the assembly of motors, motor support framing, connections and the existing concrete framing of the Motor Room Floor bounded by Gridlines D and E and Gridlines 2 and 8 do not result in resonance at the normal range of motor operating speeds +/- 15 percent of the normal operating speed.
 - 1. Include in the Finite Element Model:
 - a. Motors:
 - 1) The model shall account for the mass and mounting details of the motor. A discrete mass placed at the center of gravity of the motor using rigid links to connect to the mounting plate and framing is acceptable.
 - b. Motor mounting plate and support framing shown in the Contract Drawings:
 - 1) The motor mounting plate attachment to the frame shall be modeled with discrete connections along the interface with the frame.
 - 2) The frame attachment to the concrete may be assumed to be moment released connections.
 - 3) The steel frame members shall be modeled as an assembly of thin plate shell elements.
 - c. Existing concrete slabs, beams and other elements:
 - 1) For concrete elements the modulus of elasticity shall be assumed to be 3,200,000 psi to account for actual concrete strength and assumed cracked section reductions.
 - 2) The slabs and beams may be assumed to be fixed at the Gridlines boundaries of the model.
 - d. A rotating unbalanced force acting at the center of gravity of the motors:
 - 1) The unbalanced force shall be determined in accordance with ISO 1940/1 using the rotor mass and G number (balance quality grade) furnished by the motor manufacturer.
 - e. The finite element analysis may use either a Ritz Vector Solver or an Eigen Value Solver with sufficient modes as necessary to obtain a mass participation of at least 95%.
 - 2. Include in the Finite Element Model analysis results submittal:
 - a. Modal analysis showing the period and mass participation factor for the first 6 modes.
 - b. Steady state vibration analysis showing the first two operating speeds resulting in resonance.

2.07 ENCLOSURE AND FRAME

- A. Motor enclosure shall be as scheduled and specified in the individual driven equipment specifications. Motors shall be Weather Protected Type I (WP1), vertical position, flange-mounted, with sealed bearings.
- B. All the enclosure's bolts, studs, and other fastening devices shall be made of corrosion-resistant materials.
- C. The motor frame shall be of heavy fabricated steel or cast iron construction of such design and proportions as to hold all components rigidly in their correct positions and provide adequate protection for the type of enclosure employed.
- D. Provide the air circulation necessary to meet the requirements of NEMA MG-1 including the temperature rise allowed by NEMA MG-1.
- E. Provide openings in stator endplates with access covers for checking motor air gap.
- F. Lifting lugs shall be provided to facilitate handling during installation or disassembly. Lifting lugs shall be designed to accommodate lifting of the Motor and Motor Support assembly as one unit. Reference structural Drawings for motor support requirements. Contractor to furnish motor manufacturer the motor support assembly to accommodate lifting lug design.
- G. Motor exterior shall be finished with double coats of the Sherwin Williams Frank Blue, SW 6967, paint finish. Motor interior frame shall be prime painted and one coat of finish paint applied to protect against corrosion. The finish shall be adequate to protect the metal surfaces from corrosion during shipment, storage, and installation. Surfaces which cannot be painted shall be protected from corrosion for shipment by a suitable coating or wrapping.
- H. One gallon of touch-up paint shall be furnished for each motor.

2.08 DRIVE SYSTEM – RAW SEWAGE PUMPS

- A. All details regarding the driven equipment drive system, including the required motor rotation, shall be coordinated with the driven equipment.
- B. The driven equipment supplier shall perform a steady-state and transient torsional and stress analysis of the motor and driven equipment for drive trains with variable frequency drives, in accordance with criteria specified in Section 43 05 50. Obtain the necessary physical data for the torsional analysis from the motor supplier.
- C. The driven equipment supplier shall be responsible for the complete and satisfactory performance of the equipment drive system.

2.09 STATOR

- A. The stator core shall consist of an assembly of high grade, non-aging electrical steel laminations insulated to minimize eddy current losses. Iron laminations shall utilize C5 core-plate minimum, on both sides, capable of withstanding 1,400 degrees F without deterioration. Heavy end rings and through bolts or bars shall align the laminations and clamp the whole assembly together under high pressure.
- B. The stator core assembly shall be accurately and rigidly mounted and secured within the motor frame. Adequate ventilating ducts shall be provided.

- C. The stator windings shall consist of form-wound coils of high-conductivity electrical copper, accurately fitted and securely locked in place in the stator slots by nonshrinking, insulated wedges. The entire stator assembly shall be adequately braced to withstand all mechanical, electrical, and thermal stresses normally encountered in motors of this class and rating.
- D. Exposed portions of the windings shall have a smooth, durable, protective finish to ensure an insulation impervious to penetration of dust and moisture. Coils shall be accurately formed to facilitate interchangeability.
- E. Stator coils shall be tested prior to installation in the stator. Tests shall include dielectric losses or tan delta, surge, and high potential.
- F. The stator-coil end runs, including all connections, shall have extra ties and extra bracing to provide positive support to prevent deleterious flexing of the winding causing fatigue failure and consequent shorting in the slot area of the stator.
- G. Provide two additional, loose, insulated and cured, stator coils, identical to those form-wound for insertion into stator core, for each unique machine design provided. The additional, insulated stator coils shall be used for destructive surge testing as specified in paragraph Factory Testing.

2.10 ROTOR AND SHAFT

- A. The rotor core shall consist of an assembly of high grade, non-aging electrical steel laminations, rigidly clamped together and accurately supported on a suitable hub or spider which, in turn, shall be securely keyed to the shaft. Adequate ventilation passages shall be provided.
- B. The rotor squirrel cage conductors shall be of high-conductivity copper bars. End rings shall be slotted to prevent movement of the copper bars. The welding or fusing of the cage bars to the end rings shall result in an end-ring junction of uniform strength, free of all weld stresses, which shall not fail or crack due to thermal cycling. Welding shall be induction brazing or TIG, not torch welding.
- C. The rotor assembly shall be statically and dynamically balanced.
- D. The motor shaft shall be solid, shall be suitable for direct connection, and shall be made of high grade machine steel or a steel forging, of size and design adequate to withstand the load stresses encountered in motors of this rating and for this application. Hot-rolled C1045 steel shall be used at a minimum. The bearing journals shall be ground and polished. The shaft shall be key seated as required for the application. The shaft shall be permanently marked on drive end to indicate the magnetic center with a pointed indicator mounted off drive-end bearing cap. Include a reference measurement to locate magnetic center in the event of a broken pointer on motor outline drawing.

2.11 NOISE LEVEL

- A. Motors shall operate with noise levels not exceeding 88 dBA. Noise shall be determined in accordance with IEEE Standard Test Procedure for Airborne Noise Measurements on Rotating Electric Machinery. Mean pressure levels shall be measured one meter (3 feet) from the major machine surfaces.

2.12 ACCESSORY EQUIPMENT

- A. Winding Temperature Detectors:
 - 1. Two RTDs per phase shall be installed and distributed around the circumference in the motor's stator winding slots. RTDs shall be platinum, three-wire elements with a resistance of 100 ohms DIN at 0 degrees Celsius. Motor manufacturer shall coordinate any additional RTD performance requirements that may be imposed by the motor protective relay vendor such that RTDs are compatible with the motor protective relays specified.

2. Terminate stator winding RTD leads in the auxiliary terminal box. An RTD connection diagram shall be provided inside the terminal box.
 3. Submittal drawings shall show location of RTD sensing elements in the motor windings.
- B. Bearings and Lubrication System:
1. Motor bearings shall be of high-precision manufacture. Ball bearings shall be utilized for thrust loading and guide bearing service and shall be grease lubricated.
 2. Motor bearings shall be standard thrust design. The driven equipment will provide equipment to absorb the system thrust. See Section 43 23 04.
 3. Provide self-contained and self-cooled, oil lubrication system. Bearings shall be provided with pressure type lubrication fittings with removable plastic cap protective covers and grease drain with threaded, removable drain plugs and an oil level sight glass.
 4. Bearings shall have an Anti-Friction Bearing Manufacturers Association L-10 continuous-duty life rating of not less than 100,000 hours.
 5. To protect against circulating shaft currents on VFD operation, both the drive bearing and the non-drive bearing shall be insulated and the drive end equipped with a shaft grounding brush.
 6. Motor bearings shall have grease seals.
- C. Vibration Detectors:
1. Provide vibration detectors in accordance with Section 40 79 56.
 2. Terminate vibration probe leads in the low voltage terminal box. A connection diagram shall be provided inside the terminal box.
 3. Vibration levels shall not exceed the specified limits in Specifications Section 43 05 50.
- D. Main Terminal Box:
1. Provide oversized conduit terminal box supplied with the following items:
 - a. Terminal box shall be made of fabricated steel plates with hinged covers secured by knurled screws.
 - b. Terminal box shall be gasketed with provisions for grounding.
 - c. Conduit boxes shall be capable of mounting rotation in 90-degree increments, or custom oriented to suit the application and conduit entry direction (from above).
 - d. Motor leads shall be fitted with solderless lug terminals with two holes minimum and prewired to terminal box for all motors. Hole spacing and size shall meet NEMA standards.
 - e. Main supply conductor size, type, insulation, and number per phase are as indicated on the Drawings and in the Specifications.
 - f. Space for stress relief cones and bolted style connectors.
 - g. Thermal insulation.
 - h. Removable links to permit isolation of each phase of the motor from the incoming cable.
 - i. A grounding pad shall be provided for bonding of the equipment grounding conductor inside the box. Ground path shall be direct to stator frame.
 2. Connection diagrams for all devices shall be provided inside the box.
 3. The terminal chamber shall have a threaded hub for conduit connection.
- E. Auxiliary Terminal Boxes: Provide a separate box, of same quality as the main terminal box, with terminal blocks for the termination of all low voltage conductors to factory-mounted equipment. Separate boxes shall be provided for control signal terminations and space heater leads. Leads shall be prewired to terminal box for all motors.
- F. Space Heaters:
1. Provide low power density grid type space heater, rated 120 V, 60 Hz, single-phase with leads brought out to a separate terminal box.
 2. Space heater shall be located in the base of the stator with easy access for maintenance.
 3. Space heater wattage shall be sized as recommended by the motor manufacturer for the application in which the motor is installed.
 4. Provide warning label on space heater junction box and motor indicating space heater wiring is energized when motor is not running.

5. Provide a space heater connection diagram inside the auxiliary terminal box.

G. Nameplate:

1. Motor shall have stainless steel nameplate, including the following: manufacturer's name, identification, serial number, rated horsepower output, service factor, time rating temperature rise, speed at rated load, frequency, number of phases, voltage, rated load amperes, code letter and design, and dBA noise rating.
2. All related bolts and cap screws shall be of high strength zinc-plated and chromated steel.

H. Equipment Identification Plates:

1. Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type equipment identification number and letters indicated in this specification and as shown.

I. Ground Connector: Provide drilled and tapped ground connection points at opposite corners of the machine frame.

J. Special Tools: Provide any special tools required for motor installation, operation, or maintenance. Package in a heavy-duty box with each tool marked to indicate its intended use.

2.13 MOTOR STORAGE AND TRANSPORT FRAME

A. Provide a motor storage and transport frame as shown on Drawings:

1. Steel fabrication shall be hot dip galvanized steel in accordance with Section 05 50 00.
2. Air bearing casters shall be sufficient to carry a total load of 40,000 lbs applied to the motor storage and transport frame:
 - a. Air casters shall meet or exceed the requirements of ASME B30.1
 - b. Air casters shall be urethane or neoprene
 - c. Acceptable Manufacturers:
 - 1) AeroGo, Inc.
 - 2) Aerofilm Systems, Inc.
 - 3) Hovair, Inc.
 - 4) Or approved equal.
3. Use the motor storage and transport frame to move the motors during construction to avoid overloading the existing floor. Prior to Contract Final Acceptance, provide the motor storage and transport frame in good working condition to the County.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. For motors with integrally mounted terminal boxes: provide a low-impedance ground path between the surge protection and the stator core by running a copper bonding wire in parallel with the motor leads from the terminal box to the motor core. This bonding wire shall be as short as possible and shall not be used for motors with separately mounted terminal boxes.
- B. For motors with separately mounted terminal boxes: The ground connection in the terminal box shall be grounded directly to the pump station's ground grid.
- C. Terminal box space heaters shall be constantly energized even while the motor is in operation.

- D. Stator winding space heaters shall be immediately connected and energized by the Contractor upon receipt of the motor at the jobsite.

3.03 FACTORY TESTING

- A. The following tests shall be performed in accordance with the methods outlined in requirements of IEEE and ANSI including long form tests of NEMA and IEEE Standard 112. Tests are required on all motors:
1. Manufacturer's routine test (use polarization index voltage = 5,000 V for insulation resistance tests).
 2. The motor shall be tested at 50, 75, 90, and 100 percent of rated load, all at rated speed. The efficiency and power factor versus load curves from the motor tests shall be submitted for information.
 3. Lateral critical speed analysis.
 4. Material certifications on shafts, forgings, and major castings.
 5. Dynamically balance rotors in minimum of three planes.
 6. The maximum allowable residual unbalance in each correction plane (journal) shall be calculated using the following equation:

$U = 4 W/N$, where:

U = residual correction plane unbalance, in ounces-inches

W = static correction plane journal loading, in pounds

N = maximum specified operating speed, in revolutions per minute

7. After balancing, a factory running test of the assembled motor shall be performed with the motor mounted in its normal vertical operating position. The fundamental resonant frequency (reed frequency) of the assembled motor and foundation shall be at least 25 percent higher than the motor's maximum specified operating speed.
 - a. Total overall unfiltered radial peak-to-peak displacement vibration measurements shall be made on the upper and lower bearing housing as the motor is run unloaded at its rated voltage and speed. Radial vibration measurements shall be made perpendicular to the rotating shaft axis in all radial directions. The location of maximum vibration shall be located and documented.
 - b. After completing the full voltage test, a deceleration test shall be run where the motor is allowed to coast down unpowered and unloaded from its rated speed to at least 10 percent of its maximum specified operation speed while motor speed and unfiltered peak-to-peak vibration displacement data are continuously collected and recorded. Deceleration vibration data shall be that which is obtained from the location which exhibited maximum vibration levels during the full voltage test.
 - c. The maximum unfiltered overall double amplitude displacement vibration levels recorded during the full voltage test and the deceleration test shall not exceed the vibration criteria in Specification 43 05 50. If this vibration tolerance is exceeded during any motor vibration test, the motor rotor shall be rebalanced to tighter tolerances and the assembled motor vibration test repeated.
 - d. The plus and minus 5 percent bandwidth of test instruments used to measure motor factory test vibration amplitudes shall, as a minimum, extend from 35 percent to 120 percent of the motor's maximum specified operating speed. A complete description of the instruments and procedures to be used for the measurement and recording of factory vibration test data shall be submitted with test report.
8. Bearing inspection (if operating speed is above first mechanical system resonance).
9. Sound testing shall be performed at a distance of 3 feet from the motor, using a standard sound level meter on the A scale, as approved by ANSI standards. A sound test after installation with power supplied by a VFD will be required to confirm specification compliance.
10. Each motor shall be factory tested. Factory testing may be witnessed in the presence of the Project Representative at the County's option. The Project Representative shall be notified in writing by the Contractor a minimum of three weeks in advance of the date for testing the motors.
11. See factory testing requirements in Specification Section 43 23 04.

- B. Factory Test Report:
 - 1. Submit a final test report which contains the following information (All tests shall be video recorded and the recordings shall be submitted along with the final test reports.):
 - a. Detailed procedures for all tests.
 - b. All recorded, measured, and calculated data generated during each individual test.
 - c. Acceptance criteria for monitored test parameters.

3.04 FIELD QUALITY CONTROL

- A. Inspect.
- B. Perform motor test in accordance with Specification Sections 01 75 20 and 26 08 00.
- C. Perform combined test of each motor and VFD in accordance with requirements of the driven equipment specification Section.
- D. Field Test Report: Submit a final field test report with detailed procedures for all field tests, measured and recorded motor's current (ampacity) data generated during each load test and verification of adequate performance for the motors and related controls.

3.05 CABLE TERMINATIONS

- A. Conductors shall be terminated with adequate stress relief devices, suitable for vibration in motors.
- B. Low voltage conductors shall be terminated on terminal blocks with ring type connectors.
- C. Do not perform the motor main power cable terminations before the manufacturer of the VFD performs the no load testing of the VFD equipment.

END OF SECTION

SECTION 40 06 22

SEAL WATER CONTROL UNIT SCHEDULE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section contains the schedule of the control units for this work. Control units shall be supplied to control the flow of seal water to pumps and other specified devices.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ISA-S75.02	Standard Control Valve Capacity Test Procedure

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. A layout drawing of the control units.
 2. A materials list.

1.04 SCHEDULE

- A. The following table contains the schedule of control units:

Control unit number ^a	Solenoid valve numbers	Flow switch number	Size	PRV number / setting (psi)	Seal Water Flow Range / Initial Setting ^b (gpm)	Rotameter Range (gpm)	Equipment served / Usage
CU03DC011	SV03DC011	FSL03DC011	3/4 Inch	PRV03DC011 / 50 psig	0-5 / 2	0-5	P03DC011 / Seal flush
CU03DC012	SV03DC012	FSL03DC012	3/4 Inch	PRV03DC012 / 50 psig	0-5 / 2	0-5	P03DC012 / Seal flush
CU03DC013	SV03DC013	FSL03DC013	3/4 Inch	PRV03DC013 / 50 psig	0-5 / 2	0-5	P03DC013 / Seal flush
CU03DC014	SV03DC014	FSL03DC014	3/4 Inch	PRV03DC014 / 50 psig	0-5 / 2	0-5	P03DC014 / Seal flush

^a Control Units shall be in accordance with the Drawings.

^b Estimated seal water demand for the control unit. Revise seal water requirements to manufacturer's recommendation.

PART 2 PRODUCTS

- A. Pressure Regulating Valves (PRV): Section 40 05 72
- B. Line Strainers: Section 40 05 47.
- C. Rotameter:
 - 1. Section 40 05 47.
 - 2. Rotameter Scale Initial flow setting value between 50 and 80 percent of full scale.
- D. Pressure Gauge
 - 1. Section 40 05 47.
 - 2. Pressure Gauge Scale: Pressure Regulator Valve setting value between 50 and 80 percent of full scale.
- E. Flow Switches
 - 1. Section 40 70 30.
 - 2. Flow switches will be set to trip at 60 percent of the normal flow rate.
- F. Solenoid Valve: Section 40 05 82.
- G. Piping: Section 40 05 01, Seal Water (SW), ½ inch size or as otherwise specified.
- H. Isolation valves: Section 40 05 01, Seal Water (SW).
- I. Needle valve:
 - 1. Install valves suitable for potable water at all locations indicated on the Drawings.
 - 2. NPT inlet and outlet ports.
 - 3. Material: Brass.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.

3.02 FIELD QUALITY CONTROL

- A. Field Testing:
 - 1. Section 01 75 20.
 - 2. Test each control unit as part of the equipment testing, including its responses to the control system requirements and functions.
 - 3. Each valve, after installation and connection to the piping system, shall be cycled three times manually or utilizing the manual override to demonstrate proper operation.
 - 4. Each valve, upon completion of installation of the piping system, shall be cycled to fully demonstrate proper operation and confirm that operating times, under both normal operating, and emergency closure conditions, are as specified.
 - 5. Be responsible for all adjustments necessary to bring the equipment into conformance with the specifications.

END OF SECTION

SECTION 40 06 70

SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section describes the purpose and content of the following schedules contained in Sections 40 06 71 through 40 06 73.
 - 1. Section 40 06 71: Instrument Schedule
 - 2. Section 40 06 72: Alarm Schedule
 - 3. Section 40 06 73: DCS I/O Schedule
- B. Information on equipment with identification numbers and other attributes which may relate to and may require coordination with items in these schedules is found in Section 01 78 40 and on the drawings.

PART 2 PRODUCTS

2.01 SCHEDULES

- A. General:
 - 1. These schedules briefly describe major discrete devices required by the control system. Scheduled devices shall be provided as described in the schedules and in the referenced specification paragraph. Each instrument is located by a panel reference or electrical or mechanical plan drawing reference (if field mounted).
 - 2. These schedules shall not be interpreted as a set of complete data sheets for the devices but only as a listing of instruments with certain salient features described. Additional elements such as power supplies, current repeaters or isolators, mounting hardware, cord sets, and other such elements as may be required by a particular vendor in order to complete the system shall be provided even though not listed. The Contractor shall create complete ordering information for all instruments and shall submit this information to the Project Representative for review prior to manufacture.
- B. Instrument Schedule Column Descriptions:
 - 1. Tag Number: These are instrument tag numbers which include the 3-digit instrument loop (IL) numbers and individual instrument prefixes and suffixes, or component name or circuit designation.
 - 2. Description: Defines application of the loop or identifies the type of individual instrument within the loop.
 - 3. Range: Calibration for 4 – 20 ma signal. Lists lower and upper limits to convert signal to engineering units.
 - 4. Engr. Units: Engineering units used in the calibration
 - 5. Specification: Numbers refer to specification requirements for new instruments which shall be provided.
 - 6. Instr ID: The INSTRUSPEC code used in identified Specification.
 - 7. P-Dwg: Numbers refer to basic process flow drawings showing the schematic locations of primary measuring elements and final control devices within the process.
 - 8. Elec/Inst Wire Dwg: The numbers refer to instrument drawings showing the connection diagrams. The raceway schedule in Division 26 defines the actual raceway and conductors required.
 - 9. Instrument Plan drawing: The numbers refer to facility layout drawings showing the location of the instrument.
 - 10. Inst Detl Dwg/Detail #: Lists the associated Installation Detail drawings.
 - 11. Notes: Used to add any other noted conditions for the record.
- C. Alarm Schedule Column Descriptions:

1. Ovation Point Name: These are instrument tag numbers which include the 3-digit instrument loop (IL) numbers and individual instrument prefixes and suffixes, or component name or circuit designation.
2. Point Description: Defines application of the loop or identifies the type of individual instrument within the loop.
3. Alarm Group: Alpha numeric code for tags to be sorted by in the alarm manager.
4. Point Type: Alarm Point Type. Use is defined by the Site Alarm Philosophy.
 - a. Analog compares a numeric value to a alarm limit value to trigger the alarm. Analog points contain multiple low and high limits, deadbands, cutouts and delay times.
 - b. Digital is a two-state point that has one state defined as the alarm state and a delay time.
5. Reset/Set: This column holds the trip point for the alarm, a numeric value for analog alarms and descriptor words for the reset and set values of a digital alarm.
6. Priority: Alarm priority, 1 is highest. Follow WPTP Alarm Philosophy for assigning priority.
7. Delay: Time in seconds that the alarm state needs to be in before triggering the alarm.

D. DCS I/O Schedule Column Descriptions:

1. Ovation Point Name: These are instrument tag numbers which include the 3-digit instrument loop (IL) numbers and individual instrument prefixes and suffixes, or component name or circuit designation.
2. Description: Defines application of the loop or identifies the type of individual instrument within the loop.
3. P&ID: Numbers refer to basic process flow drawings showing the schematic locations of primary measuring elements and final control devices within the process.
4. Loop #: The numbers refer to instrument drawings showing the connection diagrams.
5. Ovation Panel: Used to indicate the panel number where the I/O is terminated.
6. Point Type: Used to indicate the I/O point type.
 - a. Analog: An analog point has the ability to continuously change values, for example (voltage). The purpose of an analog process point record is to pass 32-bit, floating-point, real numbers throughout the system. In addition to carrying the basic value information, each long analog record type is the default and has full alarming I/O capabilities.
 - b. Digital: The purpose of a digital process point record is to pass discrete data throughout the system. Discrete data is logical in nature, (for example ON or OFF, or TRUE/FALSE).
 - c. Packed Point: Packed Points may be used to pack up to 16 discrete digital (logical) states in one point record. Each bit of the packed point may be separately configured for I/O scanning. Additionally, the packed point can be configured for register-wide addresses.
 - d. Packed Digital Point: The purpose of a packed digital process point record is to pass discrete data from an Ovation drop without any other information, such as alarming status or I/O information. A packed digital point record contains either 32 separate digital values or two 16-bit register (analog) values. Packed digitals are frequently used to pass information contained in special functions and in text algorithms.
7. Point Address: Used to indicate full Ovation Point Address. (Drop: Controller, Branch, Position, Channel)
8. Calibration: Used with Analog points to indicate the values of the range of the analog signal transmission.
9. Reset/Set: Used with Discrete points to indicate the words to indicate with in the Reset (off) condition and Set (on) condition.
10. Notes: Used to add any other noted conditions for the record.

PART 3 EXECUTION [NOT USED]

END OF SECTION

SECTION 40 06 71

INSTRUMENT SCHEDULE

Tag No	Description	Range	Engr. Units	Specification	Instr ID	P-Dwg	Elec/Inst Wire Dwg	Location Plan Dwg	Inst Detl Dwg/Detail #
704-FI03DC011	RSP-PUMP 1 SEAL WATER FLOW INDICATOR	0-5	GPM	40 70 10	FVA	WP704-P-60011	N/A	N/A	4070-240
704-FSL03DC011	RSP-PUMP 1 SEAL WATER LOW FLOW SWITCH	0-5	GPM	40 70 30	ZS1	WP704-P-60011	WP704-I-70106	WP704-E-10002	4070-407
704-PDIT03DC011	RAW SEWAGE PUMP 1 DIFFERENTIAL PRESSURE	0-50	FEET H2O	40 70 20	PDT	WP704-P-60011	WP704-I-70105	WP704-E-10002	4079-402
704-PI03DC011	RSP-PUMP 1 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60011	N/A	N/A	4070-502
704-PI03DC012	RSP-PUMP 1 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60011	N/A	N/A	4070-502
704-PSL03DC011	RSP-PUMP 1 SEAL WATER LOW PRESSURE SWITCH	0-75	PSIG	40 70 10	PG	WP704-P-60011	N/A	N/A	4070-502
704-FI03DC021	RSP-PUMP 2 SEAL WATER FLOW INDICATOR	0-5	GPM	40 70 10	FVA	WP704-P-60012	N/A	N/A	4070-240
704-FSL03DC021	RSP-PUMP 2 SEAL WATER LOW FLOW SWITCH	0-5	GPM	40 70 30	ZS1	WP704-P-60012	WP704-I-70206	WP704-E-10002	4070-407
704-PDIT03DC021	RAW SEWAGE PUMP 2 DIFFERENTIAL PRESSURE	0-50	FEET H2O	40 70 20	PDT	WP704-P-60012	WP704-I-70205	WP704-E-10002	4079-402
704-PI03DC021	RSP-PUMP 2 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60012	N/A	N/A	4070-502
704-PI03DC022	RSP-PUMP 2 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60012	N/A	N/A	4070-502
704-PSL03DC021	RSP-PUMP 2 SEAL WATER LOW PRESSURE SWITCH	0-75	PSIG	40 70 10	PG	WP704-P-60012	N/A	N/A	4070-502
704-FI03DC031	RSP-PUMP 3 SEAL WATER FLOW INDICATOR	0-5	GPM	40 70 10	FVA	WP704-P-60013	N/A	N/A	4070-240
704-FSL03DC031	RSP-PUMP 3 SEAL WATER LOW FLOW SWITCH	0-5	GPM	40 70 30	ZS1	WP704-P-60013	WP704-I-70306	WP704-E-10003	4070-407
704-PDIT03DC031	RAW SEWAGE PUMP 3 DIFFERENTIAL PRESSURE	0-50	FEET H2O	40 70 20	PDT	WP704-P-60013	WP704-I-70305	WP704-E-10003	4079-402
704-PI03DC031	RSP-PUMP 3 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60013	N/A	N/A	4070-502
704-PI03DC032	RSP-PUMP 3 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60013	N/A	N/A	4070-502
704-PSL03DC031	RSP-PUMP 3 SEAL WATER LOW PRESSURE SWITCH	0-75	PSIG	40 70 10	PG	WP704-P-60013	N/A	N/A	4070-502
704-FI03DC041	RSP-PUMP 4 SEAL WATER FLOW INDICATOR	0-5	GPM	40 70 10	FVA	WP704-P-60014	N/A	N/A	4070-240
704-FSL03DC041	RSP-PUMP 4 SEAL WATER LOW FLOW SWITCH	0-5	GPM	40 70 30	ZS1	WP704-P-60014	WP704-I-70406	WP704-E-10003	4070-407
704-PDIT03DC041	RAW SEWAGE PUMP 4 DIFFERENTIAL PRESSURE	0-50	FEET H2O	40 70 20	PDT	WP704-P-60014	WP704-I-70405	WP704-E-10003	4079-402
704-PI03DC041	RSP-PUMP 4 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60014	N/A	N/A	4070-502
704-PI03DC042	RSP-PUMP 4 SEAL WATER PRESSURE INDICATOR	0-75	PSIG	40 70 10	PG	WP704-P-60014	N/A	N/A	4070-502

SECTION 40 06 71

INSTRUMENT SCHEDULE

Tag No	Description	Range	Engr. Units	Specification	Instr ID	P-Dwg	Elec/Inst Wire Dwg	Location Plan Dwg	Inst Detl Dwg/Detail #
704-PSL03DC041	RSP-PUMP 4 SEAL WATER LOW PRESSURE SWITCH	0-75	PSIG	40 70 10	PG	WP704-P-60014	N/A	N/A	4070-502
704-AE24AB011	RSP-RAW SEWAGE SAMPLER PH/TEMPERATURE PROBE	0-14 / 23 - 158	pH / Deg F	40 70 20	AE/AIT4	WP704-P-60021	WP704-I-70037	WP704-E-40205	4070-215
704-AIT24AB011	RSP-RAW SEWAGE SAMPLER PH/TEMPERATURE INDICATING TRANSMITTER	0-14 / 23 - 158	pH / Deg F	40 70 20	AE/AIT4	WP704-P-60021	WP704-I-70037	WP704-E-10205	4070-215
704-CE24AD011	RSP-RAW SEWAGE SAMPLER CONDUCTIVITY PROBE	0.00025-2.5	S/CM	40 70 20	AE/AIT5	WP704-P-60021	WP704-I-70037	WP704-E-40205	4070-216
704-CIT24AD011	RSP-RAW SEWAGE SAMPLER CONDUCTIVITY INDICATING TRANSMITTER	0.00025-2.5	S/CM	40 70 20	AE/AIT5	WP704-P-60021	WP704-I-70037	WP704-E-10205	4070-216
704-FSL24AA011	RSP-RAW SEWAGE SAMPLER LOW FLOW SWITCH	0 - 100	GPM	40 70 30	FS	WP704-P-60021	WP704-I-70036	WP704-E-40205	4070-407
704-FI03SP031	RSP-RAW SEWAGE PUMP ROOM BUBBLER FLOW	0-20	SCFM	40 70 10	LBE	WP704-P-60022	N/A	N/A	4070-240
704-FLT/PRV03SP031	RSP-RAW SEWAGE PUMP ROOM BUBBLER FILTERED REGULATOR	0-50	PSIG	40 70 10	LBE	WP704-P-60022	N/A	N/A	4070-240
704-LIT03SP031	RSP-RAW SEWAGE PUMP ROOM SUMP LEVEL	0-10	FEET H2O	40 70 20	PDT	WP704-P-60022	WP704-I-70020	WP704-E-10102	4070-301
704-LSH03SP031	RSP-RAW SEWAGE PUMP ROOM SUMP LEVEL HIGH SWITCH	90	FT Elevation	40 70 30	PS	WP704-P-60022	WP704-I-70020	WP704-E-10102	4070-502
704-LSHH03SP031	RSP-RAW SEWAGE PUMP ROOM SUMP LEVEL HIGH-HIGH SWITCH	92	FT Elevation	40 70 30	PS	WP704-P-60022	WP704-I-70020	WP704-E-10102	4070-502
704-LSH03SP032	RSP-RAW SEWAGE PUMP ROOM SUMP LEVEL LOW SWITCH	87	FT Elevation	40 70 30	PS	WP704-P-60022	N/A	N/A	4070-502
704-PI03SP031	RSP-RAW SEWAGE PUMP ROOM BUBBLER PRESSURE	0-50	PSIG	40 70 10	LBE	WP704-P-60022	N/A	N/A	4070-502
705-PIT16OB011	PROPANE HEADER PRESSURE	0 - 30	PSIG	40 70 20	PGT	WP705-P-60010	WP704-I-70079	WP704-E-10102	4070-502
704-LT03AV011	RSP-TEMPORARY ENGINE JACKET WATER HEAD TANK LEVEL NO.1	0-5	feet	40 70 20	PDT	WP704-TP-60005	N/A	N/A	4070-301
704-TE/TIT03EJ011	RSP-TEMPORARY ENGINE JACKET WATER OUTLET TEMPERATURE NO.1	30-250	Deg F	40 70 20	TT	WP704-TP-60005	N/A	N/A	4070-231
704-TS03EJ011	RSP-TEMPORARY ENGINE JACKET WATER OUTLET TEMPERATURE SWITCH NO.1	30-250	Deg F	40 70 30	TS	WP704-TP-60005	N/A	N/A	4070-230
704-LT03AV021	RSP-TEMPORARY ENGINE JACKET WATER HEAD TANK LEVEL NO.2	0-5	feet	40 70 20	PDT	WP704-TP-60006	N/A	N/A	4070-301

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INSTRUMENT SCHEDULE

Tag No	Description	Range	Engr. Units	Specification	Instr ID	P-Dwg	Elec/Inst Wire Dwg	Location Plan Dwg	Inst Detl Dwg/Detail #
704-TE/TIT03EJ021	RSP-TEMPORARY ENGINE JACKET WATER OUTLET TEMPERATURE NO.2	30-250	Deg F	40 70 20	TT	WP704-TP-60006	N/A	N/A	4070-231
704-TS03EJ021	RSP-TEMPORARY ENGINE JACKET WATER OUTLET TEMPERATURE SWITCH NO.2	30-250	Deg F	40 70 30	TS	WP704-TP-60006	N/A	N/A	4070-230
705-PI19FC011	WATER INLET PRESSURE BOILER 1	0 - 60	PSIG	40 70 10	PG	WP705-P-61001	N/A	N/A	4070-502
705-PI19FC013	WATER PRESSURE DIFFERENTIAL CIRCULATION PUMP BOILER 1	0 - 60	PSIG	40 70 10	PG	WP705-P-61001	N/A	N/A	4070-502
705-PI19FC012	WATER PRESSURE CIRCULATION PUMP INLET BOILER 1	0 - 60	PSIG	40 70 10	PG	WP705-P-61001	N/A	N/A	4070-502
705-TI19FB012	WATER INLET TEMPERAURE GUAGE BOILER 1	30-250	Deg F	40 70 10	TG	WP705-P-61001	N/A	N/A	4070-007
705-TIT19FB011	WATER OUTLET TEMPERATURE BOILER 1	30-250	Deg F	40 70 20	TT	WP705-P-61001	WP705-I-70051	WP705-E-10105	4070-231
705-PI19FC022	WATER INLET PRESSURE BOILER 2	0 - 60	PSIG	40 70 10	PG	WP705-P-62001	N/A	N/A	4070-502
705-PI19FC023	WATER PRESSURE DIFFERENTIAL CIRCULATION PUMP BOILER 2	0 - 60	PSIG	40 70 10	PG	WP705-P-62001	N/A	N/A	4070-502
705-PI19FC021	WATER PRESSURE CIRCULATION PUMP INLET BOILER 2	0 - 60	PSIG	40 70 10	PG	WP705-P-62001	N/A	N/A	4070-502
705-TI19FB022	WATER INLET TEMPERAURE GAUGE BOILER 2	30-250	Deg F	40 70 10	TG	WP705-P-62001	N/A	N/A	4070-007
705-TIT19FB021	WATER OUTLET TEMPERATURE BOILER 2	30-250	Deg F	40 70 20	TT	WP705-P-62001	WP705-I-70056	WP705-E-10104	4070-231
705-PI19FC031	WATER INLET PRESSURE BOILER 3	0 - 60	PSIG	40 70 10	PG	WP705-P-63001	N/A	N/A	4070-502
705-PI19FC032	WATER PRESSURE DIFFERENTIAL CIRCULATION PUMP BOILER 3	0 - 60	PSIG	40 70 10	PG	WP705-P-63001	N/A	N/A	4070-502
705-PI19FC033	WATER PRESSURE CIRCULATION PUMP INLET BOILER 3	0 - 60	PSIG	40 70 10	PG	WP705-P-63001	N/A	N/A	4070-502
705-TI19FB032	WATER INLET TEMPERAURE GAUGE BOILER 3	30-250	Deg F	40 70 10	TG	WP705-P-63001	N/A	N/A	4070-007
705-TIT19FB031	WATER OUTLET TEMPERATURE BOILER 3	30-250	Deg F	40 70 20	TT	WP705-P-63001	WP705-I-70061	WP705-E-10105	4070-231
705-PI19FC041	WATER INLET PRESSURE BOILER 4	0 - 60	PSIG	40 70 20	PG	WP705-P-64001	N/A	N/A	4070-502
705-PI19FC043	WATER PRESSURE DIFFERENTIAL CIRCULATION PUMP BOILER 4	0 - 60	PSIG	40 70 10	PG	WP705-P-64001	N/A	N/A	4070-502

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INSTRUMENT SCHEDULE

Tag No	Description	Range	Engr. Units	Specification	Instr ID	P-Dwg	Elec/Inst Wire Dwg	Location Plan Dwg	Inst Detl Dwg/Detail #
705-PI19FC042	WATER PRESSURE CIRCULATION PUMP INLET BOILER 4	0 - 60	PSIG	40 70 10	PG	WP705-P-64001	N/A	N/A	4070-502
705-TI19FB042	WATER INLET TEMPERAURE GAUGE BOILER 4	30-250	Deg F	40 70 10	TG	WP705-P-64001	N/A	N/A	4070-007
705-TIT19FB041	WATER OUTLET TEMPERATURE BOILER 4	30-250	Deg F	40 70 20	TT	WP705-P-64001	WP705-I-70067	WP705-E-10104	4070-231
705-FIT16NF012	BOILER 1 PROPANE FLOW	0-200	SCFM	40 70 20	FT	WP705-P-61000	WP705-I-70081	WP705-E-10105	4070-241
705-PI19BJ011	BOILER 1 DIGESTER GAS INLET PRESSURE	0 - 15	PSIG	40 70 20	PG	WP705-P-61000	N/A	N/A	4070-502
705-PI19BJ012	BOILER 1 PROPANE INLET PRESSURE	0 - 30	PSIG	40 70 20	PG	WP705-P-61000	N/A	N/A	4070-502
705-PI19BJ013	BOILER 1 PILOT PROPANE INLET PRESSURE	0 - 15	PSIG	40 70 20	PG	WP705-P-61000	N/A	N/A	4070-502
705-FIT16NF022	BOILER 2 PROPANE FLOW	0-200	SCFM	40 70 20	FT	WP705-P-62000	WP705-I-70082	WP705-E-10104	
705-PI19BJ021	BOILER 2 DIGESTER GAS INLET PRESSURE	0 - 15	PSIG	40 70 20	PG	WP705-P-62000	N/A	N/A	4070-502
705-PI19BJ022	BOILER 2 PROPANE INLET PRESSURE	0 - 30	PSIG	40 70 20	PG	WP705-P-62000	N/A	N/A	4070-502
705-PI19BJ023	BOILER 2 PILOT PROPANE INLET PRESSURE	0 - 15	PSIG	40 70 20	PG	WP705-P-62000	N/A	N/A	4070-502
705-FIT19BN011	BOILER 3 EGG FLOW	0-200	SCFM	40 70 20	FT	WP705-P-63000	WP705-I-70083	WP705-E-10105	4070-241
705-FIT16NF031	BOILER 3 DIGESTER GAS FLOW	0-200	SCFM	40 70 20	FT	WP705-P-63000	WP705-I-70083	WP705-E-10103	4070-241
705-FIT16NF032	BOILER 3 PROPANE FLOW	0-200	SCFM	40 70 20	FT	WP705-P-63000	WP705-I-70083	WP705-E-10105	4070-241
705-PI19BJ031	BOILER 3 DIGESTER GAS INLET PRESSURE	0 - 15	PSIG	40 70 20	PG	WP705-P-63000	N/A	N/A	4070-502
705-PI19BJ032	BOILER 3 PROPANE INLET PRESSURE	0 - 30	PSIG	40 70 20	PG	WP705-P-63000	N/A	N/A	4070-502
705-PI19BJ033	BOILER 3 PILOT PROPANE INLET PRESSURE	0 - 15	PSIG	40 70 20	PG	WP705-P-63000	N/A	N/A	4070-502
705-PI19FB034	BOILER 3 PROPANE INLET PRESSURE BEFORE STRAINER	0 - 30	PSIG	40 70 20	PG	WP705-P-63000	N/A	N/A	4070-502
705-TI19FD031	BOILER 3 HOT WATER TEMPERATURE	30-250	F	40 70 10	TG	WP705-P-63001	N/A	N/A	4070-007
705-FIT16NF041	BOILER 4 DIGESTER GAS FLOW	0-200	SCFM	40 70 20	FT	WP705-P-64000	WP705-I-70084	WP705-E-10104	4070-241
705-FIT16NF042	BOILER 4 PROPANE FLOW	0-200	SCFM	40 70 20	FT	WP705-P-64000	WP705-I-70084	WP705-E-10104	4070-241
704-FSH01001	RSP #1 AND #2 EYEWASH STATION FLOW SWITCH 1 NW MOTOR LEVEL	1.5	GPM	22 45 33	FS	WP704-P-60001	WP704-I-70501	WP704-E-10102	4070-407
704-FSH01002	RSP #1 AND #2 EYEWASH STATION FLOW SWITCH 2 NE MOTOR LEVEL	1.5	GPM	22 45 33	FS	WP704-P-60001	WP704-I-70501	WP704-E-10103	4070-407

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INSTRUMENT SCHEDULE

Tag No	Description	Range	Engr. Units	Specification	Instr ID	P-Dwg	Elec/Inst Wire Dwg	Location Plan Dwg	Inst Detl Dwg/Detail #
704-AE03BR011	RSP PUMP LEVEL NORTHWEST CORNER LEL ANALYZER	0-100	LEL	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70614	WP704-E-10002	4070-112
704-AE03BR012	RSP PUMP LEVEL NORTHWEST CORNER H2S ANALYZER	0-20	PPM	40 70 20	AE/AIT2	WP704-P-60035	WP704-I-70614	WP704-E-10002	4070-601
704-AIT03BR011	RSP PUMP LEVEL NORTHWEST CORNER LEL/H2S TRANSMITTER	0-100 0-50	% LEL PPM H2S	40 70 20	AE/AIT1 AE/AIT2	WP704-P-60035	WP704-I-70614	WP704-E-10002	4070-112
704-AE03BV41	RSP PUMP LEVEL NORTH BATTERY ROOM CO ANALYZER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60036	WP704-I-70615	WP704-E-10003	4070-112
704-AIT03BV41	RSP PUMP LEVEL NORTH BATTERY ROOM CO TRANSMITTER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60036	WP704-I-70615	WP704-E-10003	4070-112
704-AE03BV42	RSP PUMP LEVEL SOUTH BATTERY ROOM CO ANALYZER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60036	WP704-I-70616	WP704-E-10003	4070-112
704-AIT03BV42	RSP PUMP LEVELSOUTH BATTERY ROOM CO TRANSMITTER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60036	WP704-I-70616	WP704-E-10003	4070-112
704-AE03BV011	RSP MOTOR LEVEL ENGINE MAINT RM 421 LEL ANALYZER	0-100	LEL	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70617	WP704-E-10102	4070-112
704-AE03BV012	RSP MOTOR LEVEL ENGINE MAINT RM 421 CO ANALYZER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70617	WP704-E-10102	4070-112
704-AIT03BV011	RSP MOTOR LEVEL ENGINE MAINT RM 421 LEL/CO TRANSMITTER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70617	WP704-E-10102	4070-112
704-AE03BV021	RSP MOTOR LEVEL NORTH OF GENERATOR LEL ANALYZER	0-100	LEL	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70618	WP704-E-10102	4070-112
704-AE03BV022	RSP MOTOR LEVEL NORTH OF GENERATOR CO ANALYZER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70618	WP704-E-10102	4070-112
704-AIT03BV021	RSP MOTOR LEVEL NORTH OF GENERATOR LEL/CO TRANSMITTER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70618	WP704-E-10102	4070-112
704-AE03BV031	RSP NW CORNER NEAR GENERATOR SILENCER CO ANALYZER	0-100	LEL	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70619	WP704-E-10202	4070-112
704-AIT03BV031	RSP NW CORNER NEAR GENERATOR SILENCER CO TRANSMITTER	0-100	PPM	40 70 20	AE/AIT1	WP704-P-60035	WP704-I-70619	WP704-E-10202	4070-112
704-TE03EJ011	RSP ENGINE NO.4 JACKET WATER OUTLET TEMPERATURE ELEMENT	30-250	Deg F	40 70 20	TE	WP704-TP-60005	N/A	N/A	4070-220

INSTRUMENT SCHEDULE

Tag No	Description	Range	Engr. Units	Specification	Instr ID	P-Dwg	Elec/Inst Wire Dwg	Location Plan Dwg	Inst Detl Dwg/Detail #
704-TIT03EJ011	RSP ENGINE NO.4 JACKET WATER OUTLET TEMPERATURE TRANSMITTER	30-250	Deg F	40 70 20	TT	WP704-TP-60005	N/A	N/A	4070-231
704-TS03EJ011	RSP ENGINE NO.4 JACKET WATER OUTLET TEMPERATURE SWITCH	30-250	Deg F	40 70 30	TS	WP704-TP-60005	N/A	N/A	4070-230
704-LIT03AV011	RSP TEMPORARY JACKET WATER HEAD TANK 1 LEVEL TRANSMITTER	0-5	feet	40 70 20	PDT	WP704-TP-60005	N/A	N/A	4070-301
704-TE03EJ021	RSP ENGINE NO.3 JACKET WATER OUTLET TEMPERATURE ELEMENT	30-250	Deg F	40 70 20	TE	WP704-TP-60006	N/A	N/A	4070-220
704-TIT03EJ021	RSP ENGINE NO.3 JACKET WATER OUTLET TEMPERATURE TRANSMITTER	30-250	Deg F	40 70 20	TT	WP704-TP-60006	N/A	N/A	4070-231
704-TS03EJ021	RSP ENGINE NO.3 JACKET WATER OUTLET TEMPERATURE SWITCH	30-250	Deg F	40 70 30	TS	WP704-TP-60006	N/A	N/A	4070-230
704-LIT03AV021	RSP TEMPORARY JACKET WATER HEAD TANK 2 LEVEL TRANSMITTER	0-5	feet	40 70 20	PDT	WP704-TP-60006	N/A	N/A	4070-301

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ALARM SCHEDULE

Ovation Point Name	Point Description	Alarm Group	Point Type	Reset/Set	Priority	Delay
WP704ZIC26BD011	704-SWGR02 MAIN MV BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD26BD011	704-SWGR02 MAIN MV BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC03DC051	704-SWGR02 A-SIDE SPARE BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC051	704-SWGR02 A-SIDE SPARE BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC0111	704-SWGR02 RS PUMP 1 MV BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC03DC011	704-SWGR02 RS PUMP 1 MV BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC012	704-SWGR02 RS PUMP 1 UPS FAULT	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC0211	704-SWGR02 RS PUMP 2 MV BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC03DC021	704-SWGR02 RS PUMP 2 MV BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC022	704-SWGR02 RS PUMP 2 UPS FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC26BD031	704-SWGR02 MV TIE BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704VI03DC011	RAW SEWAGE PUMP 1 PUMP VIB X	*	MHM	*	2	1 sec
WP704VI03DC012	RAW SEWAGE PUMP 1 PUMP VIB Y	*	MHM	*	2	1 sec
WP704VI03DC013	RAW SEWAGE PUMP 1 PUMP BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC014	RAW SEWAGE PUMP 1 PUMP BEARING VIB Y	*	MHM	*	2	1 sec
WP704SI03DC012	RAW SEWAGE PUMP 1 SHAFT SPEED	*	MHM	*	2	1 sec
WP704VI03DC015	RAW SEWAGE PUMP 1 MOTOR NDE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC016	RAW SEWAGE PUMP 1 MOTOR NDE BEARING VIB Y	*	MHM	*	2	1 sec
WP704VI03DC017	RAW SEWAGE PUMP 1 MOTOR DE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC018	RAW SEWAGE PUMP 1 MOTOR DE BEARING VIB Y	*	MHM	*	2	1 sec
WP704NDA03DC011	RAW SEWAGE PUMP 1 REMOTE STATUS	*	DISCRETE IN	*	2	1 sec
WP704NDJ03DC011	RAW SEWAGE PUMP 1 RUNNING	*	DISCRETE IN	*	2	1 sec
WP704NDR03DC011	RAW SEWAGE PUMP 1 READY	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC011	RAW SEWAGE PUMP 1 FAULTED	*	DISCRETE IN	*	2	1 sec
WP704ZSO03DC011	RAW SEWAGE PUMP 1 SEAL WATER VALVE OPENED	*	DISCRETE IN	*	2	1 sec
WP704PAL03DC011	RAW SEWAGE PUMP 1 SEAL WATER LOW PRESSURE	*	DISCRETE IN	*	2	1 sec
WP704FAL03DC011	RAW SEWAGE PUMP 1 SEAL WATER LOW FLOW	*	DISCRETE IN	*	2	1 sec
WP704SI03DC011	RAW SEWAGE PUMP 1 SPEED FEEDBACK	*	ANALOG IN	*	2	1 sec
WP704DPI03DC011	RAW SEWAGE PUMP 1 DIFFERENTIAL PRESSURE	*	ANALOG IN	*	2	1 sec
WP704TI03OVX11	704-ICP0311 OVATION PANEL TEMPERATURE	*	ANALOG IN	*	2	1 sec
WP704TI03DC011	RAW SEWAGE PUMP 1 PUMP BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC012	RAW SEWAGE PUMP 1 MOTOR DE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC013	RAW SEWAGE PUMP 1 MOTOR NDE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC014	RAW SEWAGE PUMP 1 MOTOR WINDING TEMP A	*	RTD IN	*	2	1 sec
WP704TI03DC015	RAW SEWAGE PUMP 1 MOTOR WINDING TEMP B	*	RTD IN	*	2	1 sec
WP704TI03DC016	RAW SEWAGE PUMP 1 MOTOR WINDING TEMP C	*	RTD IN	*	2	1 sec
WP704VI03DC021	RAW SEWAGE PUMP 2 PUMP VIB X	*	MHM	*	2	1 sec
WP704VI03DC022	RAW SEWAGE PUMP 2 PUMP VIB Y	*	MHM	*	2	1 sec
WP704VI03DC023	RAW SEWAGE PUMP 2 PUMP BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC024	RAW SEWAGE PUMP 2 PUMP BEARING VIB Y	*	MHM	*	2	1 sec
WP704SI03DC022	RAW SEWAGE PUMP 2 SHAFT SPEED	*	MHM	*	2	1 sec
WP704VI03DC025	RAW SEWAGE PUMP 2 MOTOR NDE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC026	RAW SEWAGE PUMP 2 MOTOR NDE BEARING VIB Y	*	MHM	*	2	1 sec
WP704VI03DC027	RAW SEWAGE PUMP 2 MOTOR DE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC028	RAW SEWAGE PUMP 2 MOTOR DE BEARING VIB Y	*	MHM	*	2	1 sec
WP704NDA03DC021	RAW SEWAGE PUMP 2 REMOTE STATUS	*	DISCRETE IN	*	2	1 sec
WP704NDJ03DC021	RAW SEWAGE PUMP 2 RUNNING	*	DISCRETE IN	*	2	1 sec
WP704NDR03DC021	RAW SEWAGE PUMP 2 READY	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC021	RAW SEWAGE PUMP 2 FAULTED	*	DISCRETE IN	*	2	1 sec
WP704ZSO03DC021	RAW SEWAGE PUMP 2 SEAL WATER VALVE OPENED	*	DISCRETE IN	*	2	1 sec
WP704PAL03DC021	RAW SEWAGE PUMP 2 SEAL WATER LOW PRESSURE	*	DISCRETE IN	*	2	1 sec
WP704FAL03DC021	RAW SEWAGE PUMP 2 SEAL WATER LOW FLOW	*	DISCRETE IN	*	2	1 sec
WP704SI03DC021	RAW SEWAGE PUMP 2 SPEED FEEDBACK	*	ANALOG IN	*	2	1 sec
WP704DPI03DC021	RAW SEWAGE PUMP 2 DIFFERENTIAL PRESSURE	*	ANALOG IN	*	2	1 sec
WP704TI03OVX21	704-ICP0311 OVATION PANEL TEMPERATURE	*	ANALOG IN	*	2	1 sec
WP704TI03DC021	RAW SEWAGE PUMP 2 PUMP BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC022	RAW SEWAGE PUMP 2 MOTOR DE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC023	RAW SEWAGE PUMP 2 MOTOR NDE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC024	RAW SEWAGE PUMP 2 MOTOR WINDING TEMP A	*	RTD IN	*	2	1 sec
WP704TI03DC025	RAW SEWAGE PUMP 2 MOTOR WINDING TEMP B	*	RTD IN	*	2	1 sec
WP704TI03DC026	RAW SEWAGE PUMP 2 MOTOR WINDING TEMP C	*	RTD IN	*	2	1 sec
WP704ZIC26BD012	704-SWGR02 B-SIDE MAIN MV BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD26BD012	704-SWGR02 B-SIDE MAIN MV BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC03DC061	704-SWGR02 B-SIDE SPARE BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC061	704-SWGR02 B-SIDE SPARE BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC0311	704-SWGR02 RS PUMP 3 MV BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC03DC031	704-SWGR02 RS PUMP 3 MV BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC032	704-SWGR02 RS PUMP 3 UPS FAULT	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC0411	704-SWGR02 RS PUMP 4 MV BREAKER FAULT	*	DISCRETE IN	*	2	1 sec
WP704ZIC03DC041	704-SWGR02 RS PUMP 4 MV BREAKER CLOSED	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC042	704-SWGR02 RS PUMP 4 UPS FAULT	*	DISCRETE IN	*	2	1 sec
WP704LI03SP031	RS PUMP ROOM SUMP LEVEL	*	ANALOG IN	*	2	1 sec
WP704TI03EJ011	TEMP RS ENGINE JACKET COOLING TEMP 1	*	ANALOG IN	*	2	1 sec
WP704LI03AV011	TEMP RS ENGINE JACKET COOLING TANK LEVEL 1	*	ANALOG IN	*	2	1 sec
WP704TI03EJ021	TEMP RS ENGINE JACKET COOLING TEMP 2	*	ANALOG IN	*	2	1 sec
WP704LI03AV021	TEMP RS ENGINE JACKET COOLING TANK LEVEL 2	*	ANALOG IN	*	2	1 sec
WP704VI03DC031	RAW SEWAGE PUMP 3 PUMP VIB X	*	MHM	*	2	1 sec
WP704VI03DC032	RAW SEWAGE PUMP 3 PUMP VIB Y	*	MHM	*	2	1 sec
WP704VI03DC033	RAW SEWAGE PUMP 3 PUMP BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC034	RAW SEWAGE PUMP 3 PUMP BEARING VIB Y	*	MHM	*	2	1 sec
WP704SI03DC032	RAW SEWAGE PUMP 3 SHAFT SPEED	*	MHM	*	2	1 sec
WP704VI03DC035	RAW SEWAGE PUMP 3 MOTOR NDE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC036	RAW SEWAGE PUMP 3 MOTOR NDE BEARING VIB Y	*	MHM	*	2	1 sec
WP704VI03DC037	RAW SEWAGE PUMP 3 MOTOR DE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC038	RAW SEWAGE PUMP 3 MOTOR DE BEARING VIB Y	*	MHM	*	2	1 sec
WP704NDA03DC031	RAW SEWAGE PUMP 3 REMOTE STATUS	*	DISCRETE IN	*	2	1 sec
WP704NDJ03DC031	RAW SEWAGE PUMP 3 RUNNING	*	DISCRETE IN	*	2	1 sec
WP704NDR03DC031	RAW SEWAGE PUMP 3 READY	*	DISCRETE IN	*	2	1 sec
WP704XAD03DC031	RAW SEWAGE PUMP 3 FAULTED	*	DISCRETE IN	*	2	1 sec
WP704ZSO03DC031	RAW SEWAGE PUMP 3 SEAL WATER VALVE OPENED	*	DISCRETE IN	*	2	1 sec
WP704PAL03DC031	RAW SEWAGE PUMP 3 SEAL WATER LOW PRESSURE	*	DISCRETE IN	*	2	1 sec
WP704FAL03DC031	RAW SEWAGE PUMP 3 SEAL WATER LOW FLOW	*	DISCRETE IN	*	2	1 sec
WP704SI03DC031	RAW SEWAGE PUMP 3 SPEED FEEDBACK	*	ANALOG IN	*	2	1 sec
WP704DPI03DC031	RAW SEWAGE PUMP 3 DIFFERENTIAL PRESSURE	*	ANALOG IN	*	2	1 sec
WP704TI03OVX31	704-ICP0311 OVATION PANEL TEMPERATURE	*	ANALOG IN	*	2	1 sec
WP704TI03DC031	RAW SEWAGE PUMP 3 PUMP BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC032	RAW SEWAGE PUMP 3 MOTOR DE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC033	RAW SEWAGE PUMP 3 MOTOR NDE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC034	RAW SEWAGE PUMP 3 MOTOR WINDING TEMP A	*	RTD IN	*	2	1 sec
WP704TI03DC035	RAW SEWAGE PUMP 3 MOTOR WINDING TEMP B	*	RTD IN	*	2	1 sec
WP704TI03DC036	RAW SEWAGE PUMP 3 MOTOR WINDING TEMP C	*	RTD IN	*	2	1 sec
WP704VI03DC041	RAW SEWAGE PUMP 4 PUMP VIB X	*	MHM	*	2	1 sec
WP704VI03DC042	RAW SEWAGE PUMP 4 PUMP VIB Y	*	MHM	*	2	1 sec
WP704VI03DC043	RAW SEWAGE PUMP 4 PUMP BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC044	RAW SEWAGE PUMP 4 PUMP BEARING VIB Y	*	MHM	*	2	1 sec
WP704SI03DC042	RAW SEWAGE PUMP 4 SHAFT SPEED	*	MHM	*	2	1 sec
WP704VI03DC045	RAW SEWAGE PUMP 4 MOTOR NDE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC046	RAW SEWAGE PUMP 4 MOTOR NDE BEARING VIB Y	*	MHM	*	2	1 sec
WP704VI03DC047	RAW SEWAGE PUMP 4 MOTOR DE BEARING VIB X	*	MHM	*	2	1 sec
WP704VI03DC048	RAW SEWAGE PUMP 4 MOTOR DE BEARING VIB Y	*	MHM	*	2	1 sec
WP704NDA03DC041	RAW SEWAGE PUMP 4 REMOTE STATUS	*	DISCRETE IN	*	2	1 sec
WP704NDJ03DC041	RAW SEWAGE PUMP 4 RUNNING	*	DISCRETE IN	*	2	1 sec
WP704NDR03DC041	RAW SEWAGE PUMP 4 READY	*	DISCRETE IN	*	2	1 sec

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ALARM SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	ALARM GROUP	POINT TYPE	RESET/SET	PRIORITY	DELAY
WP704XAD03DC041	RAW SEWAGE PUMP 4 FAULTED	*	DISCRETE IN	*	2	1 sec
WP704ZSO03DC041	RAW SEWAGE PUMP 4 SEAL WATER VALVE OPENED	*	DISCRETE IN	*	2	1 sec
WP704PAL03DC041	RAW SEWAGE PUMP 4 SEAL WATER LOW PRESSURE	*	DISCRETE IN	*	2	1 sec
WP704FAL03DC041	RAW SEWAGE PUMP 4 SEAL WATER LOW FLOW	*	DISCRETE IN	*	2	1 sec
WP704SI03DC041	RAW SEWAGE PUMP 4 SPEED FEEDBACK	*	ANALOG IN	*	2	1 sec
WP704DPI03DC041	RAW SEWAGE PUMP 4 DIFFERENTIAL PRESSURE	*	ANALOG IN	*	2	1 sec
WP704TI03OVX41	704-ICP0311 OVATION PANEL TEMPERATURE	*	ANALOG IN	*	2	1 sec
WP704TI03DC041	RAW SEWAGE PUMP 4 PUMP BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC042	RAW SEWAGE PUMP 4 MOTOR DE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC043	RAW SEWAGE PUMP 4 MOTOR NDE BEARING TEMP	*	RTD IN	*	2	1 sec
WP704TI03DC044	RAW SEWAGE PUMP 4 MOTOR WINDING TEMP A	*	RTD IN	*	2	1 sec
WP704TI03DC045	RAW SEWAGE PUMP 4 MOTOR WINDING TEMP B	*	RTD IN	*	2	1 sec
WP704TI03DC046	RAW SEWAGE PUMP 4 MOTOR WINDING TEMP C	*	RTD IN	*	2	1 sec
WP704LSL03AV011	RSP TEMPORARY JACKET WATER HEAD TANK 1 LOW LEVEL ALARM	*	DISCRETE IN	*	2	1 sec
WP704LSL03AV012	RSP TEMPORARY JACKET WATER HEAD TANK 2 LOW LEVEL ALARM	*	DISCRETE IN	*	2	1 sec
WP704FSH01001	RSP MOTOR LEVEL EYE/FACE WASH 1 FLOW SWITCH ALARM	*	DISCRETE IN	*	2	1 sec
WP704FSH01002	RSP MOTOR LEVEL EYE/FACE WASH 2 FLOW SWITCH ALARM	*	DISCRETE IN	*	2	1 sec
WP704AI03BR011	RSP PUMP LEVEL NORTHWEST CORNER LEL ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BR012	RSP PUMP LEVEL NORTHWEST CORNER H2S ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV41	RSP PUMP LEVEL NORTH BATTERY ROOM CO ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV42	RSP PUMP LEVEL SOUTH BATTERY ROOM CO ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV011	RSP MOTOR LEVEL ENGINE MAINT RM 421 LEL ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV012	RSP MOTOR LEVEL ENGINE MAINT RM 421 CO ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV021	RSP MOTOR LEVEL NORTH OF GENERATOR LEL ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV022	RSP MOTOR LEVEL NORTH OF GENERATOR CO ALARM	*	ANALOG IN	*	2	1 sec
WP704AI03BV031	RSP NW CORNER OF CRANE OPENING LEL ALARM	*	ANALOG IN	*	2	1 sec

* ALARM GROUP AND RESET/SET ASSIGNMENT TO BE DETERMINED DURING PROGRAMMING EFFORT

SECTION 40 06 73

OVATION DCS I/O SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
OVATION POINTS TO DELETE									
WP704NDJ03DC011	RSP 1 ON / RUNNING	WP704-DP-60001	WP704-DI-70071	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 01, 05	---	---	
WP704XAD03DC011	RSP 1 TROUBLE /FAULT	WP704-DP-60001	WP704-DI-70071	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 01, 06	---	---	
WP704PSH16OB011	DIG 123 PROPANE PRESSURE HI	WP705-DP-60010	WP704-DI-70079	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 02, 011	---	---	
WP704PSL16OB011	DIG 123 PROPANE PRESSURE LOW	WP705-DP-60010	WP704-DI-70079	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 02, 012	---	---	
WP704XAD20AE021	RSP BACKUP STAR AIR COMPRESSOR CTRL PWR FAIL	WP704-DP-60041	WP704-DI-70035	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 03, 07	---	---	
WP704ZIO03DJ011	RSP 1 LPG FUEL SELECTED	WP704-DP-60001	WP704-DI-70074	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 01	---	---	
WP704ZIO03DJ012	RSP 1 MPG FUEL SELECTED	WP704-DP-60001	WP704-DI-70074	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 02	---	---	
WP704NDA03DJ011	RSP 1 GOVERNOR IN REMOTE	WP704-DP-60001	WP704-DI-70074	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 03	---	---	
WP704XAD20AB011	RSP BACKUP STARTING AIR COMP COMMON ALM	WP704-DP-60041	WP704-DI-70032	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 06	---	---	
WP704NDA03SA011	STEAM SEPARATOR 1 IN REMOTE	---	WP704-DI-70076	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 14	---	---	
WP704NDJ03DC021	RSP 2 ON / RUNNING	WP704-DP-60001	WP704-DI-70062	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 01, 05	---	---	
WP704XAD03DC021	RSP 2 TROUBLE /FAULT	WP704-DP-60001	WP704-DI-70062	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 01, 06	---	---	
WP704ZIO03DJ021	RSP 2 LPG FUEL SELECTED	WP704-DP-60001	WP704-DI-70065	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 01, 08	---	---	
WP704ZIO03DJ022	RSP 2 MPG FUEL SELECTED	WP704-DP-60001	WP704-DI-70065	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 01, 09	---	---	
WP704NDA03DJ021	RSP 2 GOVERNOR IN REMOTE	WP704-DP-60001	WP704-DI-70065	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 01, 10	---	---	
WP704NDA03SA021	STEAM SEPARATOR 2 IN REMOTE	WP704-DP-60004	WP704-DI-70067	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 01, 14	---	---	
WP704NDJ03CP011	RSP WASTE HEAT PUMP 1 ON	WP704-DP-60048	WP704-DI-70024	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 02, 15	---	---	
WP704NDA03CP011	RSP WASTE HEAT PUMP 1 REMOTE	WP704-DP-60048	WP704-DI-70024	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 02, 16	---	---	
WP704XAD03SA011	STEAM SEPARATOR 1 PRESS CNTRL FAIL	---	WP704-DI-70075	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 01	---	---	
WP704TSH03SB011	RSP HEAT REC BLR 1 HI TEMP	WP704-DP-60003	WP704-DI-70077	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 02	---	---	
WP704TSHH03SB012	RSP HEAT REC BLR 1 HIHI TEMP	WP704-DP-60003	WP704-DI-70077	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 03	---	---	
WP704NDB03SB012	STEAM SEP 1 BYPASS MODE STATUS	---	WP704-DI-70077	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 04	---	---	
WP704PSH03SC011	STEAM SEP 1 HI PRESSURE	WP704-DP-60003	WP704-DI-70078	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 05	---	---	
WP704PSHH03SC012	STEAM SEP 1 HIHI PRESSURE	WP704-DP-60003	WP704-DI-70078	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 06	---	---	
WP704LSL03SC011	STEAM SEP 1 LOW LEVEL	WP704-DP-60003	WP704-DI-70078	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 07	---	---	
WP704LSSL03SC012	STEAM SEP 1 LOLO LEVEL	WP704-DP-60003	WP704-DI-70078	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 06, 08	---	---	
WP704XAD03SA021	STEAM SEPARATOR 2 PRESS CNTRL FAIL	---	WP704-DI-70066	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 01	---	---	
WP704TSH03SB021	RSP HEAT REC BLR 2 HI TEMP	WP704-DP-60004	WP704-DI-70068	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 02	---	---	
WP704TSHH03SB022	RSP HEAT REC BLR 2 HIHI TEMP	WP704-DP-60004	WP704-DI-70068	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 03	---	---	
WP704NDB03SB022	STEAM SEP 2 BYPASS MODE STATUS	---	WP704-DI-70068	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 04	---	---	
WP704PSH03SC021	STEAM SEP 2 HI PRESSURE	WP704-DP-60004	WP704-DI-70069	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 05	---	---	
WP704PSHH03SC022	STEAM SEP 2 HIHI PRESSURE	WP704-DP-60004	WP704-DI-70069	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 06	---	---	
WP704LSL03SC021	STEAM SEP 2 LOW LEVEL	WP704-DP-60004	WP704-DI-70069	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 07	---	---	
WP704LSSL03SC022	STEAM SEP 2 LOLO LEVEL	WP704-DP-60004	WP704-DI-70069	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 07, 08	---	---	
WP704MNI03CP011	RSP WASTE HEAT PUMP 1 RUN COMMAND	WP704-DP-60048	WP704-DI-70024	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 06	---	---	
WP704XAD03SB011	STEAM SEP 1 TROUBLE ALARM	---	WP704-DI-70077	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 01	---	---	
WP704XAD03SB021	STEAM SEP 2 TROUBLE ALARM	---	WP704-DI-70068	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 02	---	---	
WP704LC03DA011	RSP PMP 1 WET WELL LVL DMD	WP704-DP-60001	WP704-DI-70070	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 01	---	---	
WP704PC03SA011	STEAM SEPARATOR 1 PRESS CNTRL	---	WP704-DI-70076	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 08	---	---	
WP704LC03DA021	RSP PMP 2 WET WELL LVL DMD	WP704-DP-60001	WP704-DI-70061	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 04, 03	---	---	
WP704PC03SA021	STEAM SEPARATOR 2 PRESS CNTRL	WP704-DP-60004	WP704-DI-70067	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 04, 08	---	---	
WP704SI03DG011	RSP 1 SPEED	WP704-DP-60001	WP704-DI-70072	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 01, 03	---	---	
WP704TI03SB011	RSP1 STEAM SEPARATOR TEMPERATURE	WP704-DP-60003	WP704-DI-70077	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 01, 07	---	---	
WP704SI03DG021	RSP 2 SPEED	WP704-DP-60001	WP704-DI-70063	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 02, 02	---	---	
WP704TI03SB021	RSP2 STEAM SEPARATOR TEMPERATURE	WP704-DP-60004	WP704-DI-70068	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 02, 06	---	---	
WP704PI20AB021	BACKUP STARTING AIR HEADER PRESSURE	WP704-DP-60041	WP704-DI-70033	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 05, 06	---	---	
WP704PI03SA011	STEAM SEPARATOR 1 PRESSURE	WP704-DP-60003	WP704-DI-70075	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 06, 01	---	---	
WP704TI19LA011	RSP ENGINE COOLING WATER TEMPERATURE	WP704-DP-60047	WP704-DI-70029	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 06, 05	---	---	
WP704PX03SA012	STEAM SEPARATOR 1 OUTPUT SIGNAL	---	WP704-DI-51046	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 06, 08	---	---	
WP704PI03SA021	STEAM SEPARATOR 2 PRESSURE	WP704-DP-60004	WP704-DI-70066	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 01	---	---	
WP704PX03SA022	STEAM SEPARATOR 2 OUTPUT SIGNAL	---	WP704-DI-51047	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 02	---	---	
WP704NDJ03DC031	RSP 3 ON / RUNNING	WP704-DP-60002	WP704-DI-70053	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 03	---	---	
WP704XAD03DC031	RSP 3 TROUBLE /FAULT	WP704-DP-60002	WP704-DI-70053	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 04	---	---	
WP704ZIO03DJ031	RSP 3 LPG FUEL SELECTED	WP704-DP-60002	WP704-DI-70056	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 06	---	---	
WP704ZIO03DJ032	RSP 3 MPG FUEL SELECTED	WP704-DP-60002	WP704-DI-70056	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 07	---	---	
WP704NDA03DJ031	RSP 3 GOVERNOR IN REMOTE	WP704-DP-60002	WP704-DI-70056	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 08	---	---	

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OVATION DCS I/O SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP704NDA03SA031	STEAM SEPARATOR 3 IN REMOTE	---	WP704-DI-70058	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 12	---	---	
WP704NDJ03DC041	RSP 4 ON / RUNNING	WP704-DP-60002	WP704-DI-70044	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 03	---	---	
WP704XAD03DC041	RSP 4 TROUBLE /FAULT	WP704-DP-60002	WP704-DI-70044	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 04	---	---	
WP704NDJ19KI011	RSP ENGINE WEST CIRC PUMP ON	WP704-DP-60047	WP704-DI-70027	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 05	---	---	
WP704PSL19KI011	RSP ENGINE WEST CIRC PUMP PRESSURE LOW	WP704-DP-60047	WP704-DI-70027	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 06	---	---	
WP704NDJ19KI021	RSP ENGINE EAST CIRC PUMP ON	WP704-DP-60047	WP704-DI-70028	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 07	---	---	
WP704ZIO03DJ041	RSP 4 LPG FUEL SELECTED	WP704-DP-60002	WP704-DI-70047	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 08	---	---	
WP704ZIO03DJ042	RSP 4 MPG FUEL SELECTED	WP704-DP-60002	WP704-DI-70047	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 09	---	---	
WP704NDA03DJ041	RSP 4 GOVERNOR IN REMOTE	WP704-DP-60002	WP704-DI-70047	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 10	---	---	
WP704NDA03SA041	STEAM SEPARATOR 4 IN REMOTE	---	WP704-DI-70049	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 01, 14	---	---	
WP704XAD03SA031	STEAM SEPARATOR 3 PRESS CNTRL FAIL	---	WP704-DI-70057	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 01	---	---	
WP704TSH03SB031	RSP HEAT REC BLR 3 HI TEMP	---	WP704-DI-70059	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 02	---	---	
WP704TSHH03SB032	RSP HEAT REC BLR 3 HIHI TEMP	---	WP704-DI-70059	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 03	---	---	
WP704NDB03SB032	STEAM SEP 3 BYPASS MODE STATUS	---	WP704-DI-70059	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 04	---	---	
WP704PSH03SC031	STEAM SEP 3 HI PRESSURE	WP704-DP-60005	WP704-DI-70059	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 05	---	---	
WP704PSHH03SC032	STEAM SEP 3 HIHI PRESSURE	WP704-DP-60005	WP704-DI-70059	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 06	---	---	
WP704LSL03SC031	STEAM SEP 3 LOW LEVEL	WP704-DP-60005	WP704-DI-70059	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 07	---	---	
WP704LSLL03SC032	STEAM SEP 3 LOLO LEVEL	---	WP704-DI-70069	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 08	---	---	
WP704XAD03XX011	704-LCP0312 24VDC POWER 1 FAIL	---	WP704-DI-52023	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 09	---	---	
WP704XAD03XX012	704-LCP0312 24VDC POWER 2 FAIL	---	WP704-DI-52023	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 10	---	---	
WP704XAD03XX013	704-LCP0312 UPS FAIL	---	WP704-DI-52023	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 11	---	---	
WP704XAD03SA041	STEAM SEPARATOR 4 PRESS CNTRL FAIL	---	WP704-DI-70048	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 01	---	---	
WP704TSH03SB041	RSP HEAT REC BLR 4 HI TEMP	---	WP704-DI-70050	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 02	---	---	
WP704TSHH03SB042	RSP HEAT REC BLR 4 HIHI TEMP	---	WP704-DI-70050	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 03	---	---	
WP704NDB03SB042	STEAM SEP 4 BYPASS MODE STATUS	---	WP704-DI-70050	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 04	---	---	
WP704PSH03SC041	STEAM SEP 4 HI PRESSURE	WP704-DP-60006	WP704-DI-70051	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 05	---	---	
WP704PSHH03SC042	STEAM SEP 4 HIHI PRESSURE	WP704-DP-60006	WP704-DI-70051	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 06	---	---	
WP704LSL03SC041	STEAM SEP 4 LOW LEVEL	WP704-DP-60006	WP704-DI-70051	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 07	---	---	
WP704LSLL03SC042	STEAM SEP 4 LOLO LEVEL	WP704-DP-60006	WP704-DI-70051	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 08	---	---	
WP704XAD12AB011	HYDROSTAL SCREENINGS PUMP 1 FAIL	---	WP704-DI-52024	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 12	---	---	
WP704NDA12AB011	HYDROSTAL SCREENINGS PUMP 1 REMOTE	---	WP704-DI-52024	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 13	---	---	
WP704NDJ12AB011	HYDROSTAL SCREENINGS PUMP 1 ON	---	WP704-DI-52024	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 04, 14	---	---	
WP704NDJ03CP021	RSP WASTE HEAT PUMP 2 ON	WP704-DP-60048	WP704-DI-70025	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 15	---	---	
WP704NDA03CP021	RSP WASTE HEAT PUMP 2 REMOTE	WP704-DP-60048	WP704-DI-70025	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 16	---	---	
WP704MNJ12AB011	HYDROSTAL SCREENINGS PUMP 1 RUN	---	WP704-DI-52031	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 07	---	---	
WP704XAD03SB031	STEAM SEP 3 TROUBLE ALARM	---	WP704-DI-70059	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 01	---	---	
WP704XAD03SB041	STEAM SEP 4 TROUBLE ALARM	---	WP704-DI-70050	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 02	---	---	
WP704MNJ12AB021	HYDROSTAL SCREENINGS PUMP 2 RUN	---	WP704-DI-52032	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 07	---	---	
WP704MNJ03CP021	RSP WASTE HEAT PUMP 2 RUN COMMAND	WP704-DP-60048	WP704-DI-70025	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 14	---	---	
WP704PC03SA031	STEAM SEPARATOR 3 PRESS CNTRL	WP700-DP-60101	WP704-DI-70058	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 01	---	---	
WP704LC03DA031	RSP PMP 3 WET WELL LVL DMD	WP704-DP-60002	WP704-DI-70052	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 03	---	---	
WP704PC03SA041	STEAM SEPARATOR 4 PRESS CNTRL	WP700-DP-60101	WP704-DI-70049	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 04, 01	---	---	
WP704LC03DA041	RSP PMP 4 WET WELL LVL DMD	WP704-DP-60002	WP704-DI-70043	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 04, 03	---	---	
WP704SI03DG031	RSP 3 SPEED	WP704-DP-60002	WP704-DI-70054	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 02, 04	---	---	
WP704TI03SB031	RSP3 STEAM SEPARATOR	---	WP704-DI-70059	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 02, 06	---	---	
WP704SI03DG041	RSP 4 SPEED	WP704-DP-60002	WP704-DI-70045	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 03, 03	---	---	
WP704TI03SB041	RSP4 STEAM SEPARATOR TEMPERATURE	WP704-DP-60006	WP704-DI-70050	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 03, 07	---	---	
WP704PI03SA031	STEAM SEPARATOR 3 PRESSURE	WP700-DP-60101	WP704-DI-70057	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 01	---	---	
WP704PX03SA032	STEAM SEPARATOR 3 OUTPUT SIGNAL	---	WP704-DI-52045	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 02	---	---	
WP704PI03SA041	STEAM SEPARATOR 4 PRESSURE	WP704-DP-60006	WP704-DI-70048	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 06, 01	---	---	
WP704PX03SA042	STEAM SEPARATOR 4 OUTPUT SIGNAL	---	WP704-DI-52046	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 06, 02	---	---	
WP704TC03CP011	OUTPUT TO RSP WASTE HEAT EXCHANGER VLV 1	WP704-DP-60048	WP704-DI-52047	704-ICP0302	ANALOG OUT	012/072, LOCAL, 04, 07, 02	---	---	
WP704TC03CP012	OUTPUT TO RSP WASTE HEAT EXCHANGER VLV 2	WP704-DP-60048	WP704-DI-52047	704-ICP0302	ANALOG OUT	012/072, LOCAL, 04, 07, 03	---	---	
WP704TI03CP011	RSP WASTE HEAT EXCHANGER OUTLET TEMP	WP704-DP-60048	WP704-DI-52043	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 03, 02	---	---	
WP704HS03CP011	RSP WASTE HEAT PUMP 1 DEVICE NET COMMS	WP704-DP-60048	---	704-ICP0301	DEVICE NET	011/071, DEVICENET, 00, 00	---	---	
WP704HS03CP012	RSP WASTE HEAT PUMP 2 DEVICE NET COMMS	WP704-DP-60048	---	704-ICP0302	DEVICE NET	012/072, DEVICENET, 00, 00	---	---	
WP704FSL03IC091	FAN 704-SF03ER011 FLOW LOW	WP704-DP-60032	WP704-DI-70015	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 04, 09	---	---	

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OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP704TI19HA011	WASTE HEAT RADIATOR 1/2 OUTLET TEMP	WP704-DP-60046	WP704-DI-51046	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 06, 07			
WP704TI19HA012	WASTE HEAT RADIATOR 1/2 CIRC PMP INLET TEMP	WP704-DP-60046	WP704-DI-51046	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 06, 06			
WP704MNC19HA011	WASTE HEAT RADIATOR 1 ACTUATORS CLOSED	WP704-DP-60046		704-ICP0301	DISCRETE OUT				Not found in construction/demo drawing
WP704TC19HA011	WASTE HEAT RADIATOR 1 FAN SPEED OUTPUT	WP704-DP-60046	WP704-DI-51033	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 04			
WP704XAD19HA011	WASTE HEAT RADIATOR 1 FAN FAIL	WP704-DP-60046	WP704-DI-51016	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 11			
WP704NDA19HA011	WASTE HEAT RADIATOR 1 FAN IN REMOTE	WP704-DP-60046	WP704-DI-51016	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 09			
WP704NDJ19HA011	WASTE HEAT RADIATOR 1 FAN ON	WP704-DP-60046	WP704-DI-51016	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 10			
WP704MNJ19HA011	WASTE HEAT RADIATOR 1 FAN CALL TO RUN	WP704-DP-60046	WP704-DI-51032	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 10			
WP704QL19HA011	WASTE HEAT RADIATOR 1 FAN ON	WP704-DP-60046	WP704-DI-51032	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 09			
WP704MNC19HA021	WASTE HEAT RADIATOR 2 ACTUATORS CLOSED	WP704-DP-60046	WP704-DI-52032	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 08			
WP704TC19HA021	WASTE HEAT RADIATOR 2 FAN SPEED OUTPUT	WP704-DP-60046	WP704-DI-52033	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 06			
WP704XAD19HA021	WASTE HEAT RADIATOR 2 FAN FAIL	WP704-DP-60046		704-ICP0302	DISCRETE IN				Not found in construction/demo drawing
WP704NDA19HA021	WASTE HEAT RADIATOR 2 FAN IN REMOTE	WP704-DP-60046		704-ICP0302	DISCRETE IN				Not found in construction/demo drawing
WP704NDJ19HA021	WASTE HEAT RADIATOR 2 FAN ON	WP704-DP-60046		704-ICP0302	DISCRETE IN				Not found in construction/demo drawing
WP704MNJ19HA021	WASTE HEAT RADIATOR 2 FAN CALL TO RUN	WP704-DP-60046	WP704-DI-52032	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 11			
WP704QL19HA021	WASTE HEAT RADIATOR 2 FAN ON	WP704-DP-60046	WP704-DI-52032	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 10			
WP704XAD19JP021	WASTE HEAT RAD CIRC PUMP 2 FAIL	WP704-DP-60046	WP704-DI-70026	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 06, 06			
WP704TC19JP021	WASTE HEAT RAD CIRC PUMP 2 SPEED OUTPUT	WP704-DP-60046	WP704-DI-52033	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 08			
WP704NDA19JP021	WASTE HEAT RAD CIRC PUMP 2 IN REMOTE	WP704-DP-60046	WP704-DI-70026	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 06, 04			
WP704NDJ19JP021	WASTE HEAT RAD CIRC PUMP 2 ON	WP704-DP-60046	WP704-DI-70026	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 06, 05			
WP704MNJ19JP021	WASTE HEAT RAD CIRC PUMP 2 CALL TO RUN	WP704-DP-60046	WP704-DI-52032	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 12			
WP704XAD19JP011	WASTE HEAT RAD CIRC PMP 1 FAIL	WP704-DP-60046	WP704-DI-51016	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 14			
WP704TC19JP011	WASTE HEAT RAD CIRC PMP 1 SPEED OUTPUT	WP704-DP-60046	WP704-DI-51033	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 07			
WP704NDA19JP011	WASTE HEAT RAD CIRC PMP 1 IN REMOTE	WP704-DP-60046	WP704-DI-51016	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 12			
WP704NDJ19JP011	WASTE HEAT RAD CIRC PMP 1 ON	WP704-DP-60046	WP704-DI-51016	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 13			
WP704MNJ19JP011	WASTE HEAT RAD CIRC PMP 1 CALL TO RUN	WP704-DP-60046	WP704-DI-51032	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 11			
WP704TC19JM011	RSP HEAT REC TEMP CNTRL VLV FEED BACK	WP704-DP-60047	WP704-DI-51047	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 05			
WP704TC19JM012	RSP HEAT REC TEMP CNTRL VLV OUTPUT	WP704-DP-60047	WP704-DI-51033	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 06			
EXISTING OVATION POINTS THAT WILL BE RE-USED									
WP704LSHH03SP031	RSP ROOM SUMP PUMP 1/2 LEVEL HIGH	WP704-P-60022	WP704-I-70020	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 02, 05	----	NO CHANGE	
WP704NDJ03SP031	RSP ROOM SUMP PUMP 1 ON	WP704-P-60022	WP704-I-70020	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 02, 03	---	NO CHANGE	
WP704NDJ03SP032	RSP ROOM SUMP PUMP 2 ON	WP704-P-60022	WP704-I-70020	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 02, 04	----	NO CHANGE	
WP705NDJ19FB011	BOILER 1 HOT WATER ON	WP705-P-61001	WP705-I-70052	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 01	----	NO CHANGE	
WP705XAD19FB011	BOILER 1 HOT WATER FAIL	WP705-P-61001	WP705-I-70052	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 02	----	NO CHANGE	
WP705NDA19FB011	BOILER 1 HOT WATER IN REMOTE	WP705-P-61001	WP705-I-70052	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 03	----	NO CHANGE	
WP705NDJ19FB012	BOILER 1 HOT WATER CIRC PUMP DEMAND	WP705-P-61001	WP705-I-70055	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 04	----	NO CHANGE	
WP705NDA19FB012	BOILER 1 AUTO FUEL SELECT	WP705-P-61001	WP705-I-70055	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 05	----	NO CHANGE	
WP705NDA19FB013	BOILER 1 DIG GAS FUEL SELECT	WP705-P-61001	WP705-I-70055	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 06	----	NO CHANGE	
WP705NDJ19FC011	BOILER 1 HOT WATER CIRC PMP ON	WP705-P-61001	WP705-I-70053	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 07	----	NO CHANGE	
WP705NDA19FC011	BOILER 1 HOT WATER CIRC PMP IN REMOTE	WP705-P-61001	WP705-I-70053	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 08	----	NO CHANGE	
WP704FSL24AA011	RS SAMPLER LOW FLOW	WP704-P-60021	WP704-I-70036	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 07	----	NO CHANGE	
WP704XAD24AA011	RS SAMPLER TROUBLE ALM	WP704-P-60021	WP704-I-70036	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 07, 08	----	NO CHANGE	
WP704HS03ED011	RS PMP1 LOLO LVL SHUTDOWN DISABLED/ RSP LOW LEV	WP704-P-60011	WP704-I-70003	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 02, 01	----	NO CHANGE	
WP704HS03ED012	RS PMP2 LOLO LVL SHUTDOWN DISABLED	WP704-P-60012	WP704-I-70003	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 02, 02	----	NO CHANGE	
WP705NDJ19FC021	BOILER 2 HOT WATER CIRC PMP ON	WP705-P-62001	WP705-I-70058	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 02, 03	----	NO CHANGE	
WP705NDA19FC021	BOILER 2 HOT WATER CIRC PUMP REMOTE	WP705-P-62001	WP705-I-70058	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 02, 04	----	NO CHANGE	
WP705NDA19FB031	BOILER 3 HOT WATER IN REMOTE	WP705-P-63001	WP705-I-70062	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 01	----	NO CHANGE	
WP705NDJ19FB031	BOILER 3 HOT WATER ON	WP705-P-63001	WP705-I-70062	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 02	----	NO CHANGE	
WP705XAD19FB031	BOILER 3 HOT WATER FAIL	WP705-P-63001	WP705-I-70062	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 03	----	NO CHANGE	
WP705NDJ19FB032	BOILER 3 HOT WATER CIRC PUMP DEMAND	WP705-P-63001	WP705-I-70066	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 04	----	NO CHANGE	
WP705NDA19FB032	BOILER 3 AUTO FUEL SELECT	WP705-P-63001	WP705-I-70066	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 05	----	NO CHANGE	
WP705NDA19FB033	BOILER 3 DIG GAS FUEL SELECT	WP705-P-63001	WP705-I-70066	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 06	----	NO CHANGE	
WP705NDA19FC031	BOILER 3 HOT WATER CIRC PMP IN REMOTE	WP705-P-63001	WP705-I-70063	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 07	----	NO CHANGE	
WP705NDJ19FC031	BOILER 3 HOT WATER CIRC PMP ON	WP705-P-63001	WP705-I-70063	704-ICP0301	DISCRETE IN	011/071, LOCAL, 02, 08, 08	----	NO CHANGE	
WP704MNJ24AA011	RAW SEWAGE SAMPLER RUN COMMAND	WP704-P-60021	WP704-I-70036	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 05	----	NO CHANGE	
WP705MNJ19FC021	BOILER 2 HOT WATER CIRC PMP CALL TO RUN	WP705-P-62001	WP705-I-70058	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 07	----	NO CHANGE	

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OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP705MNJ19FB031	BOILER 3 HOT WATER CALL TO RUN	WP705-P-63001	WP705-I-70062	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 08	---	NO CHANGE	
WP705MNO19FB031	BOILER 3 HOT WATER MSG FEED OPEN	WP705-P-63001	WP705-I-70062	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 09	---	NO CHANGE	
WP705MNO19FB032	BOILER 3 HOT WATER PROP FEED OPEN	WP705-P-63001	WP705-I-70062	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 10	---	NO CHANGE	
WP705MNJ19FC031	BOILER 3 HOT WATER CIRC PMP CALL TO RUN	WP705-P-63001	WP705-I-70063	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 01, 11	---	NO CHANGE	
WP705MNJ19FB011	BOILER 1 HOT WATER CALL TO RUN	WP705-P-61001	WP705-I-70052	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 04	---	NO CHANGE	
WP705MNO19FB011	BOILER 1 HOT WATER MSG FEED OPEN	WP705-P-61001	WP705-I-70052	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 05	---	NO CHANGE	
WP705MNO19FB012	BOILER 1 HOT WATER PROP FEED OPEN	WP705-P-61001	WP705-I-70052	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 06	---	NO CHANGE	
WP705MNJ19FC011	BOILER 1 HOT WATER CIRC PMP CALL TO RUN	WP705-P-61001	WP705-I-70053	704-ICP0301	DISCRETE OUT	011/071, LOCAL, 03, 02, 07	---	NO CHANGE	
WP705TC19FA011	BOILER 1 FIRING RATE OUTPUT	WP705-P-61001	WP705-I-70051	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 03	NO CHANGE	---	
WP705TC19JJ012	BOILER 1 HOT WATER TEMP CTRL VLV OUTPUT	WP705-P-61001	WP705-I-70054	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 03, 05	NO CHANGE	---	
WP705TC19FA031	BOILER 3 FIRING RATE OUTPUT	WP705-P-63001	WP705-I-70061	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 04, 06	NO CHANGE	---	
WP705TC19JJ032	BOILER 3 HOT WATER TEMP CTRL VLV OUTPUT	WP705-P-63001	WP705-I-70065	704-ICP0301	ANALOG OUT	011/071, LOCAL, 03, 04, 07	NO CHANGE	---	
WP704PI16OB011	PROPANE HEADER PRESSURE	WP705-P-60010	WP704-I-70079	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 02, 04	NO CHANGE	---	
WP704AI24AB011	RAW SEWAGE PUMP PH	WP704-P-60021	WP704-I-70037	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 03, 01	NO CHANGE	---	
WP704TI24AC011	RAW SEWAGE PUMP TEMPERATURE	WP704-P-60021	WP704-I-70037	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 03, 02	NO CHANGE	---	
WP704CI24AD011	RAW SEWAGE PUMP CONDUCTIVITY	WP704-P-60021	WP704-I-70037	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 03, 03	NO CHANGE	---	
WP705TI19FB031	BOILER 3 HOT WATER TEMP INPUT	WP705-P-63001	WP705-DI-70061	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 04, 06	NO CHANGE	---	
WP705TC19JJ031	BOILER 3 HOT WATER TEMP CTRL VLV FEEDBACK	WP705-P-63001	WP705-I-70065	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 04, 07	NO CHANGE	---	
WP705TC19JJ011	BOILER 1 HOT WATER TEMP CTRL VLV FEEDBACK	WP705-P-61001	WP705-I-70054	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 06, 02	NO CHANGE	---	
WP705TI19FA011	BOILER 1 TEMPERATURE	WP705-P-60101	WP705-I-70051	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 03	NO CHANGE	---	
WP705TI19FB011	BOILER 1 HOT WATER TEMP INPUT	WP705-P-61001	WP705-I-70051	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 06	NO CHANGE	---	
WP705NDJ19FB021	BOILER 2 HOT WATER ON	WP705-P-62001	WP705-I-70057	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 03	---	NO CHANGE	
WP705NDA19FB021	BOILER 2 HOT WATER IN REMOTE	WP705-P-62001	WP705-I-70057	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 04	---	NO CHANGE	
WP705XAD19FB021	BOILER 2 HOT WATER FAIL	WP705-P-62001	WP705-I-70057	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 05	---	NO CHANGE	
WP705NDJ19FB022	BOILER 2 HOT WATER CIRC PUMP DEMAND	WP705-P-62001	WP705-I-70060	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 06	---	NO CHANGE	
WP705NDA19FB022	BOILER 2 AUTO FUEL SELECT	WP705-P-62001	WP705-I-70060	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 07	---	NO CHANGE	
WP705NDA19FB023	BOILER 2 DIG GAS FUEL SELECT	WP705-P-62001	WP705-I-70060	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 08	---	NO CHANGE	
WP704HS03ED013	RAW SEWAGE PUMP 3 / LO-LO LEVEL SW / ENABLE-DISA	WP704-P-60013	WP704-I-70003	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 09	---	NO CHANGE	
WP704HS03ED014	RAW SEWAGE PUMP 4 / LO-LO LEVEL SW / ENABLE-DISA	WP704-P-60014	WP704-I-70003	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 10	---	NO CHANGE	
WP705NDA19FC041	BOILER 3 STANDBY HEATING PMP IN REMOTE	WP705-P-63001	WP705-I-70064	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 11	---	NO CHANGE	
WP705NDJ19FC041	BOILER 3 STANDBY HEATING PMP ON	WP705-P-63001	WP705-I-70064	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 05, 12	---	NO CHANGE	
WP704MNJ19FC041	BOILER 3 STANDBY HEATING PMP CALL TO RUN	WP705-P-63001	WP705-I-70064	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 08	---	NO CHANGE	
WP705MNJ19FB021	BOILER 2 HOT WATER CALL TO RUN	WP705-P-62001	WP705-I-70057	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 04	---	NO CHANGE	
WP705MNO19FB021	BOILER 2 HOT WATER MSG FEED OPEN	WP705-P-62001	WP705-I-70057	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 05	---	NO CHANGE	
WP705MNO19FB022	BOILER 2 HOT WATER PROP FEED OPEN	WP705-P-62001	WP705-I-70057	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 06	---	NO CHANGE	
WP705TC19FA021	BOILER 2 FIRING RATE OUTPUT	WP705-P-62001	WP705-I-70056	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 05	NO CHANGE	---	
WP705TC19JJ022	BOILER 2 HOT WATER TEMP CTRL VLV OUTPUT	WP705-P-62001	WP705-I-70059	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 07	NO CHANGE	---	
WP705TC19JJ021	BOILER 2 HOT WATER TEMP CTRL VLV FEEDBACK	WP705-P-62001	WP705-I-70059	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 04	NO CHANGE	---	
WP705TI19FB021	BOILER 2 HOT WATER TEMP INPUT	WP705-P-62001	WP705-I-70056	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 05	NO CHANGE	---	
NEW OVATION POINTS									
WP704ZIC26BD011	704-SWGR02 MAIN MV BREAKER CLOSED	WP704-P-60081	WP704-I-70650	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 03, 15	---	OPENED : CLOSED	
WP704XAD26BD011	704-SWGR02 MAIN MV BREAKER FAULT	WP704-P-60081	WP704-I-70650	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 03, 16	---	NORMAL : FAULT	
WP704ZIC03DC051	704-SWGR02 A-SIDE SPARE BREAKER CLOSED	WP704-P-60081	WP704-I-70657	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 05	---	OPENED : CLOSED	
WP704XAD03DC052	704-SWGR02 A-SIDE SPARE BREAKER FAULT	WP704-P-60081	WP704-I-70657	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 06	---	NORMAL : FAULT	
WP704XAD03DC012	704-SWGR02 RS PUMP 1 MV BREAKER FAULT	WP704-P-60081	WP704-I-70655	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 07	---	NORMAL : FAULT	
WP704ZIC03DC011	704-SWGR02 RS PUMP 1 MV BREAKER CLOSED	WP704-P-60081	WP704-I-70655	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 08	---	OPENED : CLOSED	
WP704XAD03DC012	704-SWGR02 RS PUMP 1 UPS FAULT	WP704-P-60081	WP704-I-70655	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 09	---	NORMAL : FAULT	
WP704XBB03DC012	704-SWGR02 RS PUMP 1 UPS ON-BATTERY	WP704-P-60081	WP704-I-70655	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 09	---	UTILITY : BATTERY	
WP704XBY03DC012	704-SWGR02 RS PUMP 1 UPS ON-STATIC BYPASS	WP704-P-60081	WP704-I-70655	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 10	---	INVERTER : BYPASS	
WP704XYN03DC012	704-SWGR02 RS PUMP 1 UPS SYSTEM NORMAL	WP704-P-60081	WP704-I-70655	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 11	---	FAULTED : NORMAL	
WP704XAD03DC022	704-SWGR02 RS PUMP 2 MV BREAKER FAULT	WP704-P-60081	WP704-I-70656	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 10	---	NORMAL : FAULT	
WP704ZIC03DC021	704-SWGR02 RS PUMP 2 MV BREAKER CLOSED	WP704-P-60081	WP704-I-70656	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 11	---	OPENED : CLOSED	
WP704XAD03DC022	704-SWGR02 RS PUMP 2 UPS FAULT	WP704-P-60081	WP704-I-70656	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 12	---	NORMAL : FAULT	
WP704XBB03DC022	704-SWGR02 RS PUMP 2 UPS ON-BATTERY	WP704-P-60081	WP704-I-70656	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 12	---	UTILITY : BATTERY	
WP704XBY03DC022	704-SWGR02 RS PUMP 2 UPS ON-STATIC BYPASS	WP704-P-60081	WP704-I-70656	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 13	---	INVERTER : BYPASS	
WP704XYN03DC022	704-SWGR02 RS PUMP 2 UPS SYSTEM NORMAL	WP704-P-60081	WP704-I-70656	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 06, 14	---	FAULTED : NORMAL	

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OVATION DCS I/O SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP704ZIC26BD031	704-SWGR02 MV TIE BREAKER CLOSED	WP704-P-60081	WP704-I-70652	704-ICP0301	DISCRETE IN	011/071, LOCAL, 01, 05, 13	---	OPENED : CLOSED	
WP704AI03BR011	RSP - CRANE HALL PUMP LEVEL NW LEL	WP704-P-60035	WP704-I-70614	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 01, 03	0 - 100 PCT	---	
WP704AI03BR012	RSP - CRANE HALL PUMP LEVEL NW H2S	WP704-P-60035	WP704-I-70614	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 01, 07	0 - 20 PPM	---	
WP704AI03BV011	RSP - CRANE HALL MOTOR LEVEL ENG MAINT LEL	WP704-P-60035	WP704-I-70617	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 02, 02	0 - 100 PCT	---	
WP704AI03BV012	RSP - CRANE HALL MOTOR LEVEL ENG MAINT CO	WP704-P-60035	WP704-I-70617	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 02, 06	0 - 100 PPM	---	
WP704AI03BV021	RSP - CRANE HALL MOTOR LEVEL GENERATOR LEL	WP704-P-60035	WP704-I-70618	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 01	0 - 100 PCT	---	
WP704AI03BV022	RSP - CRANE HALL MOTOR LEVEL GENERATOR CO	WP704-P-60035	WP704-I-70618	704-ICP0301	ANALOG IN	011/071, LOCAL, 04, 07, 02	0 - 100 PPM	---	
WP704VI03DC011	RAW SEWAGE PUMP 1 PUMP LOWER BEARING VIB X	WP704-P-60011	WP704-I-70107	704-FP0331	MHM	011/071, 01, 01, 01, 01	0 - 0.5 g	---	
WP704VI03DC012	RAW SEWAGE PUMP 1 PUMP LOWER BEARING VIB Y	WP704-P-60011	WP704-I-70107	704-FP0331	MHM	011/071, 01, 01, 01, 02	0 - 0.5 g	---	
WP704VI03DC013	RAW SEWAGE PUMP 1 PUMP UPPER BEARING VIB X	WP704-P-60011	WP704-I-70108	704-FP0331	MHM	011/071, 01, 01, 01, 03	0 - 0.5 g	---	
WP704VI03DC014	RAW SEWAGE PUMP 1 PUMP UPPER BEARING VIB Y	WP704-P-60011	WP704-I-70108	704-FP0331	MHM	011/071, 01, 01, 01, 04	0 - 0.5 g	---	
WP704VI03DC015	RAW SEWAGE PUMP 1 PUMP UPPER BEARING VIB Z	WP704-P-60011	WP704-I-70108	704-FP0331	MHM	011/071, 01, 01, 01, 05	0 - 0.5 g	---	
WP704SI03DC012	RAW SEWAGE PUMP 1 SHAFT SPEED	WP704-P-60011	WP704-I-70107	704-FP0331	MHM	011/071, 01, 01, 01, 08	0 - 300 RPM	---	
WP704VI03DC016	RAW SEWAGE PUMP 1 MOTOR DE BEARING VIB X	WP704-P-60011	WP704-I-70109	704-FP0331	MHM	011/071, 01, 01, 02, 01	0 - 0.5 g	---	
WP704VI03DC017	RAW SEWAGE PUMP 1 MOTOR DE BEARING VIB Y	WP704-P-60011	WP704-I-70109	704-FP0331	MHM	011/071, 01, 01, 02, 02	0 - 0.5 g	---	
WP704VI03DC018	RAW SEWAGE PUMP 1 MOTOR NDE BEARING VIB X	WP704-P-60011	WP704-I-70110	704-FP0331	MHM	011/071, 01, 01, 02, 03	0 - 0.5 g	---	
WP704VI03DC019	RAW SEWAGE PUMP 1 MOTOR NDE BEARING VIB Y	WP704-P-60011	WP704-I-70110	704-FP0331	MHM	011/071, 01, 01, 02, 04	0 - 0.5 g	---	
WP704VI03DC015A	RAW SEWAGE PUMP 1 MOTOR NDE BEARING VIB Z	WP704-P-60011	WP704-I-70110	704-FP0331	MHM	011/071, 01, 01, 02, 05	0 - 0.5 g	---	
WP704FAL03DC011	RAW SEWAGE PUMP 1 SEAL WATER LOW FLOW	WP704-P-60011	WP704-I-70106	704-FP0331	DISCRETE IN	011/071, 01, 01, 03, 01	---	LOW FLOW : NORMAL	
WP704PAL03DC011	RAW SEWAGE PUMP 1 SEAL WATER LOW PRESSURE	WP704-P-60011	WP704-I-70106	704-FP0331	DISCRETE IN	011/071, 01, 01, 03, 02	---	LOW PRESS : NORMAL	
WP704NDA03DC011	RAW SEWAGE PUMP 1 REMOTE STATUS	WP704-P-60011	WP704-I-70101	704-FP0331	DISCRETE IN	011/071, 01, 01, 04, 01	---	LOCAL : REMOTE	
WP704NDJ03DC011	RAW SEWAGE PUMP 1 RUNNING	WP704-P-60011	WP704-I-70101	704-FP0331	DISCRETE IN	011/071, 01, 01, 04, 02	---	STOPPED : RUNNING	
WP704NDR03DC011	RAW SEWAGE PUMP 1 READY	WP704-P-60011	WP704-I-70101	704-FP0331	DISCRETE IN	011/071, 01, 01, 04, 03	---	NOT RDY : READY	
WP704XAD03DC011	RAW SEWAGE PUMP 1 FAULTED	WP704-P-60011	WP704-I-70101	704-FP0331	DISCRETE IN	011/071, 01, 01, 04, 04	---	FAULTED : NORMAL	
WP704MNP03DC011	RAW SEWAGE PUMP 1 STOP COMMAND	WP704-P-60011	WP704-I-70102	704-FP0331	DISCRETE OUT	011/071, 01, 01, 05, 01	---	NULL : STOP	
WP704MNJ03DC011	RAW SEWAGE PUMP 1 START COMMAND	WP704-P-60011	WP704-I-70101	704-FP0331	DISCRETE OUT	011/071, 01, 01, 05, 02	---	NULL : START	
WP704YYP03DC011	RAW SEWAGE PUMP 1 PROTECTION INTERLOCK	WP704-P-60011	WP704-I-70102	704-FP0331	DISCRETE OUT	011/071, 01, 01, 05, 03	---	INTLK : NORMAL	
WP704MNJ03OV311	704-ICP0331 OVATION PANEL FAN RUN COMMAND	WP704-I-50115	WP704-I-50115	704-FP0331	DISCRETE OUT	011/071, 01, 01, 05, 16	---	STOP : RUN	
WP704SI03DC011	RAW SEWAGE PUMP 1 SPEED FEEDBACK	WP704-P-60011	WP704-I-70103	704-FP0331	ANALOG IN	011/071, 01, 02, 01, 01	0 - 300 RPM	---	
WP704DPI03DC011	RAW SEWAGE PUMP 1 DIFFERENTIAL PRESSURE	WP704-P-60011	WP704-I-70105	704-FP0331	ANALOG IN	011/071, 01, 02, 01, 02	0 - 50 FT	---	
WP704TI03OVX11	704-ICP0331 OVATION PANEL TEMPERATURE	WP704-I-50121	WP704-I-50121	704-FP0331	ANALOG IN	011/071, 01, 02, 01, 08	32 - 200 Deg F	---	
WP704SC03DC011	RAW SEWAGE PUMP 1 SPEED REFERENCE	WP704-P-60011	WP704-I-70103	704-FP0331	ANALOG OUT	011/071, 01, 02, 02, 01	0 - 300 RPM	---	
WP704TI03DC011	RAW SEWAGE PUMP 1 PUMP LOWER BEARING TEMP	WP704-P-60011	WP704-I-70107	704-FP0331	RTD IN	011/071, 01, 02, 03, 01	32 - 200 Deg F	---	
WP704TI03DC012	RAW SEWAGE PUMP 1 PUMP UPPER BEARING TEMP	WP704-P-60011	WP704-I-70108	704-FP0331	RTD IN	011/071, 01, 02, 03, 02	32 - 200 Deg F	---	
WP704TI03DC013	RAW SEWAGE PUMP 1 MOTOR DE BEARING TEMP	WP704-P-60011	WP704-I-70109	704-FP0331	RTD IN	011/071, 01, 02, 03, 03	32 - 200 Deg F	---	
WP704TI03DC014	RAW SEWAGE PUMP 1 MOTOR NDE BEARING TEMP	WP704-P-60011	WP704-I-70110	704-FP0331	RTD IN	011/071, 01, 02, 03, 04	32 - 200 Deg F	---	
WP704TI03DC015	RAW SEWAGE PUMP 1 MOTOR WINDING TEMP A	WP704-P-60011	WP704-I-70109	704-FP0331	RTD IN	011/071, 01, 02, 03, 05	32 - 200 Deg F	---	
WP704TI03DC016	RAW SEWAGE PUMP 1 MOTOR WINDING TEMP B	WP704-P-60011	WP704-I-70109	704-FP0331	RTD IN	011/071, 01, 02, 03, 06	32 - 200 Deg F	---	
WP704TI03DC017	RAW SEWAGE PUMP 1 MOTOR WINDING TEMP C	WP704-P-60011	WP704-I-70109	704-FP0331	RTD IN	011/071, 01, 02, 03, 07	32 - 200 Deg F	---	
WP704NXX03DC013	OVATION MACHINERY HEALTH MODULE 1,1,1 DATA	WP704-P-60011	---	704-FP0331	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NXX03DC015	OVATION MACHINERY HEALTH MODULE 1,1,2 DATA	WP704-P-60011	---	704-FP0331	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704VI03DC021	RAW SEWAGE PUMP 2 PUMP LOWER BEARING VIB X	WP704-P-60012	WP704-I-70207	704-FP0332	MHM	011/071, 02, 01, 01, 01	0 - 0.5 g	---	
WP704VI03DC022	RAW SEWAGE PUMP 2 PUMP LOWER BEARING VIB Y	WP704-P-60012	WP704-I-70207	704-FP0332	MHM	011/071, 02, 01, 01, 02	0 - 0.5 g	---	
WP704VI03DC023	RAW SEWAGE PUMP 2 PUMP UPPER BEARING VIB X	WP704-P-60012	WP704-I-70208	704-FP0332	MHM	011/071, 02, 01, 01, 03	0 - 0.5 g	---	
WP704VI03DC024	RAW SEWAGE PUMP 2 PUMP UPPER BEARING VIB Y	WP704-P-60012	WP704-I-70208	704-FP0332	MHM	011/071, 02, 01, 01, 04	0 - 0.5 g	---	
WP704VI03DC025	RAW SEWAGE PUMP 2 PUMP UPPER BEARING VIB Z	WP704-P-60012	WP704-I-70208	704-FP0332	MHM	011/071, 02, 01, 01, 05	0 - 0.5 g	---	
WP704SI03DC022	RAW SEWAGE PUMP 2 SHAFT SPEED	WP704-P-60012	WP704-I-70207	704-FP0332	MHM	011/071, 02, 01, 01, 08	0 - 300 RPM	---	
WP704VI03DC026	RAW SEWAGE PUMP 2 MOTOR DE BEARING VIB X	WP704-P-60012	WP704-I-70209	704-FP0332	MHM	011/071, 02, 01, 02, 01	0 - 0.5 g	---	
WP704VI03DC027	RAW SEWAGE PUMP 2 MOTOR DE BEARING VIB Y	WP704-P-60012	WP704-I-70209	704-FP0332	MHM	011/071, 02, 01, 02, 02	0 - 0.5 g	---	
WP704VI03DC028	RAW SEWAGE PUMP 2 MOTOR NDE BEARING VIB X	WP704-P-60012	WP704-I-70210	704-FP0332	MHM	011/071, 02, 01, 02, 03	0 - 0.5 g	---	
WP704VI03DC029	RAW SEWAGE PUMP 2 MOTOR NDE BEARING VIB Y	WP704-P-60012	WP704-I-70210	704-FP0332	MHM	011/071, 02, 01, 02, 04	0 - 0.5 g	---	
WP704VI03DC025A	RAW SEWAGE PUMP 2 MOTOR NDE BEARING VIB Z	WP704-P-60012	WP704-I-70210	704-FP0332	MHM	011/071, 02, 01, 02, 05	0 - 0.5 g	---	
WP704PAL03DC021	RAW SEWAGE PUMP 2 SEAL WATER LOW PRESSURE	WP704-P-60012	WP704-I-70206	704-FP0332	DISCRETE IN	011/071, 02, 01, 03, 01	---	LOW FLOW : NORMAL	
WP704FAL03DC021	RAW SEWAGE PUMP 2 SEAL WATER LOW FLOW	WP704-P-60012	WP704-I-70206	704-FP0332	DISCRETE IN	011/071, 02, 01, 03, 02	---	LOW PRESS : NORMAL	
WP704NDA03DC021	RAW SEWAGE PUMP 2 REMOTE STATUS	WP704-P-60012	WP704-I-70201	704-FP0332	DISCRETE IN	011/071, 02, 01, 04, 01	---	LOCAL : REMOTE	
WP704NDJ03DC021	RAW SEWAGE PUMP 2 RUNNING	WP704-P-60012	WP704-I-70201	704-FP0332	DISCRETE IN	011/071, 02, 01, 04, 02	---	STOPPED : RUNNING	
WP704NDR03DC021	RAW SEWAGE PUMP 2 READY	WP704-P-60012	WP704-I-70201	704-FP0332	DISCRETE IN	011/071, 02, 01, 04, 03	---	NOT RDY : READY	

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OVATION DCS I/O SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP704XAD03DC021	RAW SEWAGE PUMP 2 FAULTED	WP704-P-60012	WP704-I-70201	704-FP0332	DISCRETE IN	011/071, 02, 01, 04, 04	---	FAULTED : NORMAL	
WP704MNP03DC021	RAW SEWAGE PUMP 2 STOP COMMAND	WP704-P-60012	WP704-I-70202	704-FP0332	DISCRETE OUT	011/071, 02, 01, 05, 01	---	NULL : STOP	
WP704MNJ03DC021	RAW SEWAGE PUMP 2 START COMMAND	WP704-P-60012	WP704-I-70201	704-FP0332	DISCRETE OUT	011/071, 02, 01, 05, 02	---	NULL : START	
WP704YYP03DC021	RAW SEWAGE PUMP 2 PROTECTION INTERLOCK	WP704-P-60012	WP704-I-70202	704-FP0332	DISCRETE OUT	011/071, 02, 01, 05, 03	---	INTLK : NORMAL	
WP704MNJ03OV321	704-ICP0332 OVATION PANEL FAN RUN COMMAND	WP704-I-50203	WP704-I-50215	704-FP0332	DISCRETE OUT	011/071, 02, 01, 05, 16	---	STOP : RUN	
WP704SI03DC021	RAW SEWAGE PUMP 2 SPEED FEEDBACK	WP704-P-60012	WP704-I-70203	704-FP0332	ANALOG IN	011/071, 02, 02, 01, 01	0 - 300 RPM	---	
WP704DPI03DC021	RAW SEWAGE PUMP 2 DIFFERENTIAL PRESSURE	WP704-P-60012	WP704-I-70205	704-FP0332	ANALOG IN	011/071, 02, 02, 01, 02	0 - 50 FT	---	
WP704TI03OVX21	704-ICP0332 OVATION PANEL TEMPERATURE	WP704-I-50203	WP704-I-50221	704-FP0332	ANALOG IN	011/071, 02, 02, 01, 08	32 - 200 Deg F	---	
WP704SC02DC021	RAW SEWAGE PUMP 2 SPEED REFERENCE	WP704-P-60012	WP704-I-70203	704-FP0332	ANALOG OUT	011/071, 02, 02, 02, 01	0 - 300 RPM	---	
WP704TI03DC021	RAW SEWAGE PUMP 2 PUMP LOWER BEARING TEMP	WP704-P-60012	WP704-I-70207	704-FP0332	RTD IN	011/071, 02, 02, 03, 01	32 - 200 Deg F	---	
WP704TI03DC022	RAW SEWAGE PUMP 2 PUMP UPPER BEARING TEMP	WP704-P-60012	WP704-I-70208	704-FP0332	RTD IN	011/071, 02, 02, 03, 02	32 - 200 Deg F	---	
WP704TI03DC023	RAW SEWAGE PUMP 2 MOTOR DE BEARING TEMP	WP704-P-60012	WP704-I-70209	704-FP0332	RTD IN	011/071, 02, 02, 03, 03	32 - 200 Deg F	---	
WP704TI03DC024	RAW SEWAGE PUMP 2 MOTOR NDE BEARING TEMP	WP704-P-60012	WP704-I-70210	704-FP0332	RTD IN	011/071, 02, 02, 03, 04	32 - 200 Deg F	---	
WP704TI03DC025	RAW SEWAGE PUMP 2 MOTOR WINDING TEMP A	WP704-P-60012	WP704-I-70209	704-FP0332	RTD IN	011/071, 02, 02, 03, 05	32 - 200 Deg F	---	
WP704TI03DC026	RAW SEWAGE PUMP 2 MOTOR WINDING TEMP B	WP704-P-60012	WP704-I-70209	704-FP0332	RTD IN	011/071, 02, 02, 03, 06	32 - 200 Deg F	---	
WP704TI03DC027	RAW SEWAGE PUMP 2 MOTOR WINDING TEMP C	WP704-P-60012	WP704-I-70209	704-FP0332	RTD IN	011/071, 02, 02, 03, 07	32 - 200 Deg F	---	
WP704NXX03DC023	OVATION MACHINERY HEALTH MODULE 2,1,1 DATA	WP704-P-60012	---	704-FP0332	ETHERNET	011/071, 02, ENET, 00, 00	---	---	
WP704NXX03DC025	OVATION MACHINERY HEALTH MODULE 2,1,2 DATA	WP704-P-60012	---	704-FP0332	ETHERNET	011/071, 02, ENET, 00, 00	---	---	
WP704ZIC26BD021	704-SWGR02 B-SIDE MAIN MV BREAKER CLOSED	WP704-P-60082	WP704-I-70651	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 06, 15	---	OPENED : CLOSED	
WP704XAD26BD021	704-SWGR02 B-SIDE MAIN MV BREAKER FAULT	WP704-P-60082	WP704-I-70651	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 06, 16	---	NORMAL : FAULT	
WP704ZIC03DC061	704-SWGR02 B-SIDE SPARE BREAKER CLOSED	WP704-P-60082	WP704-I-70660	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 10	---	OPENED : CLOSED	
WP704XAD03DC062	704-SWGR02 B-SIDE SPARE BREAKER FAULT	WP704-P-60082	WP704-I-70660	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 11	---	NORMAL : FAULT	
WP704XAD03DC032	704-SWGR02 RS PUMP 3 MV BREAKER FAULT	WP704-P-60082	WP704-I-70658	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 12	---	NORMAL : FAULT	
WP704ZIC03DC031	704-SWGR02 RS PUMP 3 MV BREAKER CLOSED	WP704-P-60082	WP704-I-70658	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 13	---	OPENED : CLOSED	
WP704XAD03DC032	704-SWGR02 RS PUMP 3 UPS FAULT	WP704-P-60082	WP704-I-70658	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 14	---	NORMAL : FAULT	
WP704XBB03DC032	704-SWGR02 RS PUMP 3 UPS ON-BATTERY	WP704-P-60082	WP704-I-70658	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 06	---	UTILITY : BATTERY	
WP704XBY03DC032	704-SWGR02 RS PUMP 3 UPS ON-STATIC BYPASS	WP704-P-60082	WP704-I-70658	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 07	---	INVERTER : BYPASS	
WP704XYN03DC032	704-SWGR02 RS PUMP 3 UPS SYSTEM NORMAL	WP704-P-60082	WP704-I-70658	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 08	---	FAULTED : NORMAL	
WP704XAD03DC042	704-SWGR02 RS PUMP 4 MV BREAKER FAULT	WP704-P-60082	WP704-I-70659	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 15	---	NORMAL : FAULT	
WP704ZIC03DC041	704-SWGR02 RS PUMP 4 MV BREAKER CLOSED	WP704-P-60082	WP704-I-70659	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 07, 16	---	OPENED : CLOSED	
WP704XAD03DC042	704-SWGR02 RS PUMP 4 UPS FAULT	WP704-P-60082	WP704-I-70659	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 08, 01	---	NORMAL : FAULT	
WP704XBB03DC042	704-SWGR02 RS PUMP 4 UPS ON-BATTERY	WP704-P-60082	WP704-I-70659	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 12	---	FAULTED : NORMAL	
WP704XBY03DC042	704-SWGR02 RS PUMP 4 UPS ON-STATIC BYPASS	WP704-P-60082	WP704-I-70659	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 13	---	NORMAL : FAULT	
WP704XYN03DC042	704-SWGR02 RS PUMP 4 UPS SYSTEM NORMAL	WP704-P-60082	WP704-I-70659	704-ICP0302	DISCRETE IN	012/072, LOCAL, 01, 01, 14	---	OPENED : CLOSED	
WP705FI16NF012	BOILER 1 PROPANE FLOW	WP705-P-61000	WP705-I-70081	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 04, 03	0-200 SCFM	---	
WP705FI16NF022	BOILER 2 PROPANE FLOW	WP705-P-62000	WP705-I-70082	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 04, 04	0-200 SCFM	---	
WP705FI19BN011	BOILER 3 EGG FLOW	WP705-P-63000	WP705-I-70083	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 04, 06	0-200 SCFM	---	
WP705FI16NF031	BOILER 3 DIGESTER GAS FLOW	WP705-P-63000	WP705-I-70083	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 02	0-200 SCFM	---	
WP705FI16NF032	BOILER 3 PROPANE FLOW	WP705-P-63000	WP705-I-70083	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 03	0-200 SCFM	---	
WP705FI16NF041	BOILER 4 DIGESTER GAS FLOW	WP705-P-64000	WP705-I-70084	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 07	0-200 SCFM	---	
WP705FI16NF042	BOILER 4 PROPANE FLOW	WP705-P-64000	WP705-I-70084	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 08	0-200 SCFM	---	
WP705NDA19FB041	BOILER 4 HOT WATER IN REMOTE	WP705-P-64001	WP705-I-70068	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 01	---	LOCAL : REMOTE	
WP705NDJ19FB041	BOILER 4 HOT WATER ON	WP705-P-64001	WP705-I-70068	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 02	---	OFF : ON	
WP705XAD19FB041	BOILER 4 HOT WATER FAIL	WP705-P-64001	WP705-I-70068	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 03	---	NORMAL : FAULT	
WP705NDJ19FB042	BOILER 4 HOT WATER CIRC PUMP DEMAND	WP705-P-64001	WP705-I-70071	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 04	---	NULL : CALL	
WP705NDA19FB042	BOILER 4 AUTO FUEL SELECT	WP705-P-64001	WP705-I-70071	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 05	---	MANUAL : AUTO	
WP705NDA19FB043	BOILER 4 DIG GAS FUEL SELECT	WP705-P-64001	WP705-I-70071	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 06	---	PROP : DIG GAS	
WP705NDA19FC061	BOILER 4 HOT WATER CIRC PUMP REMOTE	WP705-P-64001	WP705-I-70069	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 07	---	LOCAL : REMOTE	
WP705NDJ19FC061	BOILER 4 HOT WATER CIRC PUMP ON	WP705-P-64001	WP705-I-70069	704-ICP0302	DISCRETE IN	012/072, LOCAL, 02, 03, 08	---	STOPPED : RUNNING	
WP705TI19FB041	BOILER 4 HOT WATER TEMPERATURE	WP705-P-64001	WP705-I-70067	704-ICP0302	ANALOG IN	012/072, LOCAL, 02, 08, 01	32 - 200 Deg F	---	
WP705TC19JJ041	BOILER 4 HOT WATER TEMP CTRL VLV FEEDBACK	WP705-P-64001	WP705-I-70070	704-ICP0302	ANALOG IN	012/072, LOCAL, 02, 08, 02	0 - 100 %	---	
WP704MNO03AW011	TEMP RS ENGINE JACKET COOLING TANK FILL VALVE 1	WP704-TP-60005	WP705-TI-70004	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 11	---	CLOSE : OPEN	
WP705MNJ19FB041	BOILER 4 HOT WATER CALL TO RUN	WP705-P-64001	WP705-I-70068	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 12	---	STOP : RUN	
WP705MNO19FB041	BOILER 4 HOT WATER MSG FEED OPEN	WP705-P-64001	WP705-I-70068	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 13	---	CLOSE : OPEN	
WP705MNO19FB042	BOILER 4 HOT WATER PROP FEED OPEN	WP705-P-64001	WP705-I-70068	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 14	---	CLOSE : OPEN	
WP705MNJ19FC061	BOILER 4 HOT WATER CIRC PMP CALL TO RUN	WP705-P-64001	WP705-I-70069	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 01, 15	---	STOP : RUN	
WP704MNO03AW021	TEMP RS ENGINE JACKET COOLING TANK FILL VALVE 2	WP704-TP-60006	WP705-TI-70005	704-ICP0302	DISCRETE OUT	012/072, LOCAL, 03, 02, 09	---	CLOSE : OPEN	

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OVATION DCS I/O SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP705TC19FA041	BOILER 4 FIRING RATE OUTPUT	WP705-P-64001	WP705-I-70067	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 01	0 - 100 %	---	
WP705TC19JJ042	BOILER 4 HOT WATER TEMP CTRL VLV OUTPUT	WP705-P-64001	WP705-I-70070	704-ICP0302	ANALOG OUT	012/072, LOCAL, 03, 03, 02	0 - 100 %	---	
WP704AI03BV041	RSP - CRANE HALL NORTH BATTERY ROOM CO	WP704-P-60035	WP704-I-70615	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 02, 04	0 - 100 PPM	---	
WP704LI03SP031	RS PUMP ROOM SUMP LEVEL	WP704-P-60023	WP704-I-70020	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 02, 05	0 - 20 FT	---	
WP704AI03BV042	RSP - CRANE HALL SOUTH BATTERY ROOM CO	WP704-P-60035	WP704-I-70616	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 02, 06	0 - 100 PCT	---	
WP704TI03EJ011	TEMP RS ENGINE JACKET COOLING TEMP 1	WP704-TP-60005	WP705-TI-70004	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 03, 05	32 - 200 Deg F	---	
WP704LI03AV011	TEMP RS ENGINE JACKET COOLING TANK LEVEL 1	WP704-TP-60005	WP705-TI-70004	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 03, 06	0 - 10 FT	---	
WP704TI03EJ021	TEMP RS ENGINE JACKET COOLING TEMP 2	WP704-TP-60006	WP705-TI-70005	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 04, 07	32 - 200 Deg F	---	
WP704LI03AV021	TEMP RS ENGINE JACKET COOLING TANK LEVEL 2	WP704-TP-60006	WP705-TI-70005	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 04, 08	0 - 10 FT	---	
WP704AI03BV031	RSP - CRANE HALL GROUND LEVEL NW CORNER CO	WP704-P-60035	WP704-I-70619	704-ICP0302	ANALOG IN	012/072, LOCAL, 04, 05, 01	0 - 100 PCT	---	
WP704VI03DC031	RAW SEWAGE PUMP 3 PUMP LOWER BEARING VIB X	WP704-P-60013	WP704-I-70307	704-ICP0313	MHM	012/072, 01, 01, 01, 01	0 - 0.5 g	---	
WP704VI03DC032	RAW SEWAGE PUMP 3 PUMP LOWER BEARING VIB Y	WP704-P-60013	WP704-I-70307	704-ICP0313	MHM	012/072, 01, 01, 01, 02	0 - 0.5 g	---	
WP704VI03DC033	RAW SEWAGE PUMP 3 PUMP UPPER BEARING VIB X	WP704-P-60013	WP704-I-70308	704-ICP0313	MHM	012/072, 01, 01, 01, 03	0 - 0.5 g	---	
WP704VI03DC034	RAW SEWAGE PUMP 3 PUMP UPPER BEARING VIB Y	WP704-P-60013	WP704-I-70308	704-ICP0313	MHM	012/072, 01, 01, 01, 04	0 - 0.5 g	---	
WP704VI03DC035	RAW SEWAGE PUMP 3 PUMP UPPER BEARING VIB Z	WP704-P-60013	WP704-I-70308	704-ICP0313	MHM	012/072, 01, 01, 01, 05	0 - 0.5 g	---	
WP704SI03DC031	RAW SEWAGE PUMP 3 SHAFT SPEED	WP704-P-60013	WP704-I-70307	704-ICP0313	MHM	012/072, 01, 01, 01, 08	0 - 300 RPM	---	
WP704VI03DC036	RAW SEWAGE PUMP 3 MOTOR DE BEARING VIB X	WP704-P-60013	WP704-I-70309	704-ICP0313	MHM	012/072, 01, 01, 02, 01	0 - 0.5 g	---	
WP704VI03DC037	RAW SEWAGE PUMP 3 MOTOR DE BEARING VIB Y	WP704-P-60013	WP704-I-70309	704-ICP0313	MHM	012/072, 01, 01, 02, 02	0 - 0.5 g	---	
WP704VI03DC038	RAW SEWAGE PUMP 3 MOTOR NDE BEARING VIB X	WP704-P-60013	WP704-I-70310	704-ICP0313	MHM	012/072, 01, 01, 02, 03	0 - 0.5 g	---	
WP704VI03DC039	RAW SEWAGE PUMP 3 MOTOR NDE BEARING VIB Y	WP704-P-60013	WP704-I-70310	704-ICP0313	MHM	012/072, 01, 01, 02, 04	0 - 0.5 g	---	
WP704VI03DC035A	RAW SEWAGE PUMP 3 MOTOR NDE BEARING VIB Z	WP704-P-60013	WP704-I-70310	704-ICP0313	MHM	012/072, 01, 01, 02, 05	0 - 0.5 g	---	
WP704PAL03DC031	RAW SEWAGE PUMP 3 SEAL WATER LOW PRESSURE	WP704-P-60013	WP704-I-70306	704-ICP0313	DISCRETE IN	012/072, 01, 01, 03, 01	---	LOW FLOW : NORMAL	
WP704FAL03DC031	RAW SEWAGE PUMP 3 SEAL WATER LOW FLOW	WP704-P-60013	WP704-I-70306	704-ICP0313	DISCRETE IN	012/072, 01, 01, 03, 02	---	LOW PRESS : NORMAL	
WP704NDA03DC031	RAW SEWAGE PUMP 3 REMOTE STATUS	WP704-P-60013	WP704-I-70301	704-ICP0313	DISCRETE IN	012/072, 01, 01, 04, 01	---	LOCAL : REMOTE	
WP704NDJ03DC031	RAW SEWAGE PUMP 3 RUNNING	WP704-P-60013	WP704-I-70301	704-ICP0313	DISCRETE IN	012/072, 01, 01, 04, 02	---	STOPPED : RUNNING	
WP704NDR03DC031	RAW SEWAGE PUMP 3 READY	WP704-P-60013	WP704-I-70301	704-ICP0313	DISCRETE IN	012/072, 01, 01, 04, 03	---	NOT RDY : READY	
WP704XAD03DC031	RAW SEWAGE PUMP 3 FAULTED	WP704-P-60013	WP704-I-70301	704-ICP0313	DISCRETE IN	012/072, 01, 01, 04, 04	---	FAULTED : NORMAL	
WP704MNP03DC031	RAW SEWAGE PUMP 3 STOP COMMAND	WP704-P-60013	WP704-I-70302	704-ICP0313	DISCRETE OUT	012/072, 01, 01, 05, 01	---	NULL : STOP	
WP704MNJ03DC031	RAW SEWAGE PUMP 3 START COMMAND	WP704-P-60013	WP704-I-70301	704-ICP0313	DISCRETE OUT	012/072, 01, 01, 05, 02	---	NULL : START	
WP704YYP03DC031	RAW SEWAGE PUMP 3 PROTECTION INTERLOCK	WP704-P-60013	WP704-I-70302	704-ICP0313	DISCRETE OUT	012/072, 01, 01, 05, 03	---	INTLK : NORMAL	
WP704MNJ03OVX31	704-ICP0333 OVATION PANEL FAN RUN COMMAND	---	WP704-I-50315	704-ICP0313	DISCRETE OUT	012/072, 01, 01, 05, 16	---	STOP : RUN	
WP704SI03DC031	RAW SEWAGE PUMP 3 SPEED FEEDBACK	WP704-P-60013	WP704-I-70303	704-ICP0313	ANALOG IN	012/072, 01, 02, 01, 01	0 - 300 RPM	---	
WP704DPI03DC031	RAW SEWAGE PUMP 3 DIFFERENTIAL PRESSURE	WP704-P-60013	WP704-I-70305	704-ICP0313	ANALOG IN	012/072, 01, 02, 01, 02	0 - 50 FT	---	
WP704TI03OVX31	704-ICP0333 OVATION PANEL TEMPERATURE	---	WP704-I-50321	704-ICP0313	ANALOG IN	012/072, 01, 02, 01, 08	32 - 200 Deg F	---	
WP704SCO2DC031	RAW SEWAGE PUMP 3 SPEED REFERENCE	WP704-P-60013	WP704-I-70303	704-ICP0313	ANALOG OUT	012/072, 01, 02, 02, 01	0 - 300 RPM	---	
WP704TI03DC031	RAW SEWAGE PUMP 3 PUMP LOWER BEARING TEMP	WP704-P-60013	WP704-I-70307	704-ICP0313	RTD IN	012/072, 01, 02, 03, 01	32 - 200 Deg F	---	
WP704TI03DC032	RAW SEWAGE PUMP 3 PUMP UPPER BEARING TEMP	WP704-P-60013	WP704-I-70308	704-ICP0313	RTD IN	012/072, 01, 02, 03, 02	32 - 200 Deg F	---	
WP704TI03DC033	RAW SEWAGE PUMP 3 MOTOR DE BEARING TEMP	WP704-P-60013	WP704-I-70309	704-ICP0313	RTD IN	012/072, 01, 02, 03, 03	32 - 200 Deg F	---	
WP704TI03DC034	RAW SEWAGE PUMP 3 MOTOR NDE BEARING TEMP	WP704-P-60013	WP704-I-70310	704-ICP0313	RTD IN	012/072, 01, 02, 03, 04	32 - 200 Deg F	---	
WP704TI03DC035	RAW SEWAGE PUMP 3 MOTOR WINDING TEMP A	WP704-P-60013	WP704-I-70309	704-ICP0313	RTD IN	012/072, 01, 02, 03, 05	32 - 200 Deg F	---	
WP704TI03DC036	RAW SEWAGE PUMP 3 MOTOR WINDING TEMP B	WP704-P-60013	WP704-I-70309	704-ICP0313	RTD IN	012/072, 01, 02, 03, 06	32 - 200 Deg F	---	
WP704TI03DC037	RAW SEWAGE PUMP 3 MOTOR WINDING TEMP C	WP704-P-60013	WP704-I-70309	704-ICP0313	RTD IN	012/072, 01, 02, 03, 07	32 - 200 Deg F	---	
WP704NXX03DC033	OVATION MACHINERY HEALTH MODULE 1,1,1 DATA	WP704-P-60013	---	704-ICP0313	ETHERNET	012/072, 01, ENET, 00, 00	---	---	
WP704NXX03DC035	OVATION MACHINERY HEALTH MODULE 1,1,2 DATA	WP704-P-60013	---	704-ICP0313	ETHERNET	012/072, 01, ENET, 00, 00	---	---	
WP704VI03DC041	RAW SEWAGE PUMP 4 PUMP LOWER BEARING VIB X	WP704-P-60014	WP704-I-70407	704-ICP0314	MHM	012/072, 02, 01, 01, 01	0 - 0.5 g	---	
WP704VI03DC042	RAW SEWAGE PUMP 4 PUMP LOWER BEARING VIB Y	WP704-P-60014	WP704-I-70407	704-ICP0314	MHM	012/072, 02, 01, 01, 02	0 - 0.5 g	---	
WP704VI03DC043	RAW SEWAGE PUMP 4 PUMP UPPER BEARING VIB X	WP704-P-60014	WP704-I-70408	704-ICP0314	MHM	012/072, 02, 01, 01, 03	0 - 0.5 g	---	
WP704VI03DC044	RAW SEWAGE PUMP 4 PUMP UPPER BEARING VIB Y	WP704-P-60014	WP704-I-70408	704-ICP0314	MHM	012/072, 02, 01, 01, 04	0 - 0.5 g	---	
WP704VI03DC045	RAW SEWAGE PUMP 4 PUMP UPPER BEARING VIB Z	WP704-P-60014	WP704-I-70408	704-ICP0314	MHM	012/072, 02, 01, 01, 05	0 - 0.5 g	---	
WP704SI03DC041	RAW SEWAGE PUMP 4 SHAFT SPEED	WP704-P-60014	WP704-I-70407	704-ICP0314	MHM	012/072, 02, 01, 01, 08	0 - 300 RPM	---	
WP704VI03DC046	RAW SEWAGE PUMP 4 MOTOR DE BEARING VIB X	WP704-P-60014	WP704-I-70409	704-ICP0314	MHM	012/072, 02, 01, 02, 01	0 - 0.5 g	---	
WP704VI03DC047	RAW SEWAGE PUMP 4 MOTOR DE BEARING VIB Y	WP704-P-60014	WP704-I-70409	704-ICP0314	MHM	012/072, 02, 01, 02, 02	0 - 0.5 g	---	
WP704VI03DC048	RAW SEWAGE PUMP 4 MOTOR NDE BEARING VIB X	WP704-P-60014	WP704-I-70410	704-ICP0314	MHM	012/072, 02, 01, 02, 03	0 - 0.5 g	---	
WP704VI03DC049	RAW SEWAGE PUMP 4 MOTOR NDE BEARING VIB Y	WP704-P-60014	WP704-I-70410	704-ICP0314	MHM	012/072, 02, 01, 02, 04	0 - 0.5 g	---	
WP704VI03DC045A	RAW SEWAGE PUMP 4 MOTOR NDE BEARING VIB Z	WP704-P-60014	WP704-I-70410	704-ICP0314	MHM	012/072, 02, 01, 02, 05	0 - 0.5 g	---	
WP704PAL03DC041	RAW SEWAGE PUMP 4 SEAL WATER LOW PRESSURE	WP704-P-60014	WP704-I-70406	704-ICP0314	DISCRETE IN	012/072, 02, 01, 03, 01	---	LOW FLOW : NORMAL	
WP704FAL03DC041	RAW SEWAGE PUMP 4 SEAL WATER LOW FLOW	WP704-P-60014	WP704-I-70406	704-ICP0314	DISCRETE IN	012/072, 02, 01, 03, 02	---	LOW PRESS : NORMAL	

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OVATION DCS I/O SCHEDULE

OVATION POINT NAME	POINT DESCRIPTION	P&ID	LOOP #	OVATION PNL	POINT TYPE	POINT ADDRESS	CALIBRATION RANGE	RESET/SET	NOTES
WP704NDA03DC041	RAW SEWAGE PUMP 4 REMOTE STATUS	WP704-P-60014	WP704-I-70401	704-ICP0314	DISCRETE IN	012/072, 02, 01, 04, 01	---	LOCAL : REMOTE	
WP704NDJ03DC041	RAW SEWAGE PUMP 4 RUNNING	WP704-P-60014	WP704-I-70401	704-ICP0314	DISCRETE IN	012/072, 02, 01, 04, 02	---	STOPPED : RUNNING	
WP704NDR03DC041	RAW SEWAGE PUMP 4 READY	WP704-P-60014	WP704-I-70401	704-ICP0314	DISCRETE IN	012/072, 02, 01, 04, 03	---	NOT RDY : READY	
WP704XAD03DC041	RAW SEWAGE PUMP 4 FAULTED	WP704-P-60014	WP704-I-70401	704-ICP0314	DISCRETE IN	012/072, 02, 01, 04, 04	---	FAULTED : NORMAL	
WP704MNP03DC041	RAW SEWAGE PUMP 4 STOP COMMAND	WP704-P-60014	WP704-I-70402	704-ICP0314	DISCRETE OUT	012/072, 02, 01, 05, 01	---	NULL : STOP	
WP704MNJ03DC041	RAW SEWAGE PUMP 4 START COMMAND	WP704-P-60014	WP704-I-70401	704-ICP0314	DISCRETE OUT	012/072, 02, 01, 05, 02	---	NULL : START	
WP704YYP03DC041	RAW SEWAGE PUMP 4 PROTECTION INTERLOCK	WP704-P-60014	WP704-I-70402	704-ICP0314	DISCRETE OUT	012/072, 02, 01, 05, 03	---	INTLK : NORMAL	
WP704MNJ03OVX41	704-ICP0334 OVATION PANEL FAN RUN COMMAND	---	WP704-I-50415	704-ICP0314	DISCRETE OUT	012/072, 02, 01, 05, 16	---	STOP : RUN	
WP704SI03DC041	RAW SEWAGE PUMP 4 SPEED FEEDBACK	WP704-P-60014	WP704-I-70403	704-ICP0314	ANALOG IN	012/072, 02, 02, 01, 01	0 - 300 RPM	---	
WP704DPI03DC041	RAW SEWAGE PUMP 4 DIFFERENTIAL PRESSURE	WP704-P-60014	WP704-I-70405	704-ICP0314	ANALOG IN	012/072, 02, 02, 01, 02	0 - 50 FT	---	
WP704TI03OVX41	704-ICP0334 OVATION PANEL TEMPERATURE	---	WP704-I-50421	704-ICP0314	ANALOG IN	012/072, 02, 02, 01, 08	32 - 200 Deg F	---	
WP704SC03DC041	RAW SEWAGE PUMP 4 SPEED REFERENCE	WP704-P-60014	WP704-I-70403	704-ICP0314	ANALOG OUT	012/072, 02, 02, 02, 01	0 - 300 RPM	---	
WP704TI03DC041	RAW SEWAGE PUMP 4 PUMP LOWER BEARING TEMP	WP704-P-60014	WP704-I-70407	704-ICP0314	RTD IN	012/072, 02, 02, 03, 01	32 - 200 Deg F	---	
WP704TI03DC042	RAW SEWAGE PUMP 4 PUMP UPPER BEARING TEMP	WP704-P-60014	WP704-I-70408	704-ICP0314	RTD IN	012/072, 02, 02, 03, 02	32 - 200 Deg F	---	
WP704TI03DC043	RAW SEWAGE PUMP 4 MOTOR DE BEARING TEMP	WP704-P-60014	WP704-I-70409	704-ICP0314	RTD IN	012/072, 02, 02, 03, 03	32 - 200 Deg F	---	
WP704TI03DC044	RAW SEWAGE PUMP 4 MOTOR NDE BEARING TEMP	WP704-P-60014	WP704-I-70410	704-ICP0314	RTD IN	012/072, 02, 02, 03, 04	32 - 200 Deg F	---	
WP704TI03DC045	RAW SEWAGE PUMP 4 MOTOR WINDING TEMP A	WP704-P-60014	WP704-I-70409	704-ICP0314	RTD IN	012/072, 02, 02, 03, 05	32 - 200 Deg F	---	
WP704TI03DC046	RAW SEWAGE PUMP 4 MOTOR WINDING TEMP B	WP704-P-60014	WP704-I-70409	704-ICP0314	RTD IN	012/072, 02, 02, 03, 06	32 - 200 Deg F	---	
WP704TI03DC047	RAW SEWAGE PUMP 4 MOTOR WINDING TEMP C	WP704-P-60014	WP704-I-70409	704-ICP0314	RTD IN	012/072, 02, 02, 03, 07	32 - 200 Deg F	---	
WP704NXX03DC043	OVATION MACHINERY HEALTH MODULE 2,1,1 DATA	WP704-P-60014	---	704-ICP0314	ETHERNET	012/072, 02, ENET, 00, 00	---	---	
WP704NXX03DC045	OVATION MACHINERY HEALTH MODULE 2,1,2 DATA	WP704-P-60014	---	704-ICP0314	ETHERNET	012/072, 02, ENET, 00, 00	---	---	
WP704FSH01001	EYE WAS SHOWER FLOW SWITCH	WP704-P-60001	WP704-I-70501	704-ICP0314	DIGITAL IN	011/071, 01, 01, 06, 15	---	---	
WP704FSH01002	EYE WAS SHOWER FLOW SWITCH	WP704-P-60001	WP704-I-70501	704-ICP0314	DIGITAL IN	011/071, 01, 01, 06, 16	---	---	
WP704SIC24AX011	RAW SEWAGE SAMPLE PUMP 1 SPEED COMMAND	WP704-P-60021	WP704-I-70091	704-ICP0314	ANALOG OUT	011/071, 01, 03, 04, 01	---	---	
WP704MNJ24AX011	RAW SEWAGE SAMPLE PUMP 1 RUN COMMAND	WP704-P-60021	WP704-I-70091	704-ICP0314	DIGITAL OUT	011/071, 01, 03, 02, 15	---	---	
WP704NDJ24AX011	RAW SEWAGE SAMPLE PUMP 1 RUNNING FEEDBACK	WP704-P-60021	WP704-I-70091	704-ICP0314	DIGITAL IN	011/071, 01, 01, 07, 12	---	---	
WP704XAD24AX011	RAW SEWAGE SAMPLE PUMP 1 FAULT	WP704-P-60021	WP704-I-70091	704-ICP0314	DIGITAL IN	011/071, 01, 01, 07, 13	---	---	
WP704SIC24AX021	RAW SEWAGE SAMPLE PUMP 2 SPEED COMMAND	WP704-P-60021	WP704-I-70091	704-ICP0314	ANALOG OUT	011/071, 01, 03, 04, 02	---	---	
WP704MNJ24AX021	RAW SEWAGE SAMPLE PUMP 2 RUN COMMAND	WP704-P-60021	WP704-I-70091	704-ICP0314	DIGITAL OUT	011/071, 01, 03, 02, 16	---	---	
WP704NDJ24AX021	RAW SEWAGE SAMPLE PUMP 2 RUNNING FEEDBACK	WP704-P-60021	WP704-I-70091	704-ICP0314	DIGITAL IN	011/071, 01, 01, 07, 14	---	---	
WP704XAD24AX021	RAW SEWAGE SAMPLE PUMP 2 FAULT	WP704-P-60021	WP704-I-70091	704-ICP0314	DIGITAL IN	011/071, 01, 01, 07, 15	---	---	
WP704FAL04Y3X11	AREA LOW VENT ALARM	WP704-P-60035	WP704-I-51021	704-ICP0301	DIGITAL IN	011/071, 01, 02, 01, 08	---	---	
WP704AAH04Y3X12	AREA HIGH GAS ALARM	WP704-P-60035	WP704-I-51021	704-ICP0301	DIGITAL IN	011/071, 01, 02, 01, 09	---	---	
WP704FAL04Y3X13	AREA LOW VENT ALARM	WP704-P-60035	WP704-I-51021	704-ICP0301	DIGITAL IN	011/071, 01, 02, 01, 10	---	---	
WP704NX03DC011	UPS03DC011 DATA MODBUS TCP	WP704-P-60081	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC021	UPS03DC012 DATA MODBUS TCP	WP704-P-60081	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX26BD011A	RLY26BD011A DATA MODBUS TCP	WP704-P-60081	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC051A	RLY03DC051A DATA MODBUS TCP	WP704-P-60081	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC011A	RLY03DC011A DATA MODBUS TCP	WP704-P-60081	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC021A	RLY03DC021A DATA MODBUS TCP	WP704-P-60081	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC031	UPS03DC031 DATA MODBUS TCP	WP704-P-60082	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC041	UPS03DC041 DATA MODBUS TCP	WP704-P-60082	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC031A	RLY03DC031A DATA MODBUS TCP	WP704-P-60082	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC041A	RLY03DC041A DATA MODBUS TCP	WP704-P-60082	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX03DC061A	RLY03DC061A DATA MODBUS TCP	WP704-P-60082	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	
WP704NX26BD021A	RLY26BD021A DATA MODBUS TCP	WP704-P-60082	---	704-WC01	ETHERNET	011/071, 01, ENET, 00, 00	---	---	

SECTION 40 41 00

PROCESS PIPING AND EQUIPMENT HEAT TRACING

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies electric heat trace tape and control for protection of piping against freezing.

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NEMA ICS 1	Industrial Control and Systems

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's product literature.
 2. Certification that tracer tape can withstand temperature specified herein.

PART 2 PRODUCTS

2.01 GENERAL

- A. Tracer tape shall consist of self-limiting, parallel circuit construction with a continuous inner core of conductive material between two copper bus wires.
- B. The resistance and heating capacity of the heating material shall vary in response to piping temperature changes.
- C. Tape shall withstand continuous exposure to 150-degree F temperature.
- D. Tracer tape shall operate using 120-volt AC, 1 phase, 60 Hz power.
- E. Maximum loading per heat trace controller shall not exceed 20A.
- F. Tracer tape shall be protected by a GFPE (30 mA) circuit breaker.
- G. Tracer tape shall be provided with copper shield and fluoropolymer jacket.

2.02 CONTROL THERMOSTATS

- A. General:
1. Each length of tracer tape shall be controlled by a thermostat. Thermostat shall be provided in an aluminum, NEMA 4, watertight enclosure.
 2. Each length of tracer tape shall be provided with signal lights wired to the terminating end. A green light shall indicate that the tape is ready and a red light, energized.

- B. Type A Thermostat: Type A thermostat shall control by sensing ambient temperature with the following characteristics:
1. Rating: 22 amperes at 480V AC.
 2. Calibration tolerance: 2 degrees F.
 3. Sensor material: stainless steel.
 4. Exposure temperature: -65 to 140 degrees F.
- C. Type B Thermostat: Type B thermostat shall control by sensing pipe temperature with the following characteristics:
1. Rating: 22 amperes at 480V AC.
 2. Calibration tolerance: 1 percent of full scale.
 3. Bulb and capillary material: stainless steel.
 4. Control exposure temperature: -65 to 140 degrees F.
 5. Sensor over-range temperature: 325 degrees F maximum.

2.03 SCHEDULE

- A. Provide tracer tape and thermostat in accordance with the following schedule:

Piping system service ¹	Piping diameter (inches)	Location ²	Minimum thermal heating requirement ³ (W/ft)	Control Temperature range (°F)	Temperature setting °F	Thermostat type
C2	1-1/2	O	5W @ 50°F	-65 to 140°F	40°F	A
SHW	4	O	5W @ 50°F	-65 to 140°F	40°F	A

¹ See Section 40 05 01

² I = Indoor; O = Outdoor

³ Based on required heat input per foot of pipe.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fasten tracer tape to pipe and valves as recommended by the manufacturer at intervals not exceeding 1 foot.
- B. Provide insulation in accordance with Section 40 42 00 over the tracer tape.
- C. Affix labels on surface indicating heat-traced pipe.

END OF SECTION

SECTION 40 42 00

PROCESS PIPING AND EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies thermal insulation for exposed piping, related equipment, and appurtenant surfaces.

1.02 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C450	Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C552	Cellular Glass Thermal Insulation
ASTM C553	Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C547	Mineral Fiber Pipe Insulation
ASTM C612	Mineral Fiber Block and Board Thermal Insulation
ASTM E96	Test Methods for Water Vapor Transmission of Materials
FEDSPEC L-P-535 E	Plastic Sheet (Sheeting) "Plastic Strip" Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid
IECC	International Energy Conservation Code (International Code Council (ICC))

1.03 OPERATING REQUIREMENTS

- A. Temperature Classes:
1. Insulation for exposed piping and equipment is classified for the following temperature ranges: low, medium, high, and very high.
 2. Low temperature class insulation shall be suitable for an operating temperature range of minus 100 to plus 100 degrees F.
 3. Medium temperature class insulation shall be suitable for an operating temperature range of 100 to 800 degrees F.
 4. High temperature class insulation shall be suitable for an operating temperature range of 800 to 1200 degrees F.
 5. Very high temperature class insulation shall be suitable for an operating temperature range of 1200 to 2000 degrees F.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer's descriptive literature, including insulation and jacket thickness, heat transfer coefficient, and methods of installation.

2. Certification of jacket ratings for water vapor transmission and puncture and stiffness as specified.
3. Samples of each insulation material type and of typical jackets and covers for fittings, valves and appurtenances.

PART 2 PRODUCTS

2.01 GENERAL

- A. Piping insulation shall be tubular type or the flexible blanket type.
- B. Insulation for air separators, valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation or the flexible blanket type.
- C. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.02 INSULATION

- A. General
 1. Low temperature class insulation shall be of the unicellular elastomeric thermal, cellular glass, or fiberglass type.
 2. Medium temperature class insulation shall be of the cellular glass or fiberglass type.
 3. High temperature class insulation shall be of the calcium silicate type or the flexible blanket type.
 4. Very high temperature class insulation shall be of the calcium silicate type or the flexible blanket type.
 5. Piping and equipment subjected to vibration (such as engine exhaust) shall be insulated with flexible blanket type.
- B. Unicellular Elastomeric Thermal Type: Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.
- C. Cellular Glass Type: Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.
- D. Mineral Fiber Blanket Type: Mineral fiber type insulation shall conform to the requirements of ASTM C553.
- E. Mineral Fiber Block and Board Type: Mineral fiber type insulation shall conform to the requirements of ASTM C612.
- F. Mineral Fiber Pipe Insulation: Mineral fiber pipe insulation shall conform to the requirements of ASTM C547.
- G. Calcium Silicate Type: Calcium silicate type insulation shall conform to the requirements of ASTM C533, Type II, Class C.
- H. Flexible Blanket Type:
 1. High Temperature Class:
 - a. High temperature insulation shall be removable 1-inch or 2-inch thick blanket-type insulation designed for continuous 1200-degree F service.
 - b. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing.
 - c. Blanket shall be custom fitted to not restrict access to any instrumentation or equipment.
 - d. Insulation shall not compact or shake down in vibrating service.

- e. Blanket insulation shall consist of a noncombustible silica cloth jacket and non-asbestos white ceramic fiber insulation.
- f. Acceptable manufacturers:
 - 1) Hitco
 - 2) Advanced Thermal Products.
 - 3) SEI Temp-Set.
 - 4) Approved Equal.
- 2. Very High Temperature Class:
 - a. Very high temperature insulation shall be removable 1-inch or 2-inch thick blanket-type insulation designed for continuous 2000 degree F service.
 - b. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing.
 - c. Blanket shall be custom-fitted to not restrict access to any instrumentation or equipment
 - d. Insulation shall not compact or shake down in vibrating service.
 - e. Blanket insulation shall consist of a noncombustible silica cloth jacket and high purity alumina and silica non-asbestos white ceramic fiber insulation.
 - f. Acceptable manufacturers:
 - 1) Hitco
 - 2) Advanced Thermal Products.
 - 3) Approved Equal.

2.03 PIPE INSULATION JACKETS

- A. Laminated Jackets: Laminated jackets shall consist of aluminum and internal polymer film. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with procedure A of ASTM E96.
- B. PVC Jackets:
 - 1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
 - 2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
 - 3. Flame Spread Rating: 25 per ASTM E84.
 - 4. Smoke Developed Index: 50 per ASTM E84.
 - 5. Manufacturers and Products:
 - a. Knauf Insulation; Proto 1000.
 - b. Johns Manville; Zeston 2000 or 300.
 - c. Speedline; 25/50 Smoke-Safe.
- C. Aluminum Jackets:
 - 1. Aluminum jackets shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 3003 or 3105, temper H-14, with integral vapor barrier. Jackets shall be minimum 0.016 inch thick.
 - 2. Jackets shall be secured with 0.020-inch thick by ½-inch wide type 304 stainless steel expansion bands secured with stainless steel wing seals at 12 inches on center.
 - 3. Sheet metal screws shall be aluminum or stainless steel. Screws shall not be used for outdoor installations.

2.04 FITTING INSULATION COVERS

- A. Polyvinylchloride (PVC) Covers: PVC covers shall be one piece, premolded PVC conforming to FEDSPEC L-P-535E, Composition A, Type II, Grade E4.
- B. Aluminum Covers: Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM C450, alloy 1100, temper O with baked on epoxy coating on the inside and with integral vapor barrier. Covers shall be minimum 0.024 inch thick.

- C. Soft Covers: Soft covers shall be of the reusable type with TFE-coated fiberglass covers and liner.

2.05 THERMAL SHIELDS

- A. Thermal shields shall be provided at pipe supports. Thermal hanger shields shall be as specified in Section 40 05 41.

2.06 FLASHING

- A. Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.
- B. Reinforcement in flashing heated up to 370 degrees F shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Apply insulation over clean, dry surfaces.
 - 2. Double layer insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.
- B. Pipe Supports and Shields:
 - 1. Where thermal pipe hanger shields are used, apply the following to all butt joints:
 - a. On hot pipe systems, apply 3-inch wide vapor barrier tape or band over the butt joints.
 - b. On cold water, chilled water, or refrigerant piping, apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3-inch wide vapor barrier tape or band.
- C. Protection:
 - 1. Protect insulation and jackets from crushing, denting, and similar damage during construction.
 - 2. Vapor barriers shall not be penetrated or otherwise damaged.
 - 3. Remove any insulation, jacket, and vapor barriers damaged during construction and install new material.
- D. Piping Insulation:
 - 1. General:
 - a. Pipe: Insulate piping continuously along its entire length including all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Unless otherwise indicated, provide piping insulation with laminated jackets.
 - 1) Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive.
 - 2) Insulation jackets shall be installed with seams located on the side of pipe (3 or 9 o'clock positions) with overlap directed downwards to act as a rain shield.
 - 3) Do not use PVC covers with medium, high, or very high temperature class insulation.
 - 4) Removable flexible blanket-type insulation shall not be jacketed.
 - b. Fittings, Connections, Flanges and Valves: Provide fitting, connection, flange and valve insulation with covers specified in this section. Secure insulation in place with 20-gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Install covers with the overlapping seam located on the side of fittings and valves such that outside of the overlap is pointing down and water does not enter the seam.
 - 2. Low Temperature Class:
 - a. Pipe: Seal off ends of insulation with a vapor barrier coating.

- b. Fittings, Connections, Flanges and Valves:
 - 1) Except where soft covers are specified, provide insulation for pipe sizes 2-inches and less with rigid PVC covers. Seal covers at edges with vapor barrier adhesive. Secure the ends of covers with vinyl tape. The tape shall overlap the jacket and the cover at least 1-inch. Do not penetrate vapor barrier.
 - 2) Except where soft covers are specified, provide insulation for pipes 2 1/2-inches and larger with rigid aluminum covers. Mechanically secure covers using corrosion-resistant tacks pushed into the overlapping throat joint.
 - 3. Medium, High, and Very High Temperature Class:
 - a. Pipe: Except for flexible blanket type insulation, seal ends of insulation with end joint strips and use waterproof adhesive to hold them in place.
 - b. Fittings, Connections, Flanges and Valves: Except where soft covers are specified, provide rigid insulation with rigid aluminum covers. Mechanically secure covers using corrosion-resistant tacks pushed into the overlapping throat joint.
 - 4. Outdoor Piping:
 - a. Pipe: Provide rigid tubular insulation (unicellular elastomeric, cellular glass, or mineral fiber types) with aluminum jackets using bands; sheet metal screws shall not be used. Where flexible blanket-type insulation is used, it shall be designed for outdoor, weather-exposed service. Where piping emerges from soil without concrete or asphalt overtop, extend the insulation a minimum of 12-inches below the finished ground level. Where piping emerges from concrete or asphalt, extend the insulation to within 1-inch of the finished surface. Do not push insulation into contact with the finished concrete or asphalt surface.
 - b. Insulation over Heat Tracing: Provide heat tracing in specified locations on the drawings, and as specified in this Section. Install insulation over the top of heat tracing according to the specifications of the heat trace tape and insulation manufacturers.
 - c. Fittings, Connections, Flanges and Valves: Provide rigid insulation with rigid aluminum covers specified in this Section. Design flexible blanket type insulation for outdoor, weather-exposed service.
- E. Mechanical Equipment Insulation:
 - 1. General:
 - a. Unless otherwise specified, fit insulation to the contours of equipment and secure it with 1/2-inch by 0.015-inch galvanized steel bands; use stainless for outdoor installations. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18-inches apart. Stagger joints and fill voids with insulating cement. Unless otherwise specified, provide insulation with laminated jackets specified in Section 40 42 00.
 - b. Unless specifically specified to be uninsulated, insulate all equipment connected to insulated piping.
 - 2. Outdoor Equipment:
 - a. Provided insulation with a coat of weatherproof mastic and a layer of open-weave glass cloth embedded into a wet tack coat.
 - b. Overlap seams at least 2-inches.
 - c. Provide a finish coat of weatherproof mastic.
 - d. The total coating thickness shall be a minimum of 1/8 inch.
 - 3. Low Temperature Class:
 - a. Where joints, breaks, and punctures occur in the insulation, seal them in facing with fire-retardant vapor barrier adhesive reinforced with 4-inch tape.
 - b. Provide insulation with a layer of open-weave glass cloth embedded into a wet coat of fire-retardant adhesive. Overlap seams at least 2-inches. Provide a finish coat of fire-retardant adhesive.
 - 4. Medium Temperature Class: Cover joints and cement them in place with 4-inch-wide strips of the same material as the laminated jackets.
 - 5. High and Very High Temperature Class:
 - a. Cover high and very high temperature equipment with custom-fitted removable blanket-type insulation.
 - b. Secure blanket-type insulation with stainless steel wire lacing and hooks.

- c. Overlap ends of blanket segments to prevent gaps and voids when the piping and equipment are heated.
- d. Secure blankets snugly under nuts and bolt heads to assure complete coverage during operation and to prevent vibration-induced gaps or voids.
- e. Secure blankets in strict accordance with the manufacturer's instructions.
- f. The blanket insulation thickness for high and very high temperature piping and equipment shall be selected to provide maximum 150°F outer surface temperature.

F. Flashing:

1. Provide flashing at jacket penetrations and terminations. Provide clearance for flashing between insulation system and piping supports.
2. Trowel a heavy tack coat of sealant over the insulation, extending it over the jacket edge 1-inch and over the pipe or protrusion 2-inches. Stretch reinforcement over the tack coat after clipping to fit over pipe and jacket. Strap clipped reinforcing with a continuous band of reinforcing to prevent curling. Then trowel sealant over the reinforcement to a minimum thickness of 1/8 inch.
3. Form aluminum caps to fit over the adjacent jacketing and to completely cover coated insulation. Hold cap in place with a jacket strap.

3.02 INSULATION THICKNESS SCHEDULE

- A. The insulation dimensional tolerances shall comply with the specified standards. Equipment insulation shall match thickness of attached piping. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Insulation Thickness for Nominal Pipe Sizes ^a							
	Nominal Pipe Size	Runouts up to 2 inches ^c	1 inch and less	1.25 to 2 inches	2.5 to 4 inches	5 and 6 inches	8 inches and larger
	Fluid temperature	Insulation Thickness	Insulation Thickness	Insulation Thickness	Insulation Thickness	Insulation Thickness	Insulation Thickness
Piping Service b, d, e,	°F	Inch	Inch	Inch	Inch	Inch	Inch
HWR/HWS ^f	140-200	1.5	1.5	2.0	2.0	2.0	2.0
CW	40-60	1.0	1.0	1.0	1.0	1.0	1.0
C1	40-60	1.0	1.0	1.0	1.0	1.0	1.0
C2	40-60	1.0	1.0	1.0	1.0	1.0	1.0
DH	100-150	1.0	1.0	1.5	1.5	1.5	1.5
EE	Up to 1200		1.5	2.0	2.0	2.0	2.0
Heat Tracing			1.0	1.0	1.0/1.5 ^g	1.5	1.5 ^h
Personnel Exposure	>140		Minimum 1.5 ^j				

^a Influenced by Table 9.8.3 of ASHRAE Standard 90.1.

^b See specification Section 40 05 01.

^c Run outs to individual terminal units (not exceeding 12 feet in length).

^d For condensation control, see specification Section 40 05 01. Unless otherwise specified, connected equipment shall be uninsulated.

^e Additional insulation requirements are specified in the Remarks at the end of individual piping system spec sheets in Section 40 05 01.

^f Including PHW, SHW, HRR, HRS and Hydronic Piping Specialty Items, which contain hot fluids.

^g 1.5-inch thick for 4" diameter

^h 1.5-inch thick for 8"-10" diameter

^j ASHRAE 90.1 or IECC thickness, whichever is thicker

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for process instrumentation and control, which consists of hardware, software, and services necessary to provide the control functions specified.
- B. The required control system uses information and requirements in other Contract Drawings, Schedules and Narrative/Specifications. The Drawings and Schedules depict application dependent data while the Narrative/Specifications define broader requirements such as overall quality and performance.
- C. The work requires instrumentation work for hardware and associated services, and testing coordination of automation work for Emerson Ovation distributed control system (DCS). Emerson Ovation DCS are existing systems being modified with the programming by the Owner using Emerson Management Services.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
API RP 551	Process Measurement Instrumentation
API RP 552	Transmission Systems
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S5.1	Instrumentation symbols and Identification
ISA S51.1	Process Instrumentation Terminology
ISA S5.3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer systems
ISA RP12.2.02	Recommendations for the Preparation, Content and Organization of Intrinsic Safety Control Drawings
NFPA 70	National Electric Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery
NFPA 820	Fire Protection in Wastewater Treatment and Collection Facilities
IBC 1632	International Building Code
UL 508	Industrial Control Equipment
UL 508A	Industrial Control Panels

Reference	Title
UL 60947	Low Voltage Switchgear and Controlgear
King County	Supervisory Process Control System (SPCS) Programming Requirements

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts of all furnished components and equipment.
- C. Fabrication drawings with keyed Bills of Materials. Furnish hard copy as well as electronic format.
- D. Seismic design information required by Section 01 73 00.
- E. Certifications.
- F. Factory test schedule and procedure including all test forms.
- G. Field test schedule and procedure including all test forms.
- H. Test Reports.
- I. Operation and maintenance data per Section 01 78 23. Provide both paper copy and electronic copy of the as-built Control Strategies in the Operation and Maintenance manual.
- J. SPCS Programming submittals per Section 40 68 71.
- K. Elementary Drawings and Loop Diagrams: Electronic format.
- L. Connection Diagrams. Electronic format.
- M. Interconnection Diagrams. Electronic format.
- N. Instrumentation work company qualifications:
 - 1. Company qualifications and experience to meet requirements. Include resume of key individuals providing specified services.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 - 1. The instrumentation work company which constructs and installs the process instrumentation and assist in control system testing shall have the following minimum qualifications:
 - a. A single company regularly engaged in the design and installation of systems of similar scope and complexity. This type of company is also known as a system integration company.
 - b. The systems integration company and its personnel shall have demonstrated a history of successful execution of the work commensurate with the scope of work of this Contract.
 - c. A minimum of three years in the business of providing system integration and instrumentation work.
 - d. Completed the same type of work specified on at least five projects of equal or larger size.
 - e. Has experience with working on plants with Emerson Ovation DCS, Ethernet (Modbus\TCP & Ethernet\IP) and DeviceNet.
 - f. Local support within 50 miles of the work site.

- g. Has an Electrical or Controls Systems engineer currently registered as a professional engineer in the state of Washington to supervise the work.
- B. The on-site Electrical or Control Systems engineer and/or technician shall have a minimum of five years' experience installing wastewater control systems of similar scope and complexity.
- C. Labeling: New and modified electrical control panels shall be in conformance with UL 508A and shall bear the UL label.
- D. Perform detailed design for all interconnected components. Interconnected components shall include new and existing mechanical and electrical equipment specified in other sections of the Contract Documents, as well as new and existing process control system equipment.
- E. Calibrate, configure, test, and start up the complete process instrumentation and control system.
- F. Place the completed system in operation including tuning loops and making final adjustments to instruments and control parameters as required during plant system and Facility start-up.
- G. Provide the services of skilled instrument technicians or engineers for testing, calibration, and adjustment activities under direct on site supervision of the Electrical or Control Systems engineer.

1.05 DEFINITIONS

- A. Unless otherwise specified, the definitions of terminology used in Division 40 shall be as defined in ISA S51.1.
- B. Electronic Format:
 - 1. Drawings shall be provided according to the requirements of Section 01 78 39.
 - 2. Tabular data shall be submitted in electronic format compatible with Microsoft Excel®.
 - 3. Text data shall be submitted in electronic format compatible with Microsoft Word®.
- C. Package System: A vendor-supplied package system is provided by a single equipment vendor who takes unit responsibility for the function and performance of the package system process control and equipment performance as a whole.
- D. Pre-installation Test Phase: Pre-installation Test Phase is defined in Section 01 75 20 and is represented in this Section as the "Factory Test" or "Factory Acceptance Testing".
- E. Supervisory Process Control System (SPCS): The Supervisory Process Control System primary basis is the Emerson Ovation DCS where the Emerson Ovation DCS communicates directly between hardwired field I/O and smart valve actuators, smart instruments, smart motor control centers (MCCs) and smart variable frequency drives (VFDs). The SPCS supports networked communications with vendor-supplied package control systems to monitor and control the vendor supplied package systems. The SPCS is specified in Sections 40 65 01 through 40 65 08 (Control Strategies).

1.06 DESCRIPTION OF SYSTEM

- A. Process Control System consists of the following, installed in accordance to NFPA 70:
 - 1. A Supervisory Process Control System, (SPCS):
 - a. The Emerson Ovation DCS is existing and shall be programmed and factory tested by Emerson Process Management under contract to King County.
 - b. This Contract will supply DCS hardware as required for IO and network communication; and Emerson Ovation DCS hardware and software necessary for interfacing with vendor-supplied package control systems, and other provided Contractor's equipment/instrumentation.

- c. Programming of the Emerson Ovation DCS will be on a separate contract from County with Emerson Process Management. Emerson Process Management will remove all programming associated with the Emerson Ovation DCS IO demolition including graphic cleanup.
 - 2. Hardwired I/O points are required for all control and related feedback signals to and from field devices and third-party controllers. Critical alarm inputs also require hardwired I/O.
 - 3. Ethernet and DeviceNet communication to field devices or third-party controllers may be utilized for input points that provide parameters for improving process visibility and knowledge.
 - 4. Ethernet connections to the Ovation DCS shall only utilize Modbus\TCP, Ethernet\IP or SNMP protocols.
 - 5. Devices that provide power consumption data shall be monitored on the facility's power monitoring network. Connection to the Ovation DCS to these devices for informational data will be via the control system router systems.
 - 6. Hardwired instrument control panel (ICP) and local control panels (LCP) including conventional panel-mounted switches, controllers, and indicators; specific purpose panels, local control panels for individual equipment manual control. Manufactured and including the requirements of UL 508/UL 508A.
 - 7. Conventional and smart field instrumentation including components such as primary elements, analyzers, indicating transmitters, and switches.
 - 8. Final control elements such as conventional and smart valve and gate positioners and solenoids.
- B. The process control system interfaces with existing Emerson Ovation DCS drop panels, new variable frequency drives, existing motor control centers, and other auxiliary equipment and uses both Ethernet and DeviceNet.
- C. Hierarchical Levels:
- 1. A description of how each unit process is controlled within this control hierarchy is shown in the control strategies as described in Section 40 65 01 through Section 40 65 09 and as shown on the Drawings.
 - 2. In all cases, the control system shall be capable of controlling all processes as described in Division 40 and as shown on the Drawings.
 - 3. Generally, the Process Control System Consists of Three Levels of Control:
 - a. The top level is generally fully automatic with the DCS used to control the process.
 - b. The second level is DCS Manual operations.
 - c. The third level is the local control with manual and sometimes automatic control independent of the DCS system.
 - 4. In all cases, equipment shall have, as indicated on the Drawings, Hand-Off-Remote or Local/Remote and Start/Stop local selector switches and pushbuttons independent of the DCS for local hand control and lock-out verification.
- D. Some areas of this Contract may involve classified areas and shall be handled per NFPA 820 and as shown in the Contract Documents.

1.07 EXISTING CONDITIONS

- A. Examine the Contract Document Drawings and Specifications to determine actual locations, sizes, materials and ratings of process connections.
- B. Any drawing indicating existing conditions presented in these Contract Documents are for information only and may not accurately represent existing conditions. Field-investigate all existing facilities modifications to ascertain the exact physical and electrical conditions in each case. After field investigation, revise as required installation and interface wiring drawings to conform to actual conditions and comply with codes and Contract requirements. Submit revisions to the Project Representative. Provide a detailed design and implement the proper method for physical installation and interface wiring for the required modifications.

1.08 DESIGN AND PERFORMANCE REQUIREMENTS

A. Catalog Cuts:

1. Include catalog information, technical specifications, and application information for each piece of equipment to be furnished.
2. Edit catalog cuts to indicate only those items, models, or series of equipment to be furnished. Cross out or otherwise obliterate all extraneous materials information. Clearly identify all configuration options for the equipment to be furnished.
3. Include data sheets in accordance to ISA S20 and a complete listing of all instruments to be furnished or modified, as well as any existing equipment that may be included in the work of this contract.

B. Drawings:

1. The Contract Drawings are functional in nature and do not show exact locations of equipment and may not show all necessary interconnections between equipment.
2. Fabrication drawings:
 - a. Submit detailed interconnection diagrams, wiring diagrams, elementary diagrams, loop diagrams, and process and instrument diagrams with all electrical and electronic components clearly identified by tag number.
 - b. Submit detailed construction drawings for all panel layouts and equipment enclosures with dimensions in inches. Show both exterior and interior views.
 - c. Drawings shall utilize the drawing numbering system, and retain the drawing sequence used in the Contract Documents. If additional drawings need to be added, or the drawing sequence needs to be modified, clearly indicate those changes via the Submittal process.
3. Wiring and loop diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with Divisions 26 and 40 and Section 40 67 00 to permit cross-referencing between contract documents and the drawings prepared by the Contractor.
4. Each control circuit, control loop, control panel layout design, etc., shall be represented on a unique drawing. Control circuits, loop diagrams, and panel layouts referenced to typical diagrams are not acceptable.
5. Drawing symbol format shall comply with NFPA 79, ISA 5.1, ISA 5.3 and where appropriate, ISA RP 12.2.02.
6. Hardcopy plots shall be 11-inch by 17-inch (half-size) or 22 inch by 34 inch (full-size), as required.
7. Minimum Text size: 0.125 inch for 22 x 34 inch drawings, 0.063 inch for 11 x 17 inch drawings.
8. Drawings shall have borders and title blocks identifying the Contract, facility, system, and revisions to the drawing, and type of drawing. Borders and title blocks shall conform to current County drafting standards.
9. Each release of a drawing shall carry a revision number, date, and a brief description of the changes. All changes associated with a given release shall be indicated on the drawing by a revision flag. Changes on the latest revision shall be indicated by clouding.
10. Transfer record drawings per Section 01 78 39 to the County in electronic format on CD and hard copy when work is completed.

C. Elementary and Loop Diagrams:

1. Contract Drawings are functional in nature and may not show the exact wiring needed to achieve the required functions.
2. Provide complete elementary diagrams for equipment control.
3. Prepare loop diagrams in compliance with ISA S5.4 and provide for all analog loops.
4. Comply with NFPA 79.
5. Show circuits and devices of a system.
6. Arrange to emphasize device elements and their functions as an aid to understanding the operation of a system and maintaining or troubleshooting that system.
7. Show wire numbers, signal polarities, and terminal block numbers. Tables for wire numbers, signal polarity, and terminal block numbers are not acceptable.

8. Wiring between circuit elements shall terminate on terminal blocks, and shall not be connected from element to element. Exceptions are: common wires among contacts on a single circuit element (e.g., switch or relay contacts, but NOT the relay coil).
- D. Wiring Diagrams:
1. Panels: comply with NFPA79.
 2. Show components of a control panel in an arrangement similar to the actual layout of the panel.
 3. Show internal wiring between devices within the panel.
 4. Show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such.
 5. Wiring diagrams shall indicate insulation color code, signal polarities, and show wire numbers and terminal block numbers.
- E. Interconnection Diagrams:
1. Submit complete interconnection diagrams for field wiring.
 2. Show each panel and field devices.
 3. Show wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.
 4. Comply with NFPA79.
- F. Certifications:
1. Temperature: Test data certified by the manufacturer to demonstrate that field electronic devices are suitable for the specified ambient temperatures.
 2. Corrosion: Test data showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic equipment has operated in similar environments for a period of not less than five years without failure due to corrosion.
- G. Seismic Design:
1. All seismic anchorage shall be in accordance with the requirements of Section 01 73 00.
 - a. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.
- H. Configuration Records:
1. Configuration parameters shall be saved to electronic media and submitted with the Operation and Maintenance manual.
 2. Configuration parameters shall be saved to electronic media and locally stored at the facility. The location shall be coordinated with the Project Representative.
- I. Control Strategies:
1. Obtain individual Control Strategies in electronic format from King County.
 2. Revise electronic and hardcopy files to match the as-built Control Strategies.

1.09 FACTORY TEST

- A. Instrumentation Work: Provide FAT for panels specified in Section 40 67 00 per Section 40 61 22. Exercise and test all functions to ensure proper manufacture and assembly of the completed panel and/or system.
- B. Prior to factory test to be witnessed by the Project Representative and led by the Test Engineer (per Section 01 75 20), complete the following:
1. Inspect and test the process instrumentation and control system including the main control panel, PLC, local control panels, etc., to ensure they are operational.
 2. Ensure that proper materials have been used during manufacture and assembly and parts and materials have been correctly assembled and wired.

3. Complete an integrated test:
 - a. Interconnect and test the process control and instrumentation system, except for primary elements, final control elements, and small control stations.
 - b. Exercise and test all functions to ensure proper manufacture and assembly of the completed panel and/or system.
 - c. Test all panels.
 - d. Simulate inputs and outputs for primary elements, final control elements, and small control stations excluded from the test.
- C. Location: Test within Washington State.
- D. The Project Representative may elect to witness the factory test. Provide a written test schedule and notify the Project Representative no less than 14 days prior to the test.
- E. The factory test: Test and document the following functions:
 1. Exercise and test all functions, including PLC software functions.
 2. Provide test equipment to simulate discrete and analog inputs and outputs. All I/O shall be exercised.
 3. Provide a testing simulation program to exercise all discrete and analog outputs to confirm proper loop operation.
 4. Provide screens for the Operator Interface Terminal (OIT), if provided, to display and alarm simulated statuses and confirm system response to operator inputs.
 5. Demonstrate that all panels and subsystems have the required spare capacity for expansion. Include test for I/O storage capacity and program memory capacity.
- F. At a minimum, have the following at the test for review and use:
 1. All applicable Drawings, Specifications, Addenda and Change Orders.
 2. Factory test procedure including all test forms.
 3. Shop drawings and hardware submittals for equipment being tested.
 4. Software documentation.
 5. Test Plan and supporting documentation.
- G. Correct deficiencies and retest prior to shipment of the equipment to the work site.
- H. Owner's programmers will be responsible to FAT Emerson Ovation DCS software programming per Section 40 61 22.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Shipping: Section 01 67 00.
 1. Ship as a single unit to work site.
 2. No internal wiring shall be disconnected for transportation.
- B. Delivery Inspection: Notify the Project Representative and provide access for inspection upon arrival of any material or equipment to be incorporated into the work. Remove protective covers when required.
- C. Control Panels:
 1. Completely wired and tested in the factory prior to being shipped to the job site.
 2. Shipped as a single unit to job site after testing is complete.
 3. No internal wiring shall be disconnected for transportation.

1.11 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

- B. Electrical classifications: Section 26 05 00.

1.12 MATERIALS AND QUALITY

- A. The Instrument Schedule in Section 40 06 71 lists major instruments required to provide the process instrumentation system. Provide all functions specified in the Instrument Schedule. Provide additional instruments that may be required to complete the instrument loops because of certain characteristics of the particular equipment selected by the Contractor. Provide such additional instruments even though not specified in the Instrument Schedule or shown on the Drawings.
- B. In some cases, it is possible to combine the functions of two or more instruments specified in the Instrument Schedule into a single instrument. An example of functions that may be ordinarily combined into a single instrument are multiple alarms derived from a common transmission signal. Alarm or safety functions derived directly from process measurements shall not be combined with instruments operating from transmission signals. Critical alarms or safety functions shall not be combined into any instrument used for process control, indication, or recording.
- C. Material shall be new, free from defects, and of the quality specified. Each type of instrument, accessory, and device shall be by the same manufacturer.
- D. Unless otherwise specified, electronic equipment shall be of solid-state construction. Components of standard electronic assemblies shall not be replaced with components of different characteristics in order to meet the performance requirements of the specification. Parts shall be as shown in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
1. The Contractor's on site Electrical or Control Systems engineer shall supervise and coordinate all activities related to requirements of the process instrumentation and controls.
 2. Equipment shall be located and protected so that it is readily accessible for operation and maintenance as required by NFPA 70. Equipment shall be located between 48 and 66 inches above the floor or a permanent work platform.
 3. Provide instrument tags for all field instruments engraved with the equipment number as identified on the Process and Instrument Diagrams and/or the Instrument Schedule Section 40 06 71. Tags shall be stainless steel and affixed to the field equipment with stainless steel screws or stainless steel wire. Engraved text shall be not less than 0.125 inches high.
 4. Use API RP 551 and PR 552 as a guide where installation procedures that are not specified herein.
 5. Coordinate installation with other work to avoid interference with normal operation of on-line equipment and processes.
 6. Provide the services of skilled instrument technicians for testing, calibration, and adjustment activities.
 7. Unless otherwise specified, instrumentation support systems shall be constructed of stainless steel.
 8. Instrument supports shall not be attached to handrails, process piping, or mechanical equipment unless required in order to perform the measurement function.
 9. No instrument shall be mounted directly flush to walls without a minimum of 5/8" spacing.
 10. Anchor and brace equipment per Section 01 73 00.
- B. Signal Transmission:

1. Unless otherwise specified, signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall have a loop compliance of at least 500 ohms.
2. Two-wire loop transmitters shall operate at 24 VDC.
3. Unless otherwise shown, milliamper signals from the field shall be converted to 1 to 5 VDC signals at the field terminal block of each panel. Conversion error shall not exceed 0.1%. All instruments within a panel shall be parallel wired with 1-5 VDC signals.
4. Loops shall be grounded at the field terminal block by bonding to the instrument panel signal ground bus. Separate grounded conductors shall be provided for each loop. Daisy chaining of grounded conductors from one loop to another is not allowed.
5. Provide isolating amplifiers for field equipment possessing a grounded input or output, or having a common mode voltage other than system ground.
6. Convert high frequency (greater than 50 Hz) pulse rate signals from field transmitters to analog 1- 5 VDC signals at the panel.
7. Convert platinum resistance temperature detector (RTD) outputs to 4-20 milliamper signals at the RTD, or where shown on the Drawings. The temperature milliamper signal may be brought from the field to the panel and converted to a 1-5 Volt DC signal.
8. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the Instrument Schedule, Section 40 06 71. When transmitters with non-standard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.
9. Equipment located in classified areas shall be explosion-proof or intrinsically safe. Provide intrinsic safety barriers approved by UL, CSA, or FM.

3.02 TESTS AND INSPECTIONS

- A. General Requirements:
 1. Meet Section 01 75 20 requirements.
 2. All required test stages beginning with the Factory Test, will be witnessed by the Project Representative and/or County-designated person unless a written exemption is provided.
 3. Notify the Project Representative of the test date 14 days prior to the test.
 4. Submit a detailed step-by-step test procedure, complete with forms for the recording of test results, testing equipment used, and identification of the technician performing and witnessing the test.
- B. Test reports: Conform to the requirements of Forms below per Section 01 33 00 and ISA S20.
- C. Test Equipment:
 1. Unless specified otherwise, provide all test equipment to complete all specified tests.
 2. Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test.
 3. Each test instrument shall be calibrated prior to the commencement of a testing activity and checked after the completion of a testing activity.
 4. Submit dated and certified calibration reports traceable to the National Institute of Standards and Technology (NIST) with the test report. Calibration certification date shall be within three months of date of use on this Contract.
 5. Provide buffer solutions and reference fluids for tests of analytical equipment.
- D. Test Stages:
 1. General:
 - a. Test each instrument loop in the following sequence:

Form	Testing Sequence
40 61 13 - A	Loop wiring and insulation resistance test data form
40 61 13 - B	Control circuit piping/tubing leak test data form
40 61 13 - C	Controller calibration test data form
40 61 13 - D	Panel indicator calibration test data form

Form	Testing Sequence
40 61 13 - E	Recorder calibration test data form
40 61 13 - F	Signal trip calibration test data form
40 61 13 - G	Field switch calibration test data form
40 61 13 - H	Transmitter calibration test data form
40 61 13 - I	Misc. instrument calibration test data form
40 61 13 - J	Individual loop test data form
40 61 13 - K	Loop commissioning test data form

2. Testing of piping, wiring, and individual components shall be completed with certified test reports completed, which shall be provided to the Project Representative prior to commencement of individual loop testing.
3. Un-witnessed factory test: It shall be performed by the Contractor prior to the County witnessed Factory Test. Refer to the Factory Test paragraph in this Section.
4. Factory test: Refer to the Factory Test paragraph in this Section.
5. Component Test- Individual component calibration and test:
 - a. Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test form.
 - b. This test is to be witnessed by the Project Representative.
 - c. Alarm trips, control trips, and switches shall be set to initial values specified in the Instrument Schedule in Section 40 06 71.
 - d. Final elements shall be checked for range, dead-band, and speed of response.
 - e. Any component that fails to meet the required tolerances shall be repaired by the manufacturer or replaced.
 - f. Repeat above tests until the component is within tolerance.
6. Component Test- loop test:
 - a. Test each instrument loop as an integrated system. This test shall check operation from transmitter to signal receiving components, and from the main control panel to final control elements. This test is to be witnessed by the Project Representative.
 - b. Inject signals at the field terminations to simulate primary measuring elements.
 - c. Output of each auto/manual station shall be manually varied from 0 to 100 percent, and correct operation of final control element verified.
 - d. Each alarm circuit shall be manually actuated at the field sensor.
 - e. Where alarm contact is connected to the Emerson Ovation DCS, work with Owner to verify the response of the alarm matches the Emerson Ovation DCS programming.
7. System Test- closed-loop test:
 - a. Meet Section 40 61 22 requirements.
 - b. Coordinate with the Project Representative for the requirements of these tests.
 - c. Test shall assist the Emerson Ovation DCS programming to demonstrate stable operation of the loop under actual Facility operating conditions. This test includes allowing the Emerson Ovation DCS programming to adjust loop tuning parameters and shall be witnessed by the Project Representative.
 - d. Emerson Ovation DCS programming goal will be to adjust tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop to provide ¼-amplitude damping or better.
8. Operational Test- SPCS system test:
 - a. Coordinate with the Project Representative for the requirements of these tests.
 - b. Test as closed automated system with the Emerson Ovation DCS programming per Sections 40 65 01 through 40 65 08.
 - c. Provide the services of a qualified technician for at least 120 labor-hours to assist in this test.
 - d. Check that the equipment is functioning correctly and as specified.

END OF SECTION

SECTION 40 61 22

SPCS TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. All work associated with the Supervisory Process Control System (SPCS) which includes Emerson Ovation DCS, the equipment interconnecting to Emerson Ovation DCS (package systems, MCCs, VFDs, motorized actuators, and instrumentation along with auxiliary systems (includes instrument air)) shall be tested in accordance with the requirements of this Section.
- B. The Contractor shall coordinate with the Project Representative and/or County-designated person for Owner's programmers (also known as Emerson Management Services) to demonstrate that SPCS was fully tested with new and modified DCS programming for physical connections to primary and secondary control elements and is a functioning, integrated, reliable, control system before final payments are released.
- C. The basic testing requirements shall require a comprehensive series of Contractor conducted tests witnessed and signed off by King County.
- D. Provide tests for all equipment and Emerson Ovation DCS programming coordination. If equipment or Emerson Ovation DCS programming coordination does not have specific tests defined in the contract, then the Contractor shall develop testing procedures. Test all Emerson Ovation DCS programming and all equipment related to the SPCS.

1.02 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Test Schedules: Per this Section and Section 01 75 20
- C. Test Plans: Per this Section and Section 01 75 20
- D. Test Reports: Per this Section and Section 01 75 20

1.03 QUALITY ASSURANCE

- A. Coordination: Contractor shall be responsible for all equipment related test schedules, plans and reports. The Owner's programmer shall be responsible for the DCS programming test schedules, plans and reports. Contractor shall coordinate with the Project Representative and/or County-designated person for Owner's programmers to ensure the DCS programming is present at each field test phase (component, system, and operational) for both temporary and permanent service and is fully tested to represent the Division 40 control strategies.

1.04 DOCUMENTATION

- A. Provide complete documentation of all test plans.

PART 2 PRODUCTS

2.01 TEST SCHEDULES, PLANS, AND REPORTS

- A. Prepare and submit for review and approval:
 - 1. Test Plan per Section 40 61 13 and Section 01 75 20.
 - 2. Test Schedules
 - 3. Test Reports
 - 4. SPCS coordination documentation for Emerson Ovation DCS programming . The Contractor shall coordinate with the Project Representative and/or County-designated person for the Owner's programmers to demonstrate that SPCS is fully tested with new and modified Emerson Ovation DCS programming for new and demolished physical connections to primary and secondary control elements and is a functioning, integrated, reliable, control system before final payments are released.
- B. Prepare and document a test plan. The test procedures shall be a formal submittal delivered to King County for review and approval before the start of the testing.
- C. Structure the test procedures in a step-by-step, building block manner with checkpoints at critical functions. The procedures shall facilitate the reporting of test results and the re-creation of error conditions.
- D. Test data sheets (forms) shall be used to record applicable drawing numbers, test equipment, discrepancies, corrective action(s) required, and test data. Data entries shall be referenced to the applicable procedures and allowable limits for each entry shall be indicated on the data sheets.
- E. Develop, maintain, and update Test Reports of all test results and conditions that were recorded during the course of the testing. The test results shall include:
 - 1. Identification of test being conducted
 - 2. Date and time of test; Tester name, Witness name
 - 3. Prerequisite tests and demonstrations
 - 4. Brief statement of test objective(s) and scope
 - 5. Brief test description
 - 6. List of test and monitoring equipment required to perform test
 - 7. Test results
 - 8. List of test deficiencies and their resolutions
 - 9. Retesting requirements (if required)
 - 10. Failure events
 - 11. Contractor's certification (as applicable).

PART 3 EXECUTION

3.01 FACTORY ACCEPTANCE TESTING

- A. Contractor to provide Section 40 67 00 panel fabrication assembly factory acceptance testing (FAT) for quality assurance prior to delivering for site installation. FAT per Section 40 61 13 and this Section includes:
 - 1. Test plan and test forms.
 - a. Test plan covering the steps in implementing the FAT for quality assurance. Develop test forms in a check-off format following the test plan along with identifying/recording any deficiencies and the solutions implemented to correct the deficiencies. Provide each panel fabrication assembly with its own test form. Each form to also include the tester and signoff by the tester that FAT was successfully performed.
 - 2. Test form check-off at minimum to include:
 - a. Physical inspection to ensure no physical damage to the panel or components.

- b. Panel has nameplate, all panel components are clearly labelled, and UL and NEC assembly labels are present. All nameplates and labels matching and identified on shop drawings.
 - c. Panel interior wiring color coded per UL and labelled. All wiring matching and identified on shop drawings.
 - d. Panel grounding is properly installed and wired.
 - e. All panel components are installed secure and plumb.
 - f. All electrical components are tested to ensure functioning/operational when power applied.
 - g. Shop drawings match the actual fabrication materials, layout, and wiring.
 - 3. Owner and/or Project Representative have option to be present for FAT and Contractor shall provide at least 14 day notification prior to testing. Test within 50 mile radius of West Point Treatment Plant with a virtual option to witness.
 - 4. Correct deficiencies and retest prior to shipment of the panels to the work site.
 - 5. Submit completed and compiled test/re-test forms as the FAT test reports for quality assurance prior to delivering for site installation.
- B. FAT for Emerson Ovation DCS programming shall be performed by the Owner's programmers (Emerson Management Services) and is included for Contractor's reference and construction schedule coordination. Emerson Management Services to provide for Ovation a virtual method to demonstrate new and modified logic to meet Section 40 65 01 through 40 65 08. The method can be through a virtual private network (VPN) simulation station that allows a witness to see a simulated operation along with operator interaction for controlling the processes. There can be no interference with the existing automation on the live system during the FAT. FAT shall be in phases per Section 40 68 71 and shall be included as part of Section 01 75 20's pre-installation test phase.

3.02 FIELD TESTING

- A. Field testing is composed of three (3) test phases per Section 01 75 20 which are identified as Site Acceptance Testing in Sections 40 61 13, 40 68 71 and 40 65 01. Each phase to be represented in the test plan as its own section.
- 1. Component test phase.
 - 2. System test phase.
 - 3. Operational test phase.
- B. Demonstrate the following as part of Section 01 75 20's component test phase:
- 1. Conformance with Section 40 61 13 and system configuration drawings.
 - 2. Proper connection and labeling of field wiring for Inputs and Outputs.
 - 3. Analog Inputs: Calibrated monitoring of all analog inputs.
 - 4. Control Outputs: Exercise each facility system component connected to Emerson Ovation DCS control outputs (valve, motor, etc.) and demonstrate SPCS or manual control and correct status indication on the plant's workstations.
 - 5. Status Inputs: Exercise each individual facility system component connected to Emerson Ovation DCS (motors, valves, etc.) and demonstrate correct status indication on the plant's workstations.
 - 6. Alarm Inputs: Exercise each alarm input to Emerson Ovation DCS from the field device and demonstrate correct indication on the plant's workstations.
 - 7. Computed Alarms: Demonstrate computed alarms in Emerson Ovation DCS and allow Owner's programmers to correct indication on the plant's workstations.
 - 8. Communications Test: Connect equipment interconnecting to Emerson Ovation DCS (package systems, MCCs, VFDs, actuators, and instrumentation) via specified protocol (Ethernet and DeviceNet) to Emerson Ovation DCS panels installed at the Treatment Plant.
 - a. Demonstrate the following:
 - 1) Proper communications to the Emerson Ovation DCS.
 - 2) Accurate bi-directional data transfer of all required analog and discrete signals between the package system, smart VFDs, smart instrumentation, and smart actuators and the Emerson Ovation DCS.
 - 3) Communications failure and recovery include loss of power and equipment interconnecting to Emerson Ovation DCS turned off.

4) Test duration shall be a minimum of three 24-hour days.

- C. Demonstrate the SPCS automatic control described in Sections 40 65 01 through 40 65 08 as part of Section 01 75 20's system/operational test phases and Section 40 61 13 requirements.
 - 1. Because the Emerson Ovation DCS drops are existing and active with existing DCS programming, coordination of transitioning new equipment/ instrumentation shall be closely provided with Emerson Ovation DCS programming which shall include interim equipment networking and interim DCS logic during construction as specified for construction restrictions per Section 01 14 00.
 - 2. Where simulation or use of dummy inputs and outputs is the best method to confirm Ovation logic, include details in the test plan.

3.03 COMMISSIONING

- A. Requirements: Section 01 75 20.

END OF SECTION

SECTION 40 63 53

POWER SUPPLY AND CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for power supply and conditioning equipment required to support the instrumentation and communication systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 70	National Electrical Code (NEC)
UL 1012	Power Units other than Class 2
UL 1283	Electromagnetic Interference Filters
UL 1449	Transient Voltage Surge Suppressors

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Dimensional Drawings.
- C. Catalog Cuts including performance parameters.
- D. Installation Information.
- E. Wiring Diagrams.
- F. Operations and maintenance information per Section 01 78 23.

1.04 QUALITY ASSURANCE

- A. Labeling: Power supply equipment shall bear a UL or other label acceptable to the inspection authority having jurisdiction for the specified application.

1.05 PLANT ELECTRICAL SUPPLY SYSTEM

- A. Electric power for instrumentation and communication systems shall be obtained from the power distribution system specified in Divisions 26. This power is not regulated, waveforms may be distorted, and significant amounts of electrical noise may be present.
- B. Unless otherwise specified, provide all necessary power supply and conditioning equipment for all required voltages and current capacities and of adequate quality to ensure reliable operation of the instrumentation and communication systems.

- C. Unless otherwise specified, assume that the power supply for instrumentation systems is 120 volts plus or minus 15 percent, 60 hertz plus or minus 3 hertz, and 5 percent harmonic distortion.

PART 2 PRODUCTS

2.01 GENERAL

- A. Except for power supply units that form an integral part of an individual piece of equipment.
 - 1. Comply with UL 1012.
 - 2. Approved by UL, CSA, or FM for the application.
- B. Power supply equipment serving multiple instrument loops shall be provided in hot-standby configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems.
- C. Provide diode isolation for redundant direct current supply units.
- D. Connect the DC power supply negative output terminal to the signal ground bus at a single point.

2.02 DIRECT-CURRENT POWER SUPPLIES

- A. DC Power Supply:
 - 1. UL labeled, regulated switching power supply with the following features:
 - 2. Barrier block terminals for all wiring connections.
 - 3. Input voltage: 90-264 VAC, 47-63 Hz.
 - 4. 24 VDC output voltage with accessible adjustment for a minimum of plus or minus 2.0 volts, 125 VDC output voltage where applicable.
 - 5. Input voltage internally fused.
 - 6. Line regulation: Shall not exceed plus or minus 0.5 percent for line voltage variation from 105 to 125 volts.
 - 7. Load Regulation: Shall not exceed plus or minus 1.5 percent for load variation from zero to full load.
 - 8. Noise and ripple: Shall not exceed 200 mV p-p, including switching noise.
 - 9. Minimum efficiency: 80%
 - 10. Electronic current limiting: 105-110% of full load, with automatic recovery.
 - 11. DC OK relay contact, opens when output voltage exceeds minus 10% of adjusted output voltage.
 - 12. DC OK indicator LED.
 - 13. Enclosure: Fully enclosed and suitable for mounting on DIN rail.
 - 14. Output current capacity shall be as specified on the contract drawings, derated to 60° C to 70° C.
 - 15. Acceptable manufacturers:
 - a. Allen Bradley 1606 Series (for 24VDC applications)
 - b. SolaHD SDN-P Series (for 24VDC applications)
 - c. PULS Q-Series (for 24VDC applications)
 - d. Acopian Modular (for 125VDC applications)
 - e. Approved Equal.
- B. Dual Redundancy Module
 - 1. UL listed, redundancy module for 1+1 and N+1 redundant DC power systems
 - 2. Diode isolation on the output
 - 3. Output capacity derated >50° C
 - 4. Input voltage alarm when either voltage input <18V; relay contacts rated <30V maximum
 - 5. LED indication of each voltage input status
 - 6. Acceptable manufacturers:
 - a. Allen Bradley 1606 Series redundancy module (for 24VDC applications)
 - b. SolaHD (for 24VDC applications)
 - c. PULS YRM (for 24VDC applications)

- d. Acopian Wall Mount Rendant Power systems (for 125VDC applications)
- e. Approved Equal.

2.03 SURGE PROTECTION

- A. For protection against line generated transients for both normal and common mode protection.
- B. The unit shall be a non-degrading, solid state, series low pass filter with transient protection having the following features:
 - 1. UL compliant for UL categories 1283 and 1449.
 - 2. Input voltage: 120 VAC single-phase, 47-63 hertz.
 - 3. Load current: 20 amperes minimum.
 - 4. MCOV: 200V
 - 5. Surge capacity: Line-neutral, line-ground, neutral-ground (8 x 20 usec): 15,000 Amps min.
 - 6. Response time: <1 nsec normal mode.
 - 7. HF noise suppression: BW: 10kHz – 50 mhz; Attenuation (normal mode): -75 dB at 100 kHz min.
 - 8. Transient suppression (per IEEE C62.41):
 - a. Category A Ringwave (6kV, 200A, 100KHz): Normal mode: 6V
 - b. Category B Ringwave (6kV, 500A, 100KHz): Normal mode: <200V
 - 9. Mounting: DIN rail with barrier type terminal blocks for line and load hard-wired connections.
 - 10. Operating temperature: -40° C to +45° C.
 - 11. Acceptable manufacturer:
 - a. Emerson Power Islatrol IE-120
 - b. Eaton/Cutler Hammer AEGIS-HW
 - c. Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount and connect in compliance with the manufacturer's instructions.
- B. Provide line side disconnect switches per Section 26 09 16.
- C. Provide line and load side overcurrent protection in compliance with NFPA 70.
- D. Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served.
- E. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.
- F. When larger than 5 KVA load capacity supported from surfaces other than concrete provide with sound isolators.
- G. Final raceway connections shall be a flexible conduit in compliance with Section 26 05 33.
- H. When not designed for exposed mounting, house in panels per Section 40 67 00.

END OF SECTION

SECTION 40 65 01
CONTROL STRATEGY
CS704-01 RAW SEWAGE PUMPING

PART 1 GENERAL

1.01 SUMMARY

- A. The raw sewage pumping (RSP) system has four vertical centrifugal pumps each with a range of 35 MGD to 147 MGD. The raw sewage pumping system operates the four pumps together to provide lift of incoming raw sewage from the discharge of raw sewage screening to the division channel, an elevation increase of 18 to 23 feet depending on the raw sewage wet well level. The pumps vary their flow rate to maintain an operator desired level in the raw sewage wet well.

1.02 REFERENCES

- A. P&IDs:
 - 1. WP704-P-60001, WP704-P-60002, WP704-P-60011, WP704-P-60012, WP704-P-60013 & WP704-P-60014.
- B. Related Control Strategies: CS704-90 Power Monitoring.
- C. Instrument Loop Diagrams:
 - 1. Loop Sheet List table.
- D. Instrument Schedule: See Section 40 06 71 Instrument Schedule
- E. Alarm Schedule: See Section 40 06 72 Alarm Schedule
- F. Ovation DCS I/O Schedule: See Section 40 06 73 Ovation DCS I/O Schedule

1.03 SYSTEM DESCRIPTION

This strategy describes the control of raw sewage pumping. There are four variable speed, 900-hp, non-clog centrifugal pumps that pump raw sewage from the wet well up to the division channel where it is split by gravity between the 4 pre-aeration tanks. Each RSP discharges through a passive anti-backflow device called a "morning glory weir" that prevents flow from the division channel from flowing back into the RSPs when they are out of service.

The RSPs are motor-driven pumps with an intermediate drive shaft. Variable frequency drives (VFD) convert the alternating current (AC) sinewave frequency from the supplied 60 hertz to a variable frequency that causes the motor to spin at the desired speed.

In case of a power outage or brown-out there are uninterruptable power supplies (UPS) designed to maintain power to the pump's VFDs long enough to perform controlled shutdowns.

Four bubble tube level measurement systems are located in the raw sewage wet well to measure level at each pump intake. The measured levels are used as process variables to control the RS pumps as well as to determine the differential level across the bar screens. The four level signals are inputs to the Distributed Control System (DCS) via the screenings controller (see CS 704-10). A 4-position switch in ACC-1 is used by the operators to select which level signal is used as the process variable for level control. The output from the level controller is sent as an analog output to each RSP VFD to control pump speed.

A LOW pressure switch is located on each of the 4 bubblers in the RSP wet well. These pressure switches are calibrated to actuate at 98.2 ft to alert the operators of a low wet well condition. If any of the LOW level switches are triggered, an alarm signal is input to the DCS by local relay logic.

A LOW-LOW pressure switch is located on each of the 4 bubblers in the RSP wet well. These pressure switches are calibrated to actuate at 96.2 ft level to alert the operators of a low-low wet well condition. To prevent the pumps from draining the wet well below levels that could cause pump damage, when any of the LOW-LOW level switches is triggered, the associated RSP is shut down by hardwired relay logic, unless the SHUTDOWN function is disabled by the ENABLE/DISABLE switch located at panel 704-ACP0301.

Two HIGH level float switches are installed at each end of the common wet well channel. These two float switches are used to alert the operators of high wet well levels via a common input to the DCS.

Two HIGH-HIGH level float switches set at 110.2 ft are installed at each end of the common wet well channel. These two float switches are used to alert the operators of high-high wet well levels via a common input to the DCS. They are also used by local hardwired relay logic to close the influent gates to prevent flooding of the screen room.

There is also a HIGH level float switch and a HIGH-HIGH level float switch installed in each of the four pre-aeration tanks. If any of the HIGH level switches are triggered, a high level alarm will be generated by the DCS. If both of the west pre-aeration tanks HIGH-HIGH level switches or both the east pre-aeration tanks HIGH-HIGH level switches are activated, all four raw sewage pumps are shutdown, by hardwired interlocks.

Pump ON and FAIL status is monitored by the DCS for each pump. The pump speed for each pump is registered at the DCS as a feedback.

The RSP pump speeds are normally controlled automatically by the DCS Raw Sewage Wet Well level controller. Each RSP has its own field panel which includes its adjustable speed drive. These drives are normally controlled by the level controller, which control the RSPs according to level measurements taken by the bubbler panel in the raw sewage wet well. The raw sewage wet well level is indicated locally at the east and west bubbler panels and the associated wet well level is repeated to local bar style displays located on each of the pump remote I/O panels.

Each RSP can be controlled manually from the pump VFD panel by using the LOCAL/REMOTE selector; however, this should not be done except in the event of a complete breakdown of the DCS speed control systems.

1.04 EQUIPMENT

A. The following equipment is monitored/controlled as part of this strategy:

Equipment No.	Equipment Name/Description	Status
704-LIT03DA011	RAW SEWAGE PUMP 1 WET WELL LEVEL TRANSMITTER	EXISTING
704-LIT03DA021	RAW SEWAGE PUMP 2 WET WELL LEVEL TRANSMITTER	EXISTING
704-LIT03DA031	RAW SEWAGE PUMP 3 WET WELL LEVEL TRANSMITTER	EXISTING
704-LIT03DA041	RAW SEWAGE PUMP 4 WET WELL LEVEL TRANSMITTER	EXISTING
704-P03DC011	RAW SEWAGE PUMP 1	NEW
704-P03DC021	RAW SEWAGE PUMP 2	NEW
704-P03DC031	RAW SEWAGE PUMP 3	NEW
704-P03DC041	RAW SEWAGE PUMP 4	NEW
704-UPS03DC011	RAW SEWAGE PUMP 1 MOTOR UPS	NEW
704-UPS03DC021	RAW SEWAGE PUMP 2 MOTOR UPS	NEW
704-UPS03DC031	RAW SEWAGE PUMP 3 MOTOR UPS	NEW
704-UPS03DC041	RAW SEWAGE PUMP 4 MOTOR UPS	NEW
704-VFD03DC011	RAW SEWAGE PUMP 1 MOTOR VFD	NEW
704-VFD03DC021	RAW SEWAGE PUMP 2 MOTOR VFD	NEW
704-VFD03DC031	RAW SEWAGE PUMP 3 MOTOR VFD	NEW

Equipment No.	Equipment Name/Description	Status
704-VFD03DC041	RAW SEWAGE PUMP 4 MOTOR VFD	NEW
704-MTR03DC011	RAW SEWAGE PUMP 1 MOTOR	NEW
704-MTR03DC021	RAW SEWAGE PUMP 2 MOTOR	NEW
704-MTR03DC031	RAW SEWAGE PUMP 3 MOTOR	NEW
704-MTR03DC041	RAW SEWAGE PUMP 4 MOTOR	NEW
704-PDIT03DC011	RAW SEWAGE PUMP 1 DIFFERENTIAL PRESSURE	NEW
704-PDIT03DC021	RAW SEWAGE PUMP 2 DIFFERENTIAL PRESSURE	NEW
704-PDIT03DC031	RAW SEWAGE PUMP 3 DIFFERENTIAL PRESSURE	NEW
704-PDIT03DC041	RAW SEWAGE PUMP 4 DIFFERENTIAL PRESSURE	NEW
704-LSLL03ED011	RAW SEWAGE WET WELL LEVEL WEST LOW-LOW LEVEL SWITCH 1	EXISTING
704-LSLL03ED012	RAW SEWAGE WET WELL LEVEL WEST LOW-LOW LEVEL SWITCH 2	EXISTING
704-LSLL03ED013	RAW SEWAGE WET WELL LEVEL EAST LOW-LOW LEVEL SWITCH 3	EXISTING
704-LSLL03ED014	RAW SEWAGE WET WELL LEVEL EAST LOW-LOW LEVEL SWITCH 4	EXISTING
704-LSL03EE011	RAW SEWAGE WET WELL LOW LEVEL WEST LEVEL SWITCH 1	EXISTING
704-LSL03EE012	RAW SEWAGE WET WELL LOW LEVEL WEST LEVEL SWITCH 2	EXISTING
704-LSL03EE013	RAW SEWAGE WET WELL LOW LEVEL EAST LEVEL SWITCH 3	EXISTING
704-LSL03EE014	RAW SEWAGE WET WELL LOW LEVEL EAST LEVEL SWITCH 4	EXISTING
704-LSH03DB011	RAW SEWAGE WET WELL WEST HIGH LEVEL SWITCH	EXISTING
704-LSHH03DF011	RAW SEWAGE WET WELL WEST HIGH-HIGH LEVEL SWITCH	EXISTING
704-LSHHH03PB011	RAW SEWAGE WET WELL WEST HIGH-HIGH-HIGH (FRRS) LEVEL SWITCH 1	EXISTING
704-LSHHH03PB012	RAW SEWAGE WET WELL WEST HIGH-HIGH-HIGH (FRRS) LEVEL SWITCH 2	EXISTING
704-LSHHH03PB013	RAW SEWAGE WET WELL WEST HIGH-HIGH-HIGH (FRRS) LEVEL SWITCH 3	EXISTING
704-LSH03DB012	RAW SEWAGE WET WELL EAST HIGH LEVEL SWITCH	EXISTING
704-LSHH03DF012	RAW SEWAGE WET WELL EAST HIGH-HIGH LEVEL SWITCH	EXISTING
704-LSHHH03PC011	RAW SEWAGE WET WELL EAST HIGH-HIGH-HIGH (FRRS) LEVEL SWITCH 1	EXISTING
704-LSHHH03PC012	RAW SEWAGE WET WELL EAST HIGH-HIGH-HIGH (FRRS) LEVEL SWITCH 2	EXISTING
704-LSHHH03PC013	RAW SEWAGE WET WELL EAST HIGH-HIGH-HIGH (FRRS) LEVEL SWITCH 3	EXISTING
706-LSH05AP011	NORTHWEST PRE-AERATION TANK HIGH LEVEL FLOAT SWITCH	EXISTING
706-LSH05AP012	SOUTHWEST PRE-AERATION TANK HIGH LEVEL FLOAT SWITCH	EXISTING
706-LSH05AP013	NORTHEAST PRE-AERATION TANK HIGH LEVEL FLOAT SWITCH	EXISTING

Equipment No.	Equipment Name/Description	Status
706-LSH05AP014	SOUTHEAST PRE-AERATION TANK HIGH LEVEL FLOAT SWITCH	EXISTING
706-LSHH05AQ011	NORTHWEST PRE-AERATION TANK HIGH HIGH LEVEL FLOAT SWITCH	EXISTING
706-LSHH05AQ012	SOUTHWEST PRE-AERATION TANK HIGH HIGH LEVEL FLOAT SWITCH	EXISTING
706-LSHH05AQ013	NORTHEAST PRE-AERATION TANK HIGH HIGH LEVEL FLOAT SWITCH	EXISTING
706-LSHH05AQ014	SOUTHEAST PRE-AERATION TANK HIGH HIGH LEVEL FLOAT SWITCH	EXISTING

1.05 ALARMS

- A. Alarm Schedule:
 1. Refer to Section 40 06 72 for process alarms.
- B. Differential Wet Well Level calculations
 1. Calculate the average Wet Well level.
 2. Calculate the differential Wet Well levels:
 - a. Wet Well #1 minus average Wet Well Level.
 - b. Wet Well #2 minus average Wet Well Level.
 - c. Wet Well #3 minus average Wet Well Level.
 - d. Wet Well #3 minus average Wet Well Level.
 3. Compare to operator entered alarm setpoint.
 - a. Create alarm if differential is greater than operator entered alarm setpoint.

1.06 INTERLOCKS

- A. The Raw Sewage Pump will decelerate (ramp down) and shut down at varying rates depending on whether the pump stop command is initiated by an Operator under normal conditions, an E-Stop or the activation of an interlock. The different Raw Sewage Pump VFD Ramp Rates are described below:
 1. NORMAL
 - a. Ramp rates can be configured in Ovation DCS, operator adjustable within allowed ranges.
 - b. NORMAL ramp rates are not used by interlocks.
 - c. Equipment ramp down rate will not exceed the RAPID RAMP DOWN rate. The Ovation DCS configurable NORMAL ramp rate will not override the RAPID RAMP DOWN rate configured within the VFD.
 2. RAPID RAMP DOWN
 - a. The VFD internal deceleration ramp rate is a programmed parameter within the VFD.
 - b. Set value limits VFD ramp rate for all setpoint changes and is the deceleration rate when the VFD is issued a ramp stop command.
 - c. The value of the pump VFD internal deceleration ramp rate is not to exceed a maximum rate that would cause equipment or system damage. This maximum allowed rate will be determined during construction and commissioning based on installed equipment and as-built system characteristics. This rate is configurable and adjustable within the VFD parameters and may be altered as required.
 3. COAST TO STOP
 - a. No ramp action, stop as quickly as possible.
 - b. Activated for certain Interlocks which bypass the RAPID RAMP DOWN rate parameter.
 - c. A single pump coasting to stop from full speed to stopped will not cause the system to go beyond the simulated hydraulic limitations. A machine protection interlock, as assumed to be only one pump at any given event, is allowed to initiate a coast to stop command.

- d. Coast stops are not to be used other than for E-Stops and Equipment Protection interlocks since this will result in an uncontrolled stopping of the pump. If all pumps coast to stop at once, this potentially will cause hydraulic transients and damage to system. Only in emergency situations should all pumps coast to stop.
- B. Raw Sewage Wet Well Low Level:
- 1. This is a hardwired interlock.
 - 2. Low level float switches send a shutdown signal to their respective pump VFD:
 - a. 704-LSLL03ED011 shuts down Pump 1.
 - b. 704-LSLL03ED012 shuts down Pump 2.
 - c. 704-LSLL03ED013 shuts down Pump 3.
 - d. 704-LSLL03ED014 shuts down Pump 4.
 - 3. Each pump has a low-level shutdown bypass to allow operations to drain the wet well.
 - 4. RAPID RAMP DOWN rates are implemented during a Wet Well Low Level interlock.
- C. Equipment Protection:
- 1. These interlocks are provided by the pump's Ovation controller and remote I/O. The relay output for Interlock Stop is interfaced with the VFD hardwire circuits.
 - 2. High-High Vibration sensed at the following locations will send a shutdown signal to their respective pump VFD:
 - a. Pump Lower Bearing X or Y direction.
 - b. Pump Bearing X, Y or Z direction.
 - c. Motor Drive End Bearing X or Y direction.
 - d. Motor Non-Drive End Bearing X, Y or Z direction.
 - 3. High-High Temperature sensed at the following locations will send a shutdown signal to their respective pump VFD:
 - a. Pump Lower Bearing.
 - b. Pump Upper Bearing.
 - c. Motor Drive End Bearing.
 - d. Motor Non-Drive End Bearing.
 - e. Motor A-Phase Winding.
 - f. Motor B-Phase Winding.
 - g. Motor C-Phase Winding.
 - 4. COAST TO STOP rates are implemented during an Equipment Protection interlock.
- D. Power Loss to Pump UPS:
- 1. This interlock is provided by the pump's Ovation controller and remote I/O. The relay output for Interlock Stop is interfaced with the VFD hardwire circuits.
 - 2. The pump's UPS status On-Battery is ON for greater than 20 seconds will trigger the pump to stop.
 - 3. The pump's UPS status On-Static Bypass is ON will trigger the pump to stop.
 - 4. RAPID RAMP DOWN rates are implemented during a power outage. After power outage occurs and pumps have been running on UPS power, they will begin the RAPID RAMP to stop.
- E. Power Quality System:
- 1. This interlock is provided by the pump's Ovation controller and remote I/O. The relay output for Interlock Stop is interfaced with the VFD hardwire circuits.
 - 2. When the Power Quality System shuts down all of the IPS and EPS Pumps, all raw sewage pumps are stopped. See Section 1.07 B for details.
 - 3. RAPID RAMP DOWN rates are implemented during a Power Quality interlock.
- F. Pre-Aeration High-High Level:
- 1. This is a hardwired interlock.
 - 2. Combination of High-High level switches at the Primary Sedimentation Pre-Aeration Tanks will send a shutdown signal to all raw sewage pump VFDs.
 - 3. RAPID RAMP DOWN rates are implemented during a Pre-Aeration High-High interlock.

- G. Flood Risk Reduction System (FRRS) Trip:
1. This is a hardwired interlock.
 2. If any of the FRRS monitored tanks detect a High-High-High level condition the FRRS system will trip first opening the Emergency Bypass and Emergency Marine Outfall gates then after a time delay, sends a safety shutdown signal to the pump VFDs. The monitored tanks are:
 - a. Influent Structure
 - b. Raw Sewage Pump West and East Wet wells
 - c. Primary Sedimentation West and East Effluent Channels
 - d. Effluent Pump Station Wet well
 3. RAPID RAMP DOWN rates are implemented during a FRRS interlock.

1.07 CONTROL OPERATION

- A. Local Operation:
1. Location of local control:
 - a. For each pump controls are located in ACC1 on 704-LCP0301.
 2. Local Indications:
 - a. Running Light.
 - b. VFD Remote Display for Speed and Status indication.
 3. Local Controls:
 - a. When the LOCAL/REMOTE Switch is in LOCAL the following functions are available.
 - b. START.
 - c. STOP.
 - d. SPEED POT for speed command adjustment.
 4. VFD internal ramp rate limits will be in effect to limit the rate of change of pump speed.
 5. All interlocks described in this Section are in effect.
- B. Power Quality Facility Rapid Stop (RAPID RAMP DOWN):
1. Power Quality Facility Rapid Stop takes precedence over all other run and stop commands.
 2. The rapid stop trip points reset when all pumps are stopped, allowing operators to restart systems as soon as conditions allow.
 3. Normal ramp rates for stopping pumps are saved in permanent locations.
 4. Rapid ramp rates for stopping pumps are saved in permanent locations.
 5. Rapid ramp rate for stopping pumps to be set as to not exceed system hydraulic limits to be determined and verified during construction and commissioning. Ramp rates must also stop pumps during a power outage scenario to allow for full redundancy and allowance for carry-over delay for each power loss event that the UPS is sized for.
 6. Control strategy CS727-03 Power Quality Rapid Shutdown will activate digital points that indicate power is lost and the pumps must be ramped down to stopped as rapidly as practicable without risking damage to the equipment.
 7. When Point WP-72703-ASIDERAPIDSTOPTRIP or WP-72703-BSIDERAPIDSTOPTRIP is ON is an indication that the existing plant flow rate can be managed by the remaining IPS and EPS pumps. These points cause no action to the Raw Sewage Pumps.
 8. When Point WP-72703-ALLRAPIDSTOPTRIP is ON:
 - a. Pumps 704-P03AC011, 704-P03AC021, 704-P03AC031 & 704-P03AC041 are rejected to Manual.
 - b. Rapid Ramp Rates for Stopping Pumps are moved into active control sheets for pumps 704-P03AC011, 704-P03AC021, 704-P03AC031 & 704-P03AC041.
 - c. Pumps 704-P03AC011, 704-P03AC021, 704-P03AC031 & 704-P03AC041 are rapidly stopped.
 - d. Normal Ramp Rates for Stopping Pumps are returned into active control sheets for pumps 704-P03AC011, 704-P03AC021, 704-P03AC031 & 704-P03AC041.
- C. DCS Manual Operation:
1. Raw Sewage Pump 1:
 - a. Pop-up window Diagram 04xxx is used to control Start/Stop and Speed functions of the pump.

- b. Motor Start/Stop Control – Use existing Level 1 Motor Start/Stop Control Macro:
 - 1) Inputs:
 - a) IN REMOTE - WP704NDA03DC011:
 - (1) 1 = REMOTE.
 - b) ON - WP704NDJ03DC011:
 - (1) 1 = RUNNING.
 - c) FAIL - WP704XAD03DC011:
 - (1) 1 = FAULTED.
 - 2) Outputs:
 - a) RUN COMMAND - WP704MNJ03DC011:
 - (1) 1 = PUMP RUN COMMAND.
 - 3) Start Permissives:
 - a) L/R in REMOTE (WP704NDA03DC011).
 - b) DCS mode Manual/Auto in Manual.
 - 4) Stop Permissives:
 - a) L/R in REMOTE (WP704NDA03DC011).
 - b) DCS mode Manual/Auto in Manual.
 - 5) Start Control: If not running: Stop Button status indicator ON.
 - a) Start Button with status indicator will be available.
 - b) Selecting Start Button will start the motor.
 - 6) Stop Control: If running: Start Button status indicator ON:
 - a) Stop Button with status indicator will be available.
 - b) Selecting Stop Button will stop the motor.
 - 7) Trips:
 - a) Interlocks active.
 - b) MHM Interlocks
 - c) Motor Fault (WP704XAD03DC011).
 - 8) Manual Rejects:
 - a) L/R in LOCAL (WP704NDA03DC011) = OFF.
 - b) Motor Fault.
 - c. Speed Control – Use existing Level 1 PID Control Macro:
 - 1) Speed input from VFD (WP704SI03DC011):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - 2) Speed Command analog output to the pump (WP704SC03DC011):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - b) Pump minimum speed is 30%, coordinated and set within VFD and DCS. Note: verify and adjust to minimum speed in pump and motor submittals.
 - 3) Control Algorithm:
 - a) PID.
 - b) Modes – In DCS Manual:
 - (1) Manual:
 - (a) Operator sets Output Value.
 - (2) Automatic - Output set by Algorithm to maintain PV on SP:
 - (a) Operator enters required Flow Setpoint.
 - (b) Rejects to Manual with Output = 0.0 if WP704NDJ03DC011 is OFF.
 - d. Electrical Power Indication:
 - 1) Electrical power signal analog input from the VFD (WP704II03DC011):
 - a) Modbus signal from VFD = 0 – 700 KW.
2. Raw Sewage Pump 2:
 - a. Pop-up window Diagram 04xxx is used to control Start/Stop and Speed functions of the pump.
 - b. Motor Start/Stop Control – Use existing Level 1 Motor Start/Stop Control Macro:
 - 1) Inputs:
 - a) IN REMOTE - WP704NDA03DC021:
 - (1) 1 = REMOTE.
 - b) ON - WP704NDJ03DC021:
 - (1) 1 = RUNNING.

- c) FAIL - WP704XAD03DC021:
 - (1) 1 = FAULTED.
 - 2) Outputs:
 - a) RUN COMMAND - WP704MNJ03DC021:
 - (1) 1 = PUMP RUN COMMAND.
 - 3) Start Permissives:
 - a) L/R in REMOTE (WP704NDA03DC021).
 - b) DCS mode Manual/Auto in Manual.
 - 4) Stop Permissives:
 - a) L/R in REMOTE (WP704NDA03DC021).
 - b) DCS mode Manual/Auto in Manual.
 - 5) Start Control: If not running: Stop Button status indicator ON:
 - a) Start Button with status indicator will be available.
 - b) Selecting Start Button will start the motor.
 - 6) Stop Control: If running: Start Button status indicator ON:
 - a) Stop Button with status indicator will be available.
 - b) Selecting Stop Button will stop the motor.
 - 7) Trips:
 - a) Interlocks active.
 - b) Motor Fault (WP704XAD03DC021).
 - 8) Manual Rejects:
 - a) L/R in LOCAL (WP704NDA03DC021) = OFF.
 - b) Motor Fault.
 - c. Speed Control – Use existing Level 1 PID Control Macro:
 - 1) Speed input from VFD (WP704SI03DC021):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - 2) Speed Command analog output to the pump (WP704SC03DC021):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - b) Pump minimum speed is 30%. Note: verify and adjust to minimum speed in pump and motor submittals.
 - 3) Control Algorithm:
 - a) PID.
 - b) Modes – In DCS Manual:
 - (1) Manual:
 - (a) Operator sets Output Value.
 - (2) Automatic - Output set by Algorithm to maintain PV on SP:
 - (a) Operator enters required Flow Setpoint.
 - (b) Rejects to Manual with Output = 0.0 if WP704NDJ03DC021 is OFF.
 - d. Electrical Power Indication:
 - 1) Electrical power signal analog input from the blower (WP704II03DC021):
 - a) Modbus signal from VFD = 0 – 700 KW.
3. Raw Sewage Pump 3:
- a. Pop-up window Diagram 04xxx is used to control Start/Stop and Speed functions of the pump.
 - b. Motor Start/Stop Control – Use existing Level 1 Motor Start/Stop Control Macro:
 - 1) Inputs:
 - a) IN REMOTE - WP704NDA03DC031:
 - (1) 1 = REMOTE.
 - b) ON - WP704NDJ03DC031:
 - (1) 1 = RUNNING.
 - c) FAIL - WP704XAD03DC031:
 - (1) 1 = FAULTED.
 - 2) Outputs:
 - a) RUN COMMAND - WP704MNJ03DC031:
 - (1) 1 = PUMP RUN COMMAND.
 - 3) Start Permissives:
 - a) L/R in REMOTE (WP704NDA03DC031).

- b) DCS mode Manual/Auto in Manual.
 - 4) Stop Permissives:
 - a) L/R in REMOTE (WP704NDA03DC031).
 - b) DCS mode Manual/Auto in Manual.
 - 5) Start Control: If not running: Stop Button status indicator ON:
 - a) Start Button with status indicator will be available.
 - b) Selecting Start Button will start the motor.
 - 6) Stop Control: If running: Start Button status indicator ON:
 - a) Stop Button with status indicator will be available.
 - b) Selecting Stop Button will stop the motor.
 - 7) Trips:
 - a) Interlocks active.
 - b) Motor Fault (WP704XAD03DC031).
 - 8) Manual Rejects:
 - a) L/R in LOCAL (WP704NDA03DC031) = OFF.
 - b) Motor Fault.
- c. Speed Control – Use existing Level 1 PID Control Macro:
 - 1) Speed input from VFD (WP704SI03DC031):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - 2) Speed Command analog output to the pump (WP704SC03DC031):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - b) Pump minimum speed is 30%. Note: verify and adjust to minimum speed in pump and motor submittals.
 - 3) Control Algorithm:
 - a) PID.
 - b) Modes – In DCS Manual:
 - (1) Manual:
 - (a) Operator sets Output Value.
 - (2) Automatic - Output set by Algorithm to maintain PV on SP:
 - (a) Operator enters required Flow Setpoint.
 - (b) Rejects to Manual with Output = 0.0 if WP704NDJ03DC031 is OFF.
 - d. Electrical Power Indication:
 - 1) Electrical power signal analog input from the blower (WP704II03DC031):
 - a) Modbus signal from VFD = 0 – 700 KW.
- 4. Raw Sewage Pump 4:
 - a. Pop-up window Diagram 04xxx is used to control Start/Stop and Speed functions of the pump.
 - b. Motor Start/Stop Control – Use existing Level 1 Motor Start/Stop Control Macro:
 - 1) Inputs:
 - a) IN REMOTE - WP704NDA03DC041:
 - (1) 1 = REMOTE.
 - b) ON - WP704NDJ03DC041:
 - (1) 1 = RUNNING.
 - c) FAIL - WP704XAD03DC041:
 - (1) 1 = FAULTED.
 - 2) Outputs:
 - a) RUN COMMAND - WP704MNJ03DC041:
 - (1) 1 = PUMP RUN COMMAND.
 - 3) Start Permissives:
 - a) L/R in REMOTE (WP704NDA03DC041).
 - b) DCS mode Manual/Auto in Manual.
 - 4) Stop Permissives:
 - a) L/R in REMOTE (WP704NDA03DC041).
 - b) DCS mode Manual/Auto in Manual.
 - 5) Start Control: If not running: Stop Button status indicator ON:
 - a) Start Button with status indicator will be available.
 - b) Selecting Start Button will start the motor.

- 6) Stop Control: If running: Start Button status indicator ON:
 - a) Stop Button with status indicator will be available.
 - b) Selecting Stop Button will stop the motor
- 7) Trips:
 - a) Interlocks active.
 - b) Motor Fault (WP704XAD03DC041).
- 8) Manual Rejects:
 - a) L/R in LOCAL (WP704NDA03DC041) = OFF.
 - b) Motor Fault.
- c. Speed Control – Use existing Level 1 PID Control Macro:
 - 1) Speed input from VFD (WP704SI03DC041):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - 2) Speed Command analog output to the pump (WP704SC03DC041):
 - a) Signal Calibration: See Section 40 06 73 Ovation DCS I/O Schedule.
 - b) Pump minimum speed is 30%. Note: verify and adjust to minimum speed in pump and motor submittals.
 - 3) Control Algorithm:
 - a) PID.
 - b) Modes – In DCS Manual:
 - (1) Manual:
 - (a) Operator sets Output Value.
 - (2) Automatic - Output set by Algorithm to maintain PV on SP:
 - (a) Operator enters required Flow Setpoint.
 - (b) Rejects to Manual with Output = 0.0 if WP704NDJ03DC041 is OFF.
- d. Electrical Power Indication:
 - 1) Electrical power signal analog input from the blower (WP704II03DC041):
 - a) Modbus signal from VFD = 0 – 700 KW.

D. DCS Automatic Operation:

NOTE TO CONTRACTOR:

Per Section 01 14 00 Work Restrictions. The Emerson Ovation programming for the RSP system pump sequencing and tunnel cleanout sequencing shall not be implemented prior to the construction period for the last pump. Testing and commissioning will be performed with all pumps.

- 1. Speed Control – DCS Manual:
 - a. The DCS provides a manual loading (MA) station (speed controller) for each RSP on Popup 33006. When the pump is in REMOTE and the MA station is in MANUAL mode, the operator can directly control the speed of the pump via the DCS. When the MA station is in AUTO mode, the speed output will be determined by the Level Controller described below.
 - b. The DCS provides for operator AUTO/MANUAL selection for each RSP. In MANUAL mode, the operator enters the desired pump speeds via the manual loading stations on Popup 33006. In AUTO mode, the DCS will determine the speed of the pump based on the control logic described further below.
- 2. Level Control – DCS Automatic:

There are two automatic modes that the operator chooses to have the pumps operate in:

 - a. Level Control Mode:
 - 1) The RSP pump speeds are normally controlled by DCS logic to maintain a constant level in the RS wet well using a PID level controller.
 - 2) The RSP Wet Well contains four bubblers to measure liquid level in the wet well at each pump suction. The process variable for the RSP Level Controller (WP-70401A-RSWWLVLSEL) is selected from one of the four level transmitters (WP704LI03DA0X1, where X=1,2,3,4) by the operator via a four position selector switch in ACC-1. The DCS receives a digital input for each pump from the switch.

- 3) If the selected level signal quality goes to BAD, the DCS will reject level control to manual at last known output and alert the operators. The operators will need to select a different level signal at ACC-1 and place the level controller back in automatic from the DCS.
 - 4) The RSP Level Controller (LC) uses a PID algorithm with the selected RSP wet well level (WP-70401A-RSWWLVLSEL) as the process variable. The operator adjustable level control setpoint (WP-70401A- RSWWLEVELSP, initial value 102.5) is used by the PID algorithm to calculate output values (WP-70401A- RSWWLVLCOU).
 - 5) The output from the level controller is sent to the RSP's via a BALANCER algorithm. The BALANCER is used to equalize the speeds when 2 or more pumps are running in AUTO so that the pumps modulate together based on the output from the level controller.
- b. Tunnel Cleanout Mode:
- 1) This is a batch mode, when this process is complete, the mode switches to Level Control Mode.
 - 2) Normally chosen when flow is approximately 80 MGD and one pump is operating.
 - 3) Operator sets the parameters, selects and confirms the change to Tunnel Cleanout mode on Popup 04xxx (RSP TUNNEL CLEANOUT SEQUENCE).
 - 4) There is an 'ABORT SEQUENCE' button on the parameter page that will stop the sequence and return the level to the starting point and control to level control.
 - 5) When the Tunnel Cleanout mode (WP70401-TCOSEQACTIVE) is activated:
 - a) Record pump operating speed in Steady State Pump Speed % (WP70401-TCOSEQSteadyStPmpSpd).
 - b) The operating pump will increase speed to the operator set Pump Out Pump Speed Setpoint. (WP70401-TCOSEQPumpSpeedSP) Initial setting of 90%.
 - c) When level lowers in the tunnel to the operator set Tunnel Cleanout Level Setpoint. (WP70401-TCOSEQCleanoutLevelSP) Initial setting of 100 ft.:
 - (1) The Cleanout Timer starts.
 - (2) Operator adjustable Cleanout Time (minutes) (WP70401-TCOSEQCleanoutTimeSP)
 - (3) Current Level Control Setpoint is copied to a holding tag, Initial Level Control Setpoint. (WP70401-TCOSEQLevelControlSP)
 - (4) The pump speed returns to level control to maintain the level at the Tunnel Cleanout Level Setpoint. (WP70401-TCOSEQCleanoutLevelSP).
 - d) After the cleanout timer expires:
 - (1) Record pump operating speed in Steady State Pump Speed % (WP70401-TCOSEQSteadyStPmpSpd).
 - (2) The pump speed reduces to operator set End of Pump Out Minimum Speed (WP70401-TCOSEQEndPumpMinSpdSP) to allow the wet well level to increase.
 - e) When the wet well level reaches the Initial Level Control Mode Setpoint (WP70401-TCOSEQLevelControlSP):
 - (1) Set the Pump Speed to the Steady State Pump Speed % (WP70401-TCOSEQSteadyStPmpSpd).
 - f) Set the Control Mode to Level Control Mode.
 - 6) When the 'ABORT SEQUENCE' button is activated:
 - a) The pump speed reduces to operator set End of Pump Out Minimum Speed (WP70401-TCOSEQEndPumpMinSpdSP) to allow the wet well level to increase.
 - b) When the wet well level reaches the Initial Level Control Mode Setpoint (WP70401-TCOSEQLevelControlSP):
 - (1) Set the Pump Speed to the Steady State Pump Speed % (WP70401-TCOSEQSteadyStPmpSpd).
 - c) Set the Control Mode to Level Control Mode.
3. RSP Pump Sequence Control:
Applies in Level Control Mode only.
- a. Sequence trigger:
- 1) The pumps will be sequenced in a way to maximize the time the pumps are operated near the best efficiency point on the pump curve. With variations to wet well level impacting

- where the pumps operate on their curves, calculations will be made to determine the current operating location.
- 2) Operators will enter pump start and stop trigger setpoints on the Raw Sewage Pump Sequence graphic page.
 - 3) Values will represent the total raw sewage pump flow in units of MGD.
- b. Ovation will be used to determine an estimated flow per pump using differential pressure, motor data and other required process data. The flow, speed and power will be used to estimate where on the pump curve the pump is currently operating. Process values such as Wet Well level, power usage, and pressure differential across the pump can be used in conjunction to known pump and power curves for estimating live flow values for each pump.
- 1) Pump Flow will be calculated based pump curve data at the operating pump rpm and total head generated.
 - 2) Raw Sewage Pump Total Flow will be calculated as the sum of the running pump flows.
 - 3) Pump Efficiency will be the theoretical efficiency based pump curve data at the operating pump rpm and total head generated.
- c. To normalize the efficiency curve, the efficiency point will be evaluated as a percentage of the best efficiency point:
- 1) Below 100.0 indicates operating to the left of the best efficiency point.
 - 2) A value of 100.0 will indicate operating at the best efficiency point.
 - 3) Above 100.0 indicates operating to the right of the best efficiency point.
- d. Fully Automatic operation of the RSP system is the normal operating mode under most conditions. In this mode, the RSP pump speeds are controlled by the DCS to automatically maintain a constant level in the RSP wet well using the PID level controller described above and the DCS also controls the sequencing (starting and stopping) of pumps.
- e. The RSP pumps operate in LEAD/LAG1/LAG2/LAG3 sequence. The LEAD pump will generally always be running unless the plant is shutdown. The LEAD pump is always started Manually but can be stopped by the Auto Sequence if the wet well level drops below the STOP Lead Pump Level Set Point (current value = 96 feet) or Level Controller output falls below LC Output Set Point (current value = 10%).
- f. The RSP sequencing logic utilizes the Supervisory Control Templates developed by King County for the Control System Upgrade project, modified for Lead, Lag1, Lag2, Lag3 operation. The following templates are utilized:
- 1) DEVICE SCHEDULE (LEAD, FOLLOW-1, FOLLOW-2...ETC).
 - 2) START/STOP AND MODULATION OF MULTIPLE DEVICES OPERATING IN PARALLEL.
- g. The DCS provides the operator with the ability to select the LEAD/LAG1/LAG2/LAG3 assignments using Popup 04xxx Raw Sewage Pump Controls. The LEAD, LAG1, LAG2 and LAG3 pump assignments determine which pump will be started or stopped when the auto sequence determines a change in the number of pumps is required. A rank is assigned for each pump as follows:
- 1) = LEAD.
 - 2) = LAG1.
 - 3) = LAG2.
 - 4) = LAG3.
- h. Ranks are only assigned for pumps that are available. If a pump becomes unavailable it is assigned the rank of LAG3 (4) and pumps that were of higher rank of the unavailable pump have their rank promoted by one.
- i. The AUTO SEQUENCE mode is ENABLED/DISABLED using Popup 04xxx.
- j. Permissives for the AUTO SEQUENCE to be ENABLED are:
- 1) Pump Sequences (present and set values) shall match (WP70401-PSEQMATCH).
 - 2) Selected Wet Well Level Signal is not BAD quality (WP-70401A-RSWWLVLSEL-BQ).
 - 3) Two, Three or Four RSP pumps are AVAILABLE (WP-70401-P03DC0X-AVAIL, where X=1,2,3,4).
- k. Pump Available Status for each pump is based on the following criteria:
- 1) Pump is READY (WP70401LP03DC0X1-B00[15], where X=1,2,3,4).
 - 2) Pump S/S Control is in AUTO (WP70401LP03DC0X1-B00[12], where X=1,2,3,4).
 - 3) Pump Speed Control is in AUTO (WP70401LD03DC0X1-ASPD, where X=1,2,3,4).

- 4) Pump start permissive is met (WP70401LP03DC0X1-B00[7], where X=1,2,3,4).
- l. The DCS will automatically start and stop the LAG1, LAG2, and LAG3 pumps, and Stop the LEAD pump based on operator defined set points when in the AUTO SEQUENCE mode is ENABLED.
- m. When the sequence logic determines that another pump shall be started, it will start the pump with the lowest rank of the pumps that currently not running and available as defined above.
- n. When the sequence logic determines that a pump shall be stopped, it will stop the pump with the highest rank of the pumps that are running and available as defined above.
- o. When a running pump in the sequence fails or is stopped manually by the operator, its status becomes unavailable. If the sequence is ENABLED, the sequencing logic will start a pump to replace the pump that is stopped. The sequence will start the pump with the lowest rank. The pump that has just become unavailable has its rank changed to LAG3.
- p. When a stopped pump that is placed back in Available Status for the sequence, the DCS will set the rank of the pump to the next highest rank of the available pumps. The ranks of other unavailable pumps will be set higher than the newly available pump.
- q. When a pump is running in DCS Manual, it is unavailable to the sequence. When this running unavailable pump has its speed and start/stop controls placed in DCS Auto, it is inserted into the sequence in a method for bumpless transfer.
 - 1) The DCS will increase the required number of running pumps in the sequence to include the newly added pump.
 - 2) The newly added pump is assigned the next highest rank of the running pumps.
 - 3) Pumps maintain current running status and respond to the Level Control setpoint.
- r. If the AUTO SEQUENCE mode is DISABLED, lead and lag pump starting and stopping is controlled manually by the operator. If a pump is stopped or fails, the operator shall manually start a pump to replace it.
- s. Pump sequencing set points for the AUTO SEQUENCE mode are entered on Popup 04xxx. Pump sequence level and control output setpoints are as follows (with initial or "baseline" values in parenthesis):
 - 1) Lead Pump Impending Stop (WP-70402-RSPLEADIMPSTPA):
 - a) Wet Well Level less than or equal to operator adjustable setpoint value for 30 seconds (WP-70401-RSPLVLLEADSTPASP, current value 101.0 ft).
 - b) Control Output less than or equal to operator entered (15.0) % for 30 seconds. (WP-70401-RSPLCOLEADSTPASP, current value 5.0%).
 - 2) Lead Pump Stop (WP-70401-RSPLEADPMSTPA):
 - a) Wet Well Level less than or equal to operator adjustable setpoint value for 30 seconds (WP-70401-RSPLVLLEADSTPSP, current value 98.0 ft).
 - b) Control Output less than or equal to operator adjustable setpoint for 30 seconds. (WP-70401-RSPLCOLEADSTPSP, current value 10.0%)
 - 3) Lag1 Pump Impending Start (WP-70402-RSPLAGIMPSTRA):
 - a) Lead Pump Running.
 - b) RSP pumps operating at efficiency point greater than or equal to operator adjustable setpoint for 5 seconds (WP-70402-RSPLVLLAGSTRASP, current value 100.0).
 - 4) Lag1 Pump Start (WP-70401-RSPLAGREQUEST):
 - a) Lead Pump Running.
 - b) RSP pumps operating at efficiency point greater than or equal to operator adjustable setpoint for 30 seconds (WP-70402-RSPLVLLAG1STRPSP, current value 101.5).
 - 5) Lag1 Pump Impending Stop (WP-70402-RSPLAGIMPSTPA):
 - a) Lead & Lag1 Pumps Running.
 - b) RSP pumps operating at efficiency point less than or equal to operator adjustable setpoint value for 5 seconds (WP-70402-RSPLVLLLAGSTPASP, current value 90.0).
 - 6) Lag1 Pump Stop (WP-70402-RSPLEADPMSTPA):
 - a) Lead & Lag1 Pumps Running.
 - b) RSP pumps operating at efficiency point less than or equal to operator adjustable setpoint value for 30 seconds (WP-70402-RSPLVLLLAGSTPSP, current value 87.0).
 - 7) Lag2 Pump Impending Start (WP-70402-RSPLAGIMPSTRA):
 - a) Lead & Lag1 Pumps Running.

- b) RSP pumps operating at efficiency point greater than or equal to operator adjustable setpoint for 5 seconds (WP-70402-RSPLVLLAGSTRASP, current value 98.6).
- 8) Lag2 Pump Start (WP-70401-RSPLAGREQUEST):
 - a) Lead & Lag1 Pumps Running.
 - b) RSP pumps operating at efficiency point greater than or equal to operator adjustable setpoint for 30 seconds (WP-70402-RSPLVLLAG1STRPSP, current value 100.1).
- 9) Lag2 Pump Impending Stop (WP-70402-RSPLAGIMPSTPA):
 - a) Lead, Lag1 & Lag2 Pumps Running.
 - b) RSP pumps operating at efficiency point less than or equal to operator adjustable setpoint value for 5 seconds (WP-70402-RSPLVLLLAGSTPASP, current value 94.7).
- 10) Lag2 Pump Stop (WP-70402-RSPLEADPMSTPA):
 - a) Lead, Lag1 & Lag2 Pumps Running.
 - b) RSP pumps operating at efficiency point less than or equal to operator adjustable setpoint value for 30 seconds (WP-70402-RSPLVLLLAGSTPSP, current value 91.7).
- 11) Lag3 Pump Impending Start (WP-70402-RSPLAGIMPSTRA):
 - a) RSP pumps operating at efficiency point greater than or equal to operator adjustable setpoint for 5 seconds (WP-70402-RSPLVLLLAGSTRASP, current value 100.0).
- 12) Lag3 Pump Start (WP-70401-RSPLAGREQUEST):
 - a) RSP pumps operating at efficiency point greater than or equal to operator adjustable setpoint for 30 seconds (WP-70402-RSPLVLLAG1STRPSP, current value 101.5).
- 13) Lag3 Pump Impending Stop (WP-70402-RSPLAGIMPSTPA):
 - a) RSP pumps operating at efficiency point less than or equal to operator adjustable setpoint value for 5 seconds (WP-70402-RSPLVLLLAGSTPASP, current value 90.0).
- 14) Lag3 Pump Stop (WP-70402-RSPLEADPMSTPA):
 - a) RSP pumps operating at efficiency point less than or equal to operator adjustable setpoint value for 30 seconds (WP-70402-RSPLVLLLAGSTPSP, current value 87.0).
- t. If RSP Wet Well LOLO Trip (WP-70402-RSPWWLLTRIPENBL) is ENABLED, the DCS will shut down all running pumps if the wet well level drops below elevation 108 feet, using 2-out-of-three logic based on the following level measurements (if 2 or more of these switches are activated):
 - 1) Low-Low float switch is activated (WP704LSLL31AF011) for 10 seconds.
 - 2) Low-Low software switch based RSP wet well Bubbler No. 1 (WP704LI31AE011) is activated for 3 seconds.
 - 3) Low-Low software switch based RSP wet well Bubbler No. 2 (WP704LI31AE012)) is activated for 3 seconds.
- u. If the pump auto sequence is DISABLED, the DCS continues to track how many pumps should be running. When the sequence is subsequently ENABLED, the DCS will start or stop the lag pump based on the number of pumps the auto sequence calculates is needed and the number of pumps currently running.
- v. Pumps are considered AVAILABLE to the Auto Sequence to start (WP-70402-P2MB1[11], where 2=1,2,3) if all of the following conditions are met:
 - 1) Pump is NOT running (WP704NDJ03DC021, where 2=1,2,3).
 - 2) Pump is READY (WP7042LP03DC021-B00[15], where 2=1,2,3).
 - 3) Pump is in AUTO (WP7042LP03DC021, where 2=1,2,3).
 - 4) All Start Permissives are met (WP7042LP03DC021-B00[7], where 2=1,2,3).
 - 5) VSD is in AUTO (WP7042LD03DC021-ASPD where 2=1,2,3).
- w. Pumps are considered AVAILABLE to the Auto Sequence to STOP (WP-70402-P2MB1[10], where 2=1,2,3) if all of the following conditions are met:
 - 1) Pump is running (WP704NDJ03DC021, where 2=1,2,3).
 - 2) Pump is READY (WP7042LP03DC021-B00[15], where 2=1,2,3).
 - 3) Pump is in AUTO (WP7042LP03DC021, where 2=1,2,3).
- x. The DCS keeps track of the number of RSP pumps running (WP-70402-NRUN) by monitoring running status points (WP704NDJ03DC021, where 2=1,2,3) using a digital counter.
- y. The DCS keeps track of the number of RSP pumps available (WP-70402-NUMAVLSTR) by monitoring the pump available status points defined above using a digital counter. (WP-70402-NUMAVLSTR).

- z. The DCS uses a digital point to track when there are no RSP pumps running (WP-70402-NORUN). This point is used in sequencing logic.

E. Miscellaneous DCS Control:

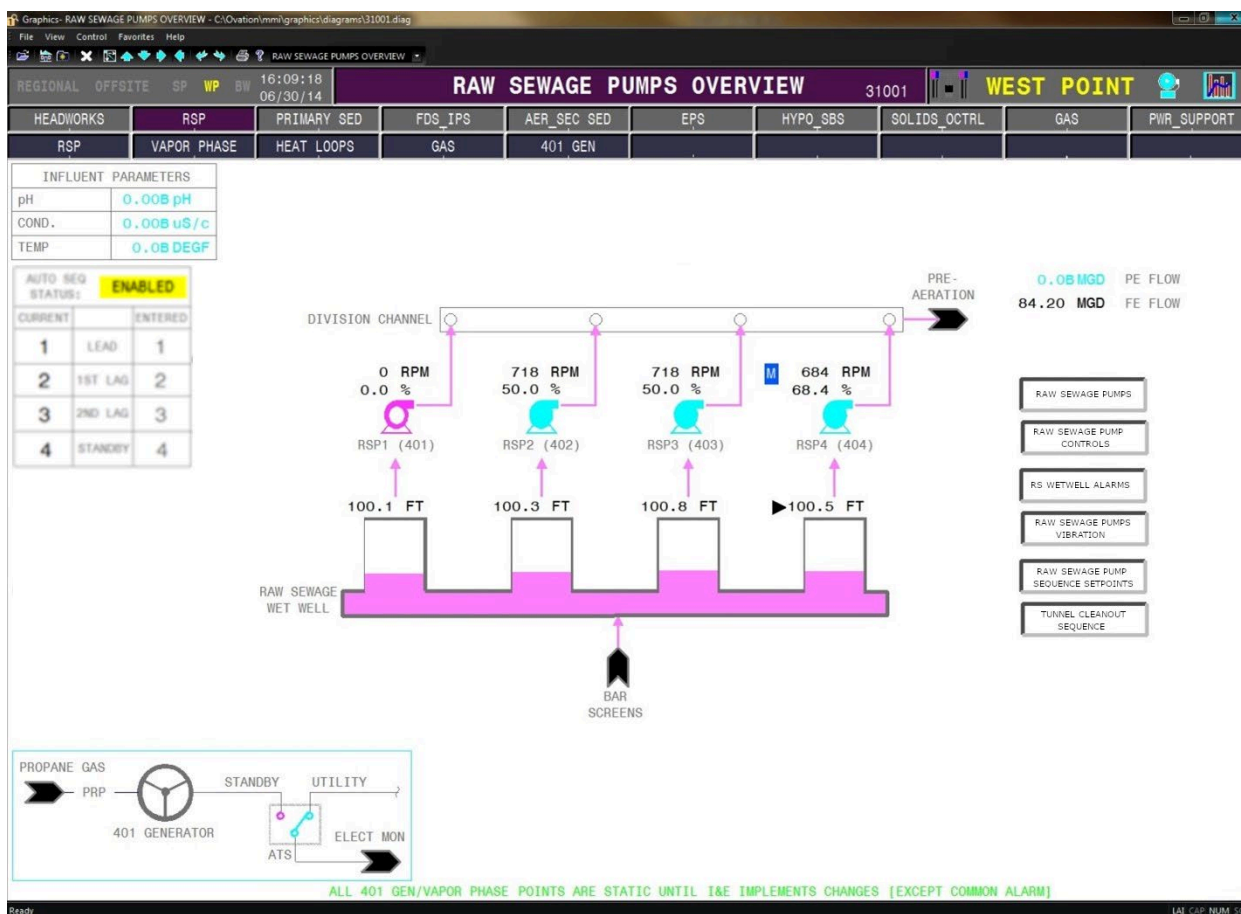
1. The DCS will provide totalizers for the following flow signals:
 - a. None.
2. The DCS will provide run timers for the following miscellaneous status signals:
 - a. RSP ON status, WP704NDJ03DC0X1, where X=1,2,3,4.
3. The DCS will provide control of the RSP Temporary Jacket Water Head Tanks make up water control valves FCV03AV011 and FCV03AV012. Reference Specification 23 82 30
 - a. Level of RSP Temporary Jacket Water Head Tank 704-T03AV011 will be monitored by WP704LT03AV011
 - b. Valve FCV03AV011 will be OPENED by output command WP704MNO03AV011 when head tank level falls below an operator adjustable head tank minimum setpoint.
 - c. Valve FCV03AV011 will be CLOSED by output command WP704MNO03AV011 when head tank level rises above an operator adjustable head tank maximum setpoint.
 - d. Low level alarm WP704LSL03AV011 of Temporary Head Tank 704-T03AV011 will be configured within the DCS, and operator adjustable.
 - e. Level of RSP Temporary Jacket Water Head Tank 704-T03AV012 will be monitored by WP704LT03AV012
 - f. Valve FCV03AV012 will be OPENED by output command WP704MNO03AV012 when head tank level falls below an operator adjustable head tank minimum setpoint.
 - g. Valve FCV03AV012 will be CLOSED by output command WP704MNO03AV012 when head tank level rises above an operator adjustable head tank maximum setpoint.
 - h. Low level alarm WP704LSL03AV012 of Temporary Head Tank 704-T03AV012 will be configured within the DCS, and operator adjustable.
4. The DCS will provide flow alarms for eye wash stations located on the motor level.
 - a. Eye wash 704-ME01001, an alarm is activated when the WP704FSH01001 signal is detected.
 - b. Eye wash 704-ME01002, an alarm is activated when the WP704FSH01002 signal is detected.

F. Graphics

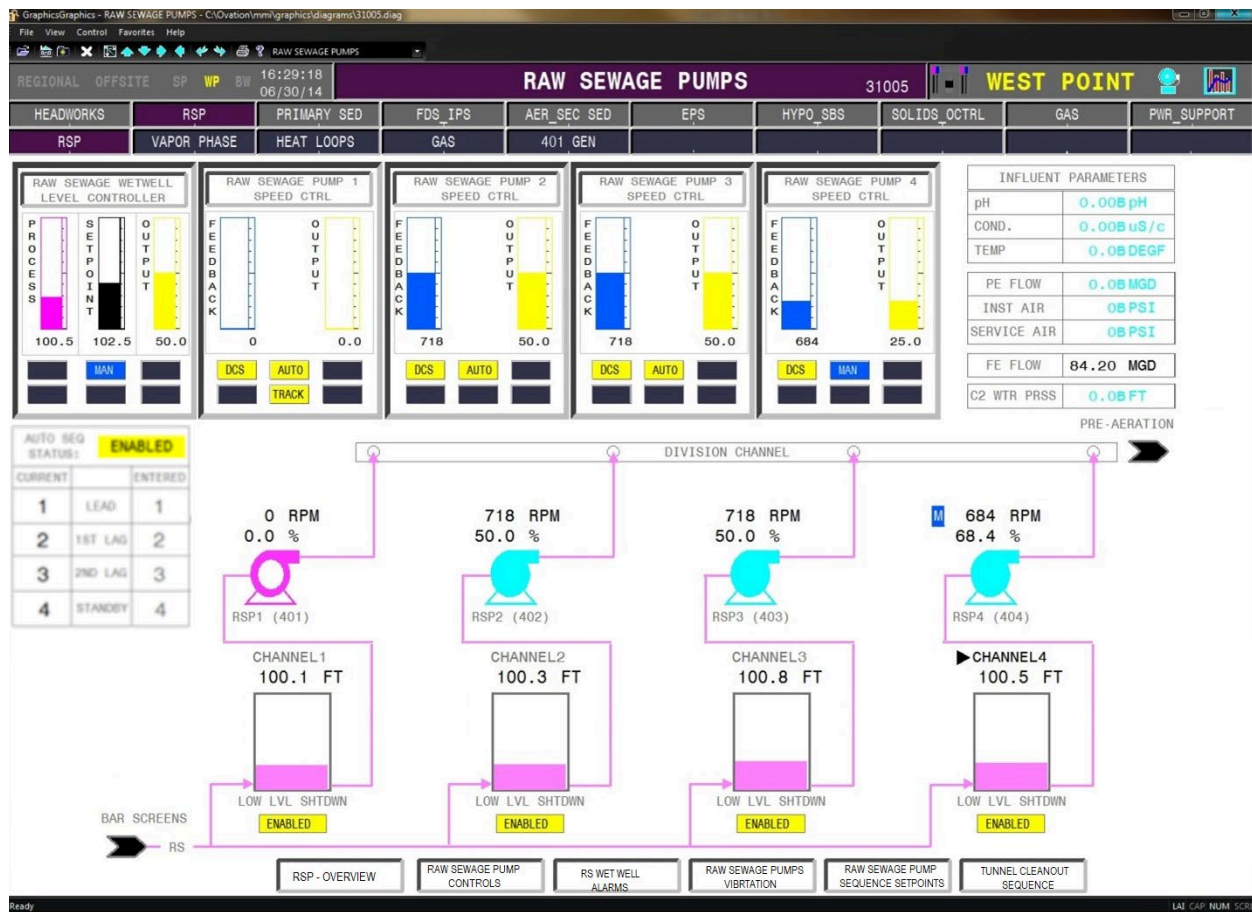
All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. The following graphic examples may be used as a basis for some of the process screens but may not reflect all requirements. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.

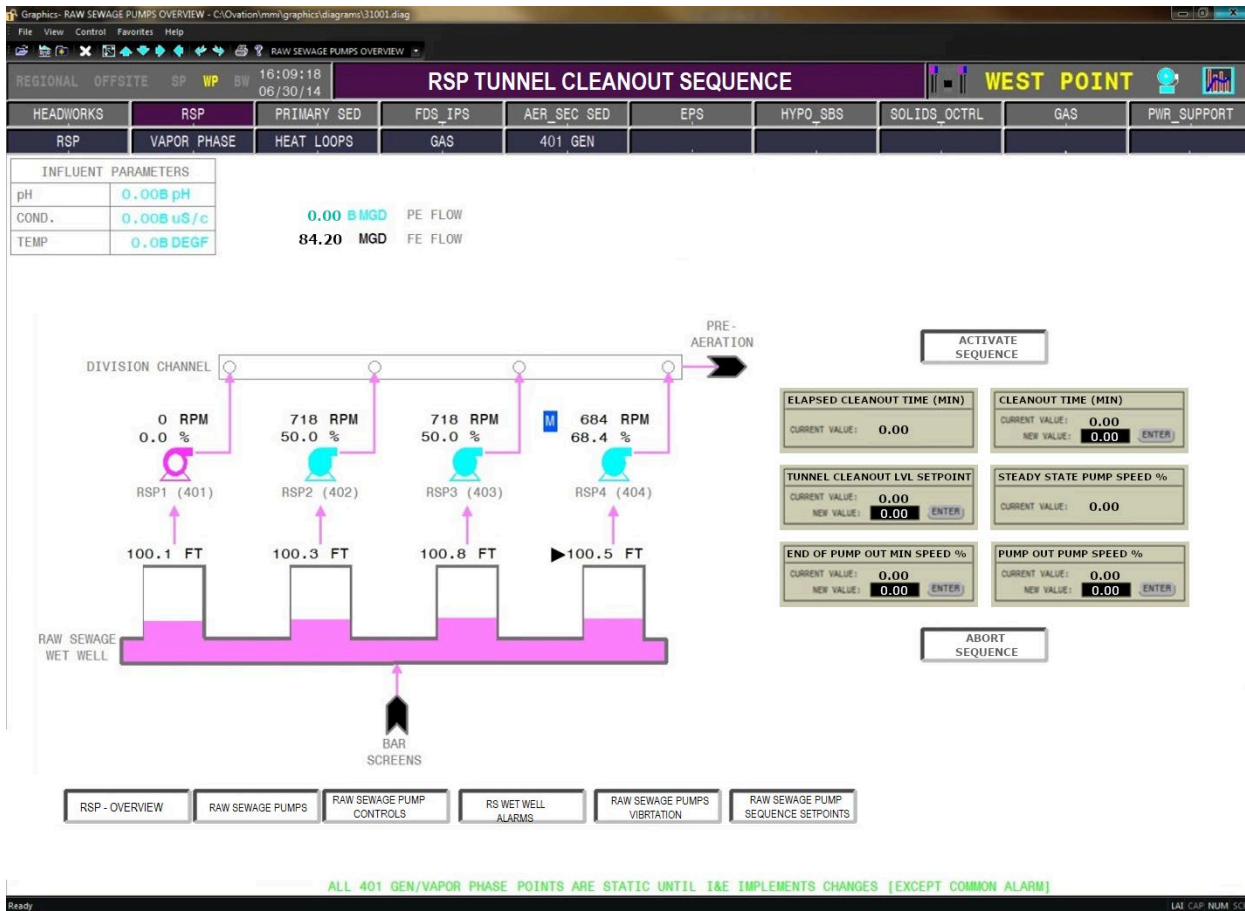
1. Diagram 31001 – RAW SEWAGE PUMPS OVERVIEW:



2. Diagram 31005 – RAW SEWAGE PUMPS:



3. Diagram 4XXXX – RSP TUNNEL CLEANOUT SEQUENCE:



4. Diagram 4XXXX – RAW SEWAGE PUMP AUTO SEQUENCE:

W1 Graphics Window 1

35034

RAW SEWAGE PUMP STATION AUTO SEQ SETPOINTS

RAW SEWAGE PUMP STATION AUTO SEQUENCE SETPOINTS																					
				Lead Pump Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>								Lead Pump Impending Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>									
Lag 1 Pump Start CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 1 Pump Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 1 Pump Impending Start CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 1 Pump Impending Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>									
Lag 2 Pump Start CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 2 Pump Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 2 Pump Impending Start CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 2 Pump Impending Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>									
Lag 3 Pump Start CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 3 Pump Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 3 Pump Impending Start CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>				Lag 3 Pump Impending Stop CURRENT VALUE: NEW VALUE: 0.00 <input type="button" value="ENTER"/>									
RSP LVL1 LOLO		RSP LVL2 LOLO		RSP LVL HIHI		RSP LEVEL HIGH		RSP LEVEL LOLO		RSP LEVEL LOW		NO AUTO SEQ PERM									

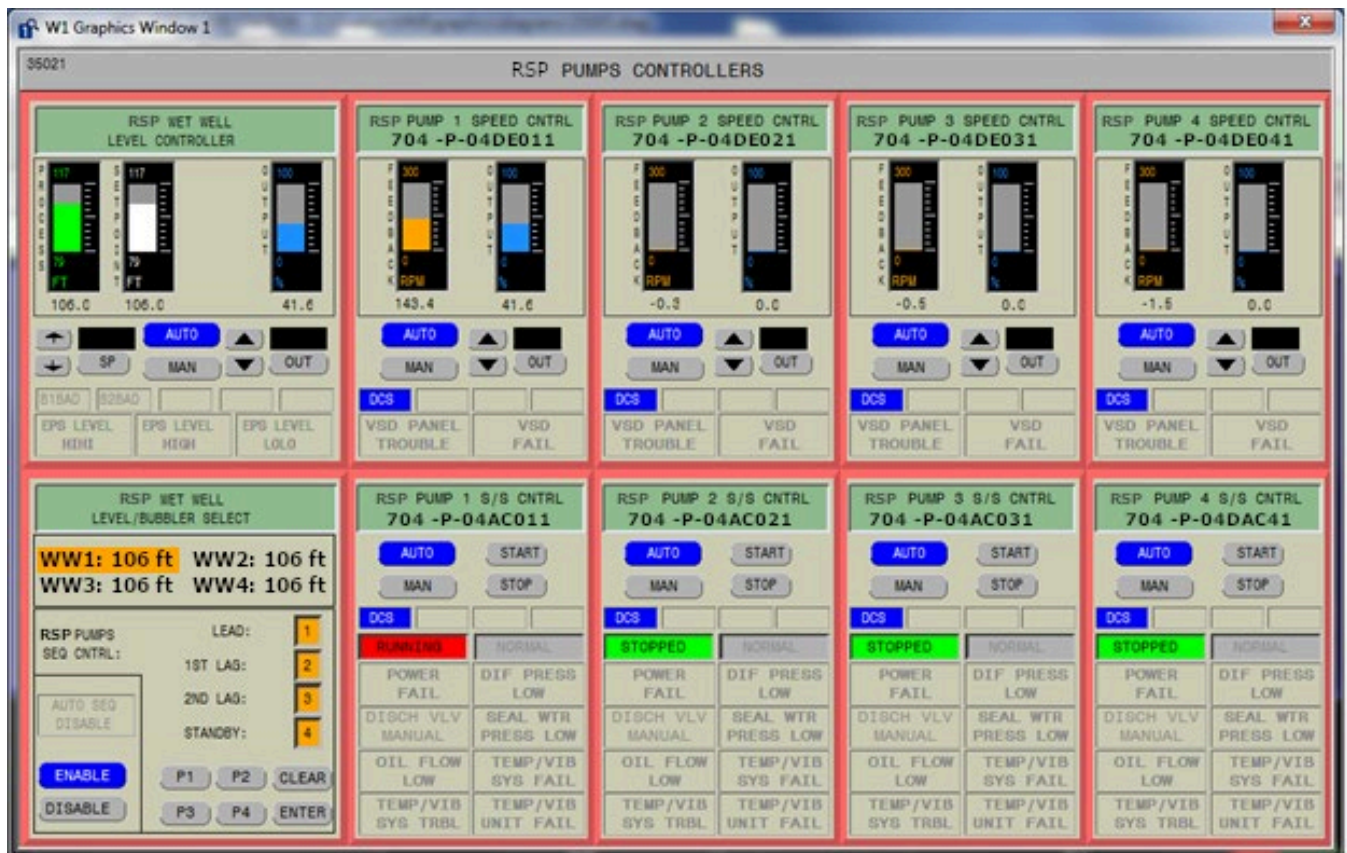
5. Diagram 31006 – RS ALARM SETPOINTS:

W1 Graphics Window 1

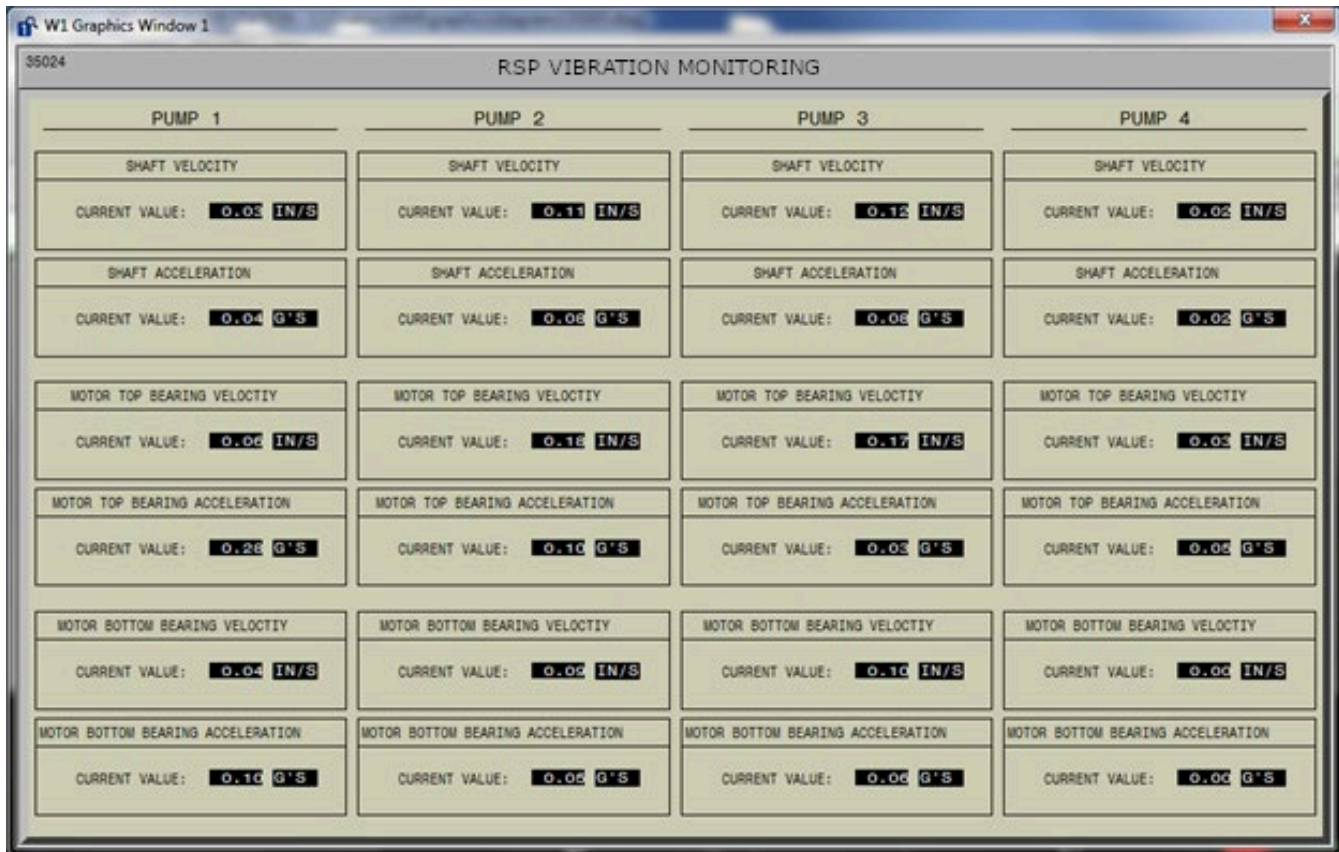
31006 RS ALARM SETPOINTS

<p>RAW SEWAGE WET WELL 1 HIGH LEVEL WARNING</p> <p>CURRENT LVL: 100.1 FT CURRENT SP: 107.5 FT SP HI: 112.0 SP LO: 95.8 NEW SP: <input type="text"/> ENTER</p> <p>LVL HI WARNING RS WW LVL BAD QTLY</p>	<p>RAW SEWAGE WET WELL 2 HIGH LEVEL WARNING</p> <p>CURRENT LVL: 100.3 FT CURRENT SP: 107.5 FT SP HI: 112.0 SP LO: 95.8 NEW SP: <input type="text"/> ENTER</p> <p>LVL HI WARNING RS WW LVL BAD QTLY</p>	<p>WETWELL LEVEL DIFFERENTIAL ALARM</p> <p>CURRENT LVL: 0.10 FT CURRENT SP: 0.50 FT SP HI: 2.0 SP LO: 0.1 NEW SP: <input type="text"/> ENTER</p> <p>LVL HI WARNING RS WW LVL BAD QTLY</p>
<p>RAW SEWAGE WET WELL 3 HIGH LEVEL WARNING</p> <p>CURRENT LVL: 100.8 FT CURRENT SP: 107.5 FT SP HI: 112.0 SP LO: 95.8 NEW SP: <input type="text"/> ENTER</p> <p>LVL HI WARNING RS WW LVL BAD QTLY</p>	<p>RAW SEWAGE WET WELL 4 HIGH LEVEL WARNING</p> <p>CURRENT LVL: 100.5 FT CURRENT SP: 107.5 FT SP HI: 112.0 SP LO: 95.8 NEW SP: <input type="text"/> ENTER</p> <p>LVL HI WARNING RS WW LVL BAD QTLY</p>	<p>PLANT PE FLOW HIGH ALARM</p> <p>CURRENT LVL: 100.3 MGD CURRENT SP: 440.0 MGD SP HI: 460.0 SP LO: 440.0 NEW SP: <input type="text"/> ENTER</p> <p>LVL HI WARNING RS WW LVL BAD QTLY</p>

6. Diagram 31007 – RAW SEWAGE WET WELL LEVEL AND PUMPS SPEED CONTROL:



7. Diagram 4XXX – RAW SEWAGE PUMP VIBRATION MONITORING:



END OF SECTION

SECTION 40 65 02

CONTROL STRATEGY CS704-03 STARTING AIR COMPRESSORS

PART 1 GENERAL

1.01 SUMMARY

- A. The RSP starting air system consists of two air compressors and one receiver. The two air compressors (lead, lag) cycle on and off to maintain pressure in the AS system.

1.02 REFERENCES

- A. P&IDS:
 - 1. WP704-P-60041
- B. Related Control Strategies: CS704-90 Raw Sewage Power Monitoring.
- C. Control Diagrams: None.
- D. Instrument Loop Diagrams:
 - 1. VA20AA01, VA20AA02, VA20AE01.
- E. Alarm Schedule: See Section 40 06 72 Alarm Schedule
- F. Ovation DCS I/O Schedule: See Section 40 06 73 Ovation DCS I/O Schedule

1.03 SYSTEM DESCRIPTION

- A. This control strategy describes the controls associated with the starting air (AS) system that supplies compressed air to the Cogen engines when they are started.
- B. The RSP starting air system consists of two air compressors and two receivers. The two air compressors (lead, lag) cycle on and off to maintain pressure in the AS system between 175 and 225 psig. The air compressors are controlled at field panel 704-FP2001. The common alarm including low oil, low pressure and high air temperature is registered at the DCS.
- C. The air receivers located near the compressors store and evenly distribute compressed air to the system. The receivers allow further cooling of the air, which causes additional moisture to condense. This moisture, along with trace amounts of oil and particulate matter, is removed through manually operated drain valves at the base of each vessel. The air pressure at the outlet of the receiver is monitored by pressure transmitter 704-PIT20AA021. The pressure measurement is registered at the DCS.
- D. The common alarms for the RSP starting air system caused by high air temperature or low oil pressure are latched and can be cleared by pushing the alarm reset button at field control panel 704-FP2001. These alarms shall be cleared before the compressor interlocks will clear, allowing the compressor to start.

1.04 EQUIPMENT

Equipment No.	Equipment Name/Description	Status
704-MTR20AA011	RSP STARTING AIR COMPRESSOR 1	EXISTING
704-MTR20AA021	RSP STARTING AIR COMPRESSOR 2	EXISTING
704-PIT20AA021	RSP STARTING AIR PRESSURE	EXISTING

1.05 ALARMS

- A. Alarm Schedule:
1. Refer to Section 40 06 72 for process alarms.

1.06 INTERLOCKS

- A. Compressor #1 Hardwired Interlocks:
1. Low Oil Pressure - Shuts down Compressor 1
 2. High Air Temperature - Shuts down Compressor 1
- B. Compressor #2 Hardwired Interlocks:
1. Low Oil Pressure - Shuts down Compressor 2
 2. High Air Temperature - Shuts down Compressor 2

1.07 CONTROL OPERATION

- A. LOCAL Field Panel 704-FP2001
1. System Lead Selector
 2. System Low Receiver Pressure
 3. Compressor #1
 - a. HOA
 - b. Low Oil Pressure
 - c. High Air Temperature
 - d. Hour Meter
 - e. Reset
 4. Compressor #2
 - a. HOA
 - b. Low Oil Pressure
 - c. High Air Temperature
 - d. Hour Meter
 - e. Reset
- B. DCS Inputs:
1. Receiver Pressure:
 - a. PV - WP704PI20AA021
 2. Combined Compressor System:
 - a. ALARM - WP704XAD20AA011
 - b. POWER FAIL - WP704XAD20AE011
- C. DCS Manual Operation:
1. None
- D. DCS Automatic Operation:
1. None
- E. Miscellaneous DCS Control:
1. None

F. Graphics

All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. Graphic examples are not provided for this section. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.

1. Diagram 31001

END OF SECTION

SECTION 40 65 03

CONTROL STRATEGY CS704-04 RAW SEWAGE SAMPLING

PART 1 GENERAL

1.01 SUMMARY

- A. The raw sewage (RS) sample system uses continuous analytical instruments to measure the properties of the RS, and to provide this data for monitoring and alarming purposes.

1.02 REFERENCES

- A. P&IDs:
1. WP704-P-60021
- B. Related Control Strategies:
1. N/A
- C. Instrument Loop Diagrams:
1. Loop Sheet List table.

Loop Sheet No.	Loop Description
WP704-I-70036	Raw Sewage Sampler
WP704-I-70037	Raw Sewage Sampler pH & Temp
WP704-I-70091	Raw Sewage Sampler Feed Pump 1
WP704-I-70092	Raw Sewage Sampler Feed Pump 2

- D. Instrument Schedule: See Section 40 06 71 Instrument Schedule.
- E. Alarm Schedule: See Section 40 06 72 Alarm Schedule.
- F. Ovation DCS I/O Schedule: See Section 40 06 73 Ovation DCS I/O Schedule.

1.03 SYSTEM DESCRIPTION

The raw sewage (RS) sample system includes continuous reading analytical instruments and a composite sampler.

To measure the properties of the RS and collect a RS sample, a continuous side stream of RS is taken from the raw sewage wet well. Two feed pumps 704-P24AX011 and 704-P24AX021 in LEAD-STANDBY configuration will provide sufficient flow to the sample collection basin. A low flow switch in the sample line is used to detect low flow conditions from the outlet of the sample collection basin and alert the operators to a problem in the sample line.

The continuous analytical instruments have sensing elements submerged in the sample basin. The transmitters are mounted outside of the sample collection room to allow assessable reading of current values locally.

The raw sewage composite sampler is a refrigerated sampler. The sampler collects set volume samples on timer-initiated or flow-proportional composite samples based on the final effluent flow signal (WP707FI09AH011). The sampler is located in the RSP pump room (aka dry well).

The composite sample consists of samples taken over a 24-hour period and must be refrigerated at 4 degrees C. The composite sample is tested for biochemical oxygen demand (BOD) and total suspended solids (TSS) concentration to determine BOD and TSS loading on the plant.

The raw sewage sampler SAM24AA011 samples flow when directed by the DCS with the RUN COMMAND 704MNJ24AA011. The plant flow is measured by the flow transmitter WP707FIT09AH011 and totalized in the DCS. Whenever the totalized flow exceeds an operator adjustable flow volume set point, the DCS initiate a sampling of raw sewage. The sampler generates a TROUBLE alarm to alert the operators to a problem with this sampler. When the sample command is issued, the totalizer is reset. The sampler running status and low flow alarm are registered at the DCS.

Temperature, pH and Conductivity are measured from the continuous flow going through the flow through boc 704-T24BQ011. These are read into the DCS as WP704TI24AC011, WP704AI24AB011, AND WO704CI24AD011 respectively.

1.04 EQUIPMENT

Equipment No.	Equipment Name/Description	Status
704-AE/AIT24AB011	Raw Sewage pH and Temperature Analyzer	NEW
704-AE/AIT24AD011	Raw Sewage Conductivity Analyzer	NEW
704-FSL24AA011	Raw Sewage Sample Low Flow Detector	NEW
704-SAM24AA011	Raw Sewage Composite Sampler	NEW
704-P24AX011	Raw Sewage Sampler Feed Pump 1	NEW
704-P24AX021	Raw Sewage Sampler Feed Pump 2	NEW

1.05 ALARMS

- A. Alarm Schedule:
 - 1. Refer to Section 40 06 72 for process alarms.

1.06 INTERLOCKS

- A. None.

1.07 SAMPLER CONTROL OPERATION

- A. Local Operation:
 - 1. The composite sampler is configured from its local display.
 - 2. The sampler can be paused.
 - 3. A grab sample can be collected
- B. DCS Inputs:
 - 1. WP704MNJ24AA011 – RUN COMMAND
 - 2. WP704XAD24AA011 – TROUBLE
- C. DCS Manual Operation:
 - 1. The operator can place the sampler system into AUTO or MANUAL mode using Popup window Diagram 31008. This Popup is accessed from 31001 or 39605.
- D. DCS Automatic Operation:

1. The operator can place the sampler into AUTO or MANUAL mode using Popup window Diagram 31008. This Popup is accessed from 31001 or 39605.
2. In AUTO mode, the operator selects the method for obtaining a composite sample using the TIME or FLOW selector buttons on Popup 31008. Normally this sampler will be flow-paced using the Plant Final Effluent Flow rate (WP707FI09AH011)
3. In AUTO FLOW mode, the flow pacing signal is totalized and the DCS initiates a sample when the accumulated primary effluent flow volume since the previous composite sample (WP-70404A-VOLACCUM) reaches the sampler volume setpoint (WP-70404A-SMPVOLSP).
4. The sampler volume setpoint (WP-72404A-SMPVOLSP) can be adjusted from the DCS. The initial setpoint value 4000 kgal. The totalizer is reset when a sample is taken.
5. In AUTO TIME mode, the DCS initiates a sample when the time elapsed since the previous composite sample reaches the sampler time setpoint (WP-70404A-SMPTIMESP). The timer is reset when a sample is taken.
6. The sampler time setpoint (WP-70404A-SMPTIMESP) for taking a sample under AUTO TIME mode can be adjusted from the DCS. The initial setpoint is 30.0 minutes.
7. If the PE flow signal (WP707FI09AH011) quality changes to BAD while the sampler is in AUTO FLOW mode, the DCS defaults to AUTO TIME mode and activates an alarm (WP-70404A-FLOWSIGBAD) to alert the operator.

E. Miscellaneous DCS Control:

1. None.

F. Graphics

1. Diagram 31001
2. Diagram 39605
3. Diagram 31008

1.08 RAW SEWAGE SAMPLER FEED PUMP CONTROL OPERATION

A. Local Operation:

1. VFD panel field mounted.
2. HIM display and keypad
3. HOA switch and Speed potentiometer for local control
4. Indication lights for Ready (GREEN), Running (RED) and Fault (AMBER)

B. DCS Inputs:

1. WP704NDJ24AX011 – RUNNING
2. WP704MNJ24AX011 – RUN COMMAND
3. WP704XAD24AX011 – FAULT
4. WP704SC24AX011 – SPEED COMMAND
5. WP704NDJ24AX021 – RUNNING
6. WP704MNJ24AX021 – RUN COMMAND
7. WP704XAD24AX021 – FAULT
8. WP704SC24AX021 – SPEED COMMAND

C. DCS Manual Operation:

1. The operator can place the sampler feed pumps into AUTO or MANUAL mode using Popup window Diagram 31008. This Popup is accessed from 31001 or 39605.
2. Pump Speed can be manually set by the operator via this Popup while in Manual Operation

D. DCS Automatic Operation:

1. The operator can place the sampler feed pumps into AUTO or MANUAL mode using Popup window Diagram 31008. This Popup is accessed from 31001 or 39605.
2. The feed pumps 704-P24AX011 and 704-P24AX021 are operated with a sequencer in a LEAD/STANDBY configuration via a popup.
3. Only one pump may be assigned to LEAD or STANDBY at a given time.

4. If LEAD pump activates a FAULT alarm, the STANDBY pump will immediately start to maintain continuous flow through 704-T24BQ011, the Flow Through Box.
5. Operators can configure a schedule based or hours run based maintenance rotation for the pumps to automatically alternate which pump is configured LEAD and STANDBY
6. If the LEAD pump is turned to MANUAL and OFF, the STANDBY pump will start automatically.

E. Miscellaneous DCS Control:

1. If the plant is shutdown or Plant Final Effluent Flow WP707FI09AH011 goes to zero, the feed pumps with shut off and the composite sampler will be paused.

F. Graphics

All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. Graphic examples are not provided for this section. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.

1. Diagram 31001
2. Diagram 39605
3. Diagram 31008

END OF SECTION

SECTION 40 65 04

CONTROL STRATEGY CS704-25_RS PUMP BUILDING HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This control strategy describes control of the HVAC systems in the Raw Sewage Pump area as it related to OVATION DCS interface and alarms. See Specification 23 09 93 for further details.

1.02 REFERENCES

- A. P&IDS:
 - 1. WP704-P-60034.
- B. Related Control Strategies: CS704-90 RAW SEWAGE POWER MONITORING, CS704-97 RSP BUILDING LEL & GAS MONITORING.
- C. Control Diagrams: None.
- D. Instrument Loop Diagrams:
 - 1. WP704-I-70601, WP704-I-70602, WP704-I-70603, & WP704-I-70604.
- E. HVAC Drawings: See Drawings: WP700-H-50001, WP700-H-50002, WP700-H-50003, WP704-H-50001, WP704-H-50002, WP704-H-80001, WP704-H-80002, WP704-H-80002, WP704-H-80003, WP704-H-80004, WP704-H-80005, WP704-H-80006, WP705-H-50001, & WP705-H-80001.
- F. Alarm Schedule: See Section 40 06 72 Alarm Schedule
- G. Ovation DCS I/O Schedule: See Section 40 06 73 Ovation DCS I/O Schedule

1.03 SYSTEM DESCRIPTION

Four HVAC systems are being upgraded as part of the Raw Sewage Pump Replacement Project. Screen Room Supply, Control Room Area, Crane Hall all levels including the new electrical room and a gallery supply fan located east of the RS pump area. For full system descriptions see Specification 23 09 93 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS.

Each HVAC air handler unit has its own controller. It is from these controllers that the systems are operated. Each HVAC controller is connected to the WPTP Site HVAC/Security network and is monitored by the Site's HVAC Building Automation System. The Site's control networks are routed together allowing any device on control networks to be monitored by the Ovation DCS system. The Ovation DCS SCADA server will read status and alarm data from each of the HVAC controllers. This data is to be used for graphic displays, trending of data and alarm historization.

The HVAC air handling units provide fresh air exchanges for their areas to minimize the potential of flammable and hazardous gases. Each air handling unit includes air flow switches to monitor and alarm when the air flow is below the design minimum. This low air flow signal is connected to the facility light and horn warning system. When a low air flow is present WHITE alarm lights will activate in the area and horns will activate. The horn can be acknowledged and silenced with a button on 704-ACP0301. The light and horn are part of the LEL and Hazardous gas alarm system, Control Strategy CS-704-97 RSP BUILDING LEL & GAS MONITORING.

1.04 EQUIPMENT

Equipment No.	Equipment Name/Description	Status
704-TC25AD011	RSP – SCREEN ROOM AIR HANDLER CONTROLLER	NEW
704-AHU25AD013	RSP – SCREEN ROOM AIR HANDLER	NEW
704-TC25AD021	RSP – CONTROL ROOM AIR HANDLER CONTROLLER	NEW
704-AHU25AD011	RSP – CONTROL ROOM AIR HANDLER	NEW
704-TC25AD022	RSP – CRANE HALL AIR HANDLER CONTROLLER	NEW
704-AHU25AD012	RSP – CRANE HALL SUPPLY AIR HANDLER	NEW
704-AHU25BS011	RSP – CRANE HALL EXHAUST AIR HANDLER	NEW
704-TC25BM011	RSP – GALLERY AIR HANDLER CONTROLLER	NEW
704-SP25AF013	RSP – GALLERY AIR HANDLER	NEW

1.05 ALARMS

- A. Alarm Schedule:
 - 1. Refer to Section 40 06 72 for process alarms.

1.06 INTERLOCKS

- A. None

1.07 CONTROL OPERATION

- A. Local Operation:
 - 1. Location of local control:
 - a. HVAC is controlled from the HVAC Air Handler Controllers.
 - 2. Local Indications:
 - a. There is a multi-page Air Handler Controller that is used to control and monitor the fans and temperature setpoints.
 - b. See HVAC User Manual for Instructions.
- B. Hardwired Alarm Circuits
 - 1. Status signal from each HVAC Air Handler Controller Panel
 - a. Low Air Flow Alarm discrete relay contact to building audible and visual alarm light/horn system warning of low HVAC flow.
- C. DCS Inputs:
 - 1. Hardwired:
 - a. None
 - 2. Modbus/TCP Ethernet Communication:
 - a. Status signals from each HVAC Air Handler Controller Panel
 - b. AHU Status:
 - 1) ON
 - 2) Alarm
 - c. FAN Status for each fan if multiple:
 - 1) ON -
 - 2) ALARM
 - d. Zone Temperatures
 - 1) Inlet Temperature
 - 2) Outlet Temperature
 - 3. Air Flow Monitoring Switches
 - a. Low Flow Alarm

D. DCS Manual Operation:

1. None

E. DCS Automatic Operation:

1. None

F. Miscellaneous DCS Control:

1. None

G. Graphics

All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. Graphic examples are not provided for this section. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.

1. Diagram HVAC Systems. - Tabular Layout.
2. Include status of all air handling units, temperatures and alarms
3. Refer to HVAC drawings for details.

END OF SECTION

SECTION 40 65 05

CONTROL STRATEGY CS704-90 RAW SEWAGE POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

- A. This section is provided for reference only. Programming of the Emerson Ovation DCS will be on a separate contract from County with Emerson.
- B. The power quality facility is installing medium voltage and low voltage power distribution equipment. This strategy is identifying the work of adding the monitoring points, control strategies and graphics to the Ovation DCS system.

1.02 REFERENCES

- A. P&IDS:
 - 1. WP704-P-60081, WP704-P-60082.
- B. Related Control Strategies: None.
- C. Control Diagrams: None.
- D. Instrument Loop Diagrams:
 - 1. Loop Diagrams listed with Paragraph 1.03 Equipment.
- E. Ovation DCS I/O Schedule:
 - 1. Ovation I/O List, Section 40 06 73, DCS I/O Schedule.

1.03 SYSTEM DESCRIPTION

- A. Electrical Distribution Equipment:
 - 1. The status of uninterruptable power supplies (UPS), switchgear breakers and breakers feeding the Raw Sewage Pumping (RSP) main pump variable frequency drives (VFD) are considered as critical information for plant operations.
 - 2. Each device will be monitored with hardwired control circuits for the following:
 - a. Breakers:
 - 1) Breaker Closed Status.
 - 2) Relay Fault Status.
 - b. UPS's:
 - 1) Fault.

1.04 EQUIPMENT

P&ID DWG #	LOOP DWG #	EQUIPMENT NUMBER	DESCRIPTION
WP704-P-60081	WP704-I-70650	704-BKR26BD011	704-MSG02 A-SIDE MAIN MV BREAKER
WP704-P-60081	WP704-I-70651	704-RLY26BD011	704-MSG02 A-SIDE MAIN MV BREAKER PROTECTION RELAY
WP704-P-60081	WP704-I-70652	704-BKR03DC011	704-MSG02 PUMP 1 MV BREAKER
WP704-P-60081	WP704-I-70653	704-RLY03DC011	704-MSG02 PUMP 1 MV BREAKER PROTECTION RELAY

P&ID DWG #	LOOP DWG #	EQUIPMENT NUMBER	DESCRIPTION
WP704-P-60081	WP704-I-70654	704-UPS03DC011	704-MSG02 PUMP 1 MOTOR UPS
WP704-P-60081	WP704-I-70655	704-BKR03DC021	704-MSG02 PUMP 2 MV BREAKER
WP704-P-60081	WP704-I-70656	704-RLY03DC021	704-MSG02 PUMP 2 MV BREAKER PROTECTION RELAY
WP704-P-60081	WP704-I-70657	704-UPS03DC021	704-MSG02 PUMP 2 MOTOR UPS
WP704-P-60081	WP704-I-70658	704-BKR03DC051	704-MSG02 A-SIDE SPARE MV BREAKER
WP704-P-60081	WP704-I-70659	704-RLY03DC051	704-MSG02 A-SIDE SPARE MV BREAKER PROTECTION RELAY
WP704-P-60081	WP704-I-70660	704-BKR26BD013	704-MSG02 MV TIE BREAKER
WP704-P-60082	WP704-I-70661	704-BKR26BD012	704-MSG02 B-SIDE MAIN MV BREAKER
WP704-P-60082	WP704-I-70662	704-RLY26BD012	704-MSG02 B-SIDE MAIN MV BREAKER PROTECTION RELAY
WP704-P-60082	WP704-I-70663	704-BKR03DC031	704-MSG02 PUMP 3 MV BREAKER
WP704-P-60082	WP704-I-70664	704-RLY03DC031	704-MSG02 PUMP 3 MV BREAKER PROTECTION RELAY
WP704-P-60082	WP704-I-70665	704-UPS03DC031	704-MSG02 PUMP 3 MOTOR UPS
WP704-P-60082	WP704-I-70666	704-BKR03DC041	704-MSG02 PUMP 4 MV BREAKER
WP704-P-60082	WP704-I-70667	704-RLY03DC041	704-MSG02 PUMP 4 MV BREAKER PROTECTION RELAY
WP704-P-60082	WP704-I-70668	704-UPS03DC041	704-MSG02 PUMP 4 MOTOR UPS
WP704-P-60082	WP704-I-70669	704-BKR03DC061	704-MSG02 B-SIDE SPARE MV BREAKER
WP704-P-60082	WP704-I-70670	704-RLY03DC061	704-MSG02 B-SIDE SPARE MV BREAKER PROTECTION RELAY
WP704-P-60011	WP704-I-70101	704-VFD03DC011	704-MSG02 RAW SEWAGE PUMP 1 VFD
WP704-P-60012	WP704-I-70201	704-VFD03DC021	704-MSG02 RAW SEWAGE PUMP 2 VFD
WP704-P-60013	WP704-I-70301	704-VFD03DC031	704-MSG02 RAW SEWAGE PUMP 3 VFD
WP704-P-60014	WP704-I-70401	704-VFD03DC041	704-MSG02 RAW SEWAGE PUMP 4 VFD

1.05 ALARMS

- A. Alarm Schedule:
1. Refer to Section 40 06 72 for process alarms.

1.06 INTERLOCKS

- A. None

1.07 DCS POINTS

- A. Hardwired Points:
1. Build the DI points listed in Section 40 06 73, DCS I/O Schedule.
 2. Configure alarms as indicated in Article 1.06 Alarms.

- B. Ethernet Points:

1. Build SCADA definition points for each type of equipment. Coordinate with County Staff to verify parameters to read.
2. Build SCADA points for each point indicated as an Ethernet Type.

1.08 CONTROL OPERATION

- A. Points are for monitoring indication and alarming only.

1.09 GRAPHICS

- A. Graphics

All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. The following graphic examples may be used as a basis for some of the process screens but may not reflect all requirements. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.

- B. Create Power Distribution Overview Graphics indicating the status represented in the P&IDs of the Contract Drawings. Coordinate with Project Representative for details.
 1. One page for the switchgear 704-SWG02.
 2. One page for each set of equipment from the switchgear above to the pumps VFDs. (4 total).

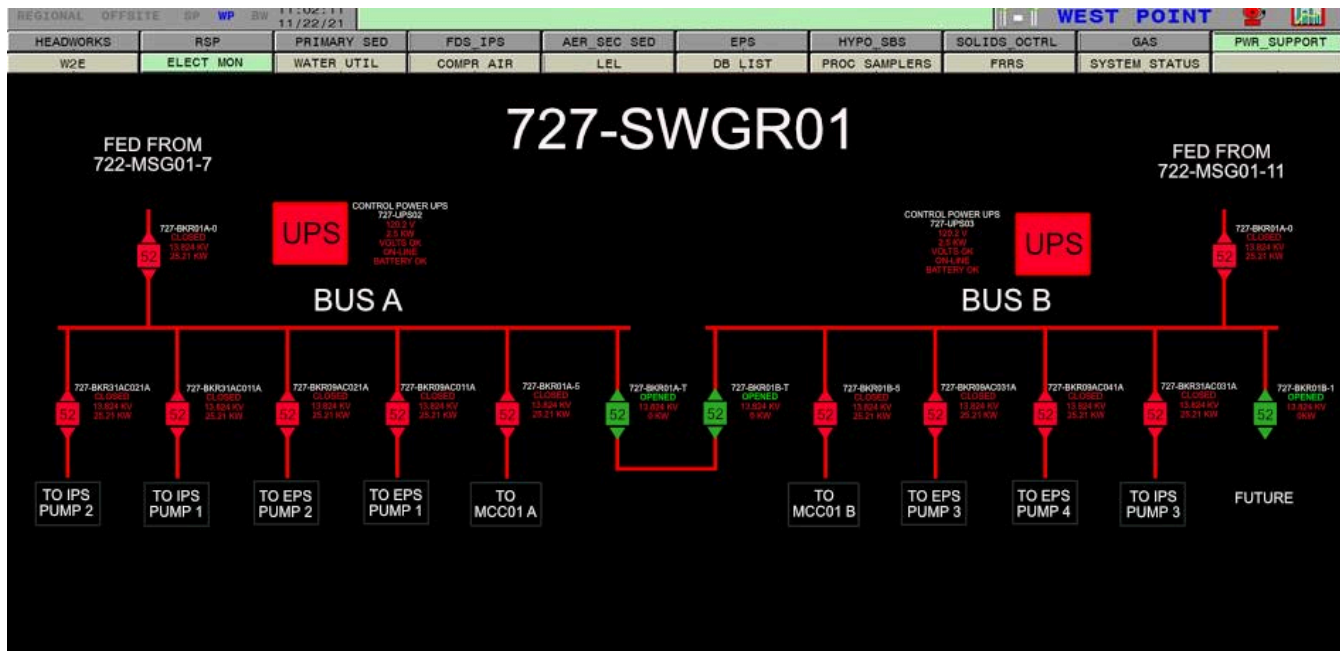


Figure 1 - SAMPLE SWITCHGEAR GRAPHIC

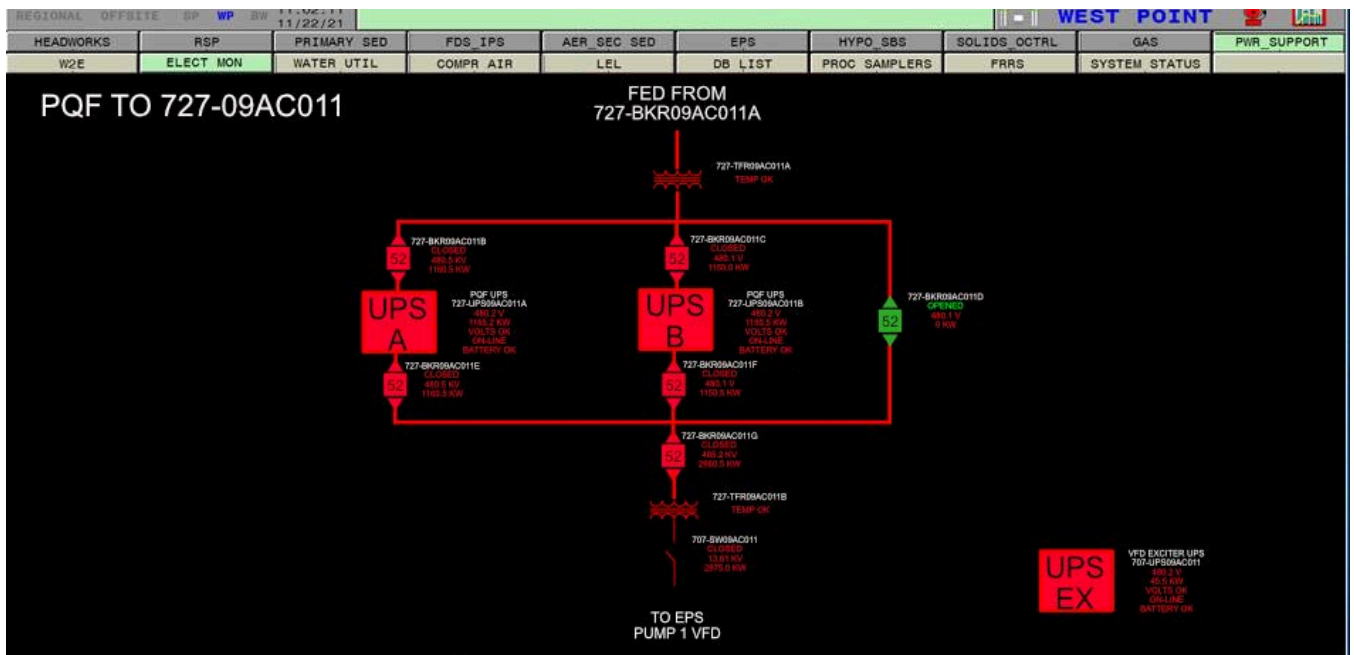


Figure 2 - SAMPLE PQF POWER TO VFD GRAPHIC

END OF SECTION

SECTION 40 65 06

CONTROL STRATEGY CS704-97 RSP BUILDING LEL & GAS MONITORING

PART 1 GENERAL

1.01 SUMMARY

- A. This control strategy defines the controls related to the LEL and gas monitoring systems at the raw sewage pumping area.

1.02 REFERENCES

- A. P&IDs:
 - 1. WP704-P-60031, WP704-P-60032, WP704-P-60035, & WP704-P-60036.
- B. Related Control Strategies: CS704-25_RS PUMP BUILDING HVAC.
- C. Control Diagrams: None.
- D. Instrument Loop Diagrams:
 - 1. WP704-I-70610, WP704-I-70611, WP704-I-70612, WP704-I-70613, WP704-I-70614, WP704-I-70615, WP704-I-70616, WP704-I-70617, WP704-I-70618, WP704-I-70619, WP704-I-70620, WP704-I-70621, WP704-I-70622, WP704-I-70623, WP704-I-70624, WP704-I-70625, WP704-I-70626, WP704-I-70627, WP704-I-70628, & WP704-I-70629.
- E. Instrument Schedule:
 - 1. See Section 40 06 71 Instrument Schedule
- F. Alarm Schedule:
 - 1. See Section 40 06 72 Alarm Schedule
- G. Ovation DCS I/O Schedule:
 - 1. See Section 40 06 73 Ovation DCS I/O Schedule

1.03 SYSTEM DESCRIPTION

- A. Flammable and hazardous gas detectors are located in various locations throughout the RSP Crane Hall.
 - 1. Lower Explosive Limit (LEL) and Carbon Monoxide (CO) levels are monitored in one location on the Pump Level. The two sensors are connected to a single transmitter, respectively, near the generator engine, in the maintenance shop and on the ground floor above the generator engine.
 - 2. Lower Explosive Limit (LEL) and Carbon Monoxide (CO) levels are monitored in two locations on the Motor Level, in each location, the two sensors are connected to a single transmitter, respectively. One is in the Engine Maintenance Room 421 and the other is located North of the Generator.
 - 3. Carbon Monoxide (CO) levels are monitored in three locations on the Ground Level. One at the Northwest Corner near the Generator Silencer, one in the North Battery Room 409, and one in the South Battery Room 408.
- B. Each sensor has an analog signal that is connected to the Ovation DCS in ACC1. The analog points in the Ovation DCS will have alarms configured to alert operators of elevated gas conditions.

- C. Each transmitter has high alarm and fault contact outputs that are connected to the facility light and horn warning system. When a high LEL, CO, or H2S reading is present, or a sensor fault is present, the AMBER (yellow) alarm lights and horns will activate. The horn can be acknowledged and silenced with a button on 704-ACP0301.
- D. The facility light and horn warning system also is triggered by a ventilation system alarm. Control Room Low Ventilation and Pump Room Low Ventilation alarms are provided by the respective Air Handler controllers. When these alarms are present, the WHITE alarm lights and horns will activate. The horn can be acknowledged and silenced with a button on 704-ACP0301.
- E. The horns are adjustable so that they are set to a minimum of 15 dBa over maximum ambient noise, without exceeding a maximum of 110 dBa. Contractor to verify maximum ambient while 3 pumps operating simultaneously at each location of installed horn. Contractor to set horns to 15dBa over measured ambient noise and provide report of settings to OWNER and ENGINEER.
- F. There is no control via DCS for this strategy.

1.04 EQUIPMENT

P&ID DWG #	LOOP DWG #	EQUIPMENT #	DESCRIPTION
WP704-P-60035	WP704-I-70614	704-AE/AIT03BR011	RSP – CRANE HALL PUMP LEVEL NW H2S & LEL
WP704-P-60036	WP704-I-70615	704-AE/AIT03BVx32	RSP – NORTH BATTERY ROOM 409 CO
WP704-P-60036	WP704-I-70616	704-AE/AIT03BVx33	RSP – SOUTH BATTERY ROOM 408 CO
WP704-P-60035	WP704-I-70617	704-AE/AIT03BV011	RSP – CRANE HALL MOTOR LEVEL RM 421 LEL & CO
WP704-P-60035	WP704-I-70618	704-AE/AIT03BV021	RSP – CRANE HALL MOTOR LEVEL GEN LEL & CO
WP704-P-60035	WP704-I-70619	704-AE/AIT03BV031	RSP – CRANE HALL GROUND LEVEL NW CORNER CO
WP704-P-60036	WP704-I-70620	704-QL03AY051	RSP – CONTROL RM AREA ALARM HORN & LIGHTS ACC1 ENTRANCE
WP704-P-60036	WP704-I-70620	704-QL03AY052	RSP – CONTROL RM AREA ALARM HORN & LIGHTS BREAK ROOM
WP704-P-60036	WP704-I-70620	704-QL03AY053	RSP – CONTROL RM AREA ALARM HORN & LIGHTS ACC1 HALLWAY
WP704-P-60035	WP704-I-70621	704-QL03AY011	RSP – CRANE HALL PUMP LEVEL ALARM HORN & LIGHTS NW CORNER
WP704-P-60035	WP704-I-70621	704-QL03AY012	RSP – CRANE HALL PUMP LEVEL ALARM HORN & LIGHTS SOUTH WALL CENTER
WP704-P-60035	WP704-I-70621	704-QL03AY013	RSP – CRANE HALL PUMP LEVEL ALARM HORN & LIGHTS NE CORNER
WP704-P-60036	WP704-I-70622	704-QL03AYx54	RSP – N/S BATTERY ROOM ENTRANCE ALARM HORN & LIGHTS
WP704-P-60035	WP704-I-70622	704-QL03AY021	RSP – CRANE HALL PUMP LEVEL ALARM HORN & LIGHTS EAST STAIR TO EAST FAN ROOM
WP704-P-60035	WP704-I-70622	704-QL03AYx39	RSP – CRANE HALL MOTOR LEVEL EAST WALL ALARM HORN & LIGHTS
WP704-P-60035	WP704-I-70623	704-QL03AY031	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS NW GALLERY ENTRANCE
WP704-P-60035	WP704-I-70623	704-QL03AY032	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS NW CORNER
WP704-P-60035	WP704-I-70623	704-QL03AY033	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS SW CORNER

P&ID DWG #	LOOP DWG #	EQUIPMENT #	DESCRIPTION
WP704-P-60035	WP704-I-70624	704-QL03AY034	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS SW ELECTRIC ROOM
WP704-P-60035	WP704-I-70624	704-QL03AY035	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS WEST SIDE MOTOR PLATFORM
WP704-P-60035	WP704-I-70624	704-QL03AY036	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS SOUTH WALL
WP704-P-60035	WP704-I-70625	704-QL03AY037	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS COLUMN C5
WP704-P-60035	WP704-I-70625	704-QL03AY08	RSP – CRANE HALL MOTOR LEVEL ALARM HORN & LIGHTS EAST GALLERY ENTRANCE
WP704-P-60035	WP704-I-70626	704-QL03AY041	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS NW OUTSIDE ENTRANCE
WP704-P-60035	WP704-I-70626	704-QL03AY042	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS NW CORNER EXIT
WP704-P-60035	WP704-I-70626	704-QL03AY043	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS SW CORNER EXIT
WP704-P-60035	WP704-I-70627	704-QL03AY044	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS SW TOOL ROOM ENTRANCE
WP704-P-60035	WP704-I-70627	704-QL03AY045	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS ELECTRICAL ROOM 411 SOUTH CENTER
WP704-P-60035	WP704-I-70627	704-QL03AY046	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS SE CORNER
WP704-P-60035	WP704-I-70628	704-QL03AY047	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS NE CORNER EXIT
WP704-P-60035	WP704-I-70628	704-QL03AY048	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS NE OUTSIDE ENTRANCE
WP704-P-60036	WP704-I-70629	704-QL03AY049	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS NORTH BATTERY ROOM 409
WP704-P-60036	WP704-I-70629	704-QL03AY050	RSP – CRANE HALL GROUND LEVEL ALARM HORN & LIGHTS SOUTH BATTERY ROOM 408

1.05 ALARMS

- A. Alarm Schedule:
1. Refer to Section 40 06 72 for process alarms.

1.06 INTERLOCKS

- A. None

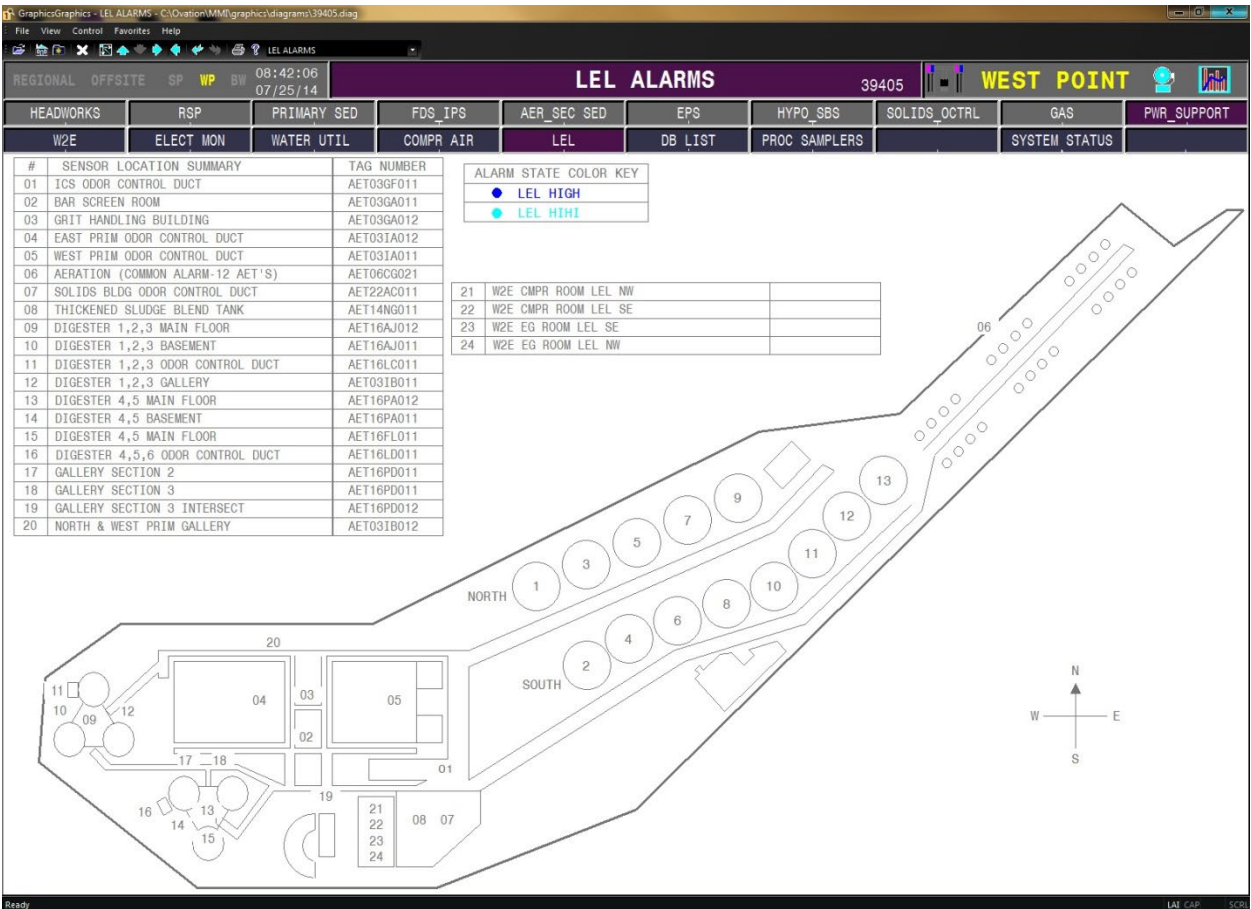
1.07 CONTROL OPERATION

- A. None – DCS points are for monitoring only.

1.08 GRAPHICS

- A. All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

- B. All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. The following graphic examples may be used as a basis for some of the process screens but may not reflect all requirements. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.
- C. Create a graphic for the Pump Level gas sensors, indicating measured level, trends, transmitter signal status alarm states.
- D. Create a graphic for the Motor Level gas sensors, indicating measured level, trends, transmitter signal status alarm states.
- E. Create a graphic for the Ground Level gas sensors, indicating measured level, trends, transmitter signal status alarm states.
- F. In addition to the detail pages specified in A, B and C above, each gas sensor needs to be added to the Site LEL overview page matching established display standards:



Existing LEL Alarm page overview graphic where status of all new LEL sensors need to be added. CO and H2S sensor status need to be displayed on process overview screens as directed by OWNER.

END OF SECTION

SECTION 40 65 08

CONTROL STRATEGY CS704-99 RAW SEWAGE OVATION PROGRAM CLEANUP

PART 1 GENERAL

1.01 SUMMARY

- A. The raw sewage pump and system demolition is permanently removing the raw sewage engine, pump room HVAC system and the associated control valves and instruments. This strategy is identifying the work of removing the associated Ovation programming elements; points, control sheets and graphics from the Ovation DCS system.

1.02 REFERENCES

- A. P&IDS:
 - 1. All WP704-DP-6xxxx drawings.
 - 2. All WP705-DP-6xxxx drawings.
- B. Related Control Strategies: None.
- C. Control Diagrams: None.
- D. Instrument Loop Diagrams:
 - 1. All WP704-DI-7xxxx drawings.
 - 2. All WP705-DI-7xxxx drawings.
- E. Ovation DCS I/O Schedule:
 - 1. See Section 40 06 73 Ovation DCS I/O Schedule.

1.03 CONTROL OPERATION

- A. All related programming in the Ovation DCS is to be removed for the equipment being demolished.
 - 1. Determine which control sheets and graphics contain points and controls for equipment that are being removed. Review with Project Representative.
 - 2. Coordinate deleting of objects with the Project Representative.
 - 3. Maintain a list of all points, control sheets and graphic elements deleted. Submit to County for removal of elements from the OSI PI system and other document cleanup.
 - 4. If all elements within a control sheet or graphic are being removed, delete the control sheet and/or graphic page.
- B. For the analog I/O points that are moving from local I/O to remote I/O change the assigned card information.

1.04 SUBMITTALS (FOR DCS PROGRAMMER)

- A. Procedures: Section 01 33 00.
- B. Provide a listing of all points, control sheets and graphics deleted.

END OF SECTION

SECTION 40 65 09

CONTROL STRATEGY CS704-05 HOT WATER BOILERS

PART 1 GENERAL

1.01 SUMMARY

- A. This control strategy defines the controls and sequence operation of the four (4) new package boiler systems, replacing the existing three (3) package boilers. Sequence control will include all four boilers, expanding the existing sequencer logic to include the additional systems. OVATION DCS program alteration will be required to implement the additional systems and provide functionality for ethernet data communication to each of the new package boilers. The new boilers are to function in-kind to existing sequenced boilers, with additional systems included.

1.02 REFERENCES

- A. Specification Section Reference: Section 23 52 39.16, 42 11 40.
- B. P&IDs: WP705-P-61000, WP705-P-61001, WP 705-P-62000, WP 705-P-62001, WP 705-P-63000, WP705-P-63001, WP 705-P-64000, WP 705-P-64001
- C. Loop Sheets: WP705-I-70051 through WP705-I-70071. WP705-I-70081, WP705-I-70082, WP705-I-70083, WP705-I-70084.

1.03 SYSTEM DESCRIPTION

- A. Four hot water boilers are used when the heat supplied by the engine generators in W2E heat recovery to the hot water system is not enough to maintain adequate hot water temperature in the primary hot water loop. Boiler 2 and Boiler 4 each provide up to 3.35 million BTU/hr while Boiler 1 and Boiler 3 provide up to 13.39 million BTU/hr.
- B. Total heat demand varies according to process and HVAC requirements throughout the plant. The DCS can be used to manually start and stop the boilers remotely as heat demands change. Total heat demand varies according to process and HVAC requirements throughout the plant.
- C. Each boiler has a hot water circulation pump (Boiler 3 has an auxiliary circulation pump as well) and a 3-way mixing valve. Each boiler uses a circulation pump to draw water from the PHW loop and circulates the water through the boiler and back to the primary heat loop. The water drawn from the PHW loop goes through a three-way mixing valve on the suction side of the pump. The position of the mixing valve determines how much water is drawn from the PHW loop and how much is recirculated through the boiler. (Currently these valves are operated manually by the operator via manual loading station. There is no automatic modulation of these valves) Each boiler can be isolated from the primary heat loop by manual valves located upstream and downstream of the boilers.
- D. Expansion Tanks: Each boiler is equipped with an expansion tank to allow expansion of water in the boiler loop during heating. Each tank is equipped with a pressure relief valve, sightglass, and drain to the plant sewer system.
- E. Air Separators: An air separator, located downstream of each boiler, allows removal of air from the boiler heat loop. The air separator drains to the plant sewer system and is vented to the heat loop expansion tanks. Controls and Indicators Temperature indicators. These are located upstream and downstream of the boiler heat loop connections to the primary heat loop.

- F. Pressure indicator: A pressure indicator is located downstream of boiler 3 and on each boiler field panel.
- G. ON indicators. ON indicators located at the boiler field panel, at ACC-1 Section C (704-ACP0301), and at the SCS (via PLC-P1) indicate that a boiler has successfully completed its ignition startup sequence and is ready for firing rate control.
- H. Boiler 1 2 3 and 4 can be operated in a fully automatic mode using a LEAD/LAG control sequence described in Section 1.06.H. The firing rate can be controlled manually or automatically using a selected PHW loop temperature as the process variable.

1.04 EQUIPMENT

- A. The following equipment is monitored/controlled as part of this strategy:

Description	Field Tag Description	Equipment Tag	P&ID
Hot Water Boiler 1		704-BO19FB011	WP705-P-61001
Boiler 1 Circulation Pump		704-P19FC011	WP705-P-61001
Boiler 1 Mixing Valve		704-TCV19JJ011	WP705-P-61001
Boiler 1 Temperature Transmitter		704-TIT19FB011	WP705-P-61001
Hot Water Boiler 2		704-BO19FB021	WP705-P-62001
Boiler 2 Circulation Pump		704-P19FC021	WP705-P-62001
Boiler 2 Mixing Valve		704-TCV19JJ021	WP705-P-62001
Boiler 2 Temperature Transmitter		704-TIT19FB021	WP705-P-62001
Hot Water Boiler 3		704-BO19FB031	WP705-P-63001
Boiler 3 Main Circulation Pump		704-P19FC031	WP705-P-63001
Boiler 3 Aux Circulation Pump		704-P19FC041	WP705-P-63001
Boiler 3 Mixing Valve		704-TCV19JJ031	WP705-P-63001
Boiler 3 Temperature Transmitter		704-TIT19FB031	WP705-P-63001

Description	Field Tag Description	Equipment Tag	P&ID
Hot Water Boiler 1		704-BO19FB011	WP705-P-61001
Boiler 1 Circulation Pump		704-P19FC011	WP705-P-61001
Boiler 1 Mixing Valve		704-TCV19JJ011	WP705-P-61001
Hot Water Boiler 4		704-BO19FB041	WP705-P-64001
Boiler 4 Circulation Pump		704-P19FC041	WP705-P-64001
Boiler 4 Mixing Valve		704-TCV19JJ041	WP705-P-64001
Boiler 4 Temperature Transmitter		704-TIT19FB041	WP705-P-64001

1.05 DCS MANUAL OPERATION

A. Boiler 1

1. Fuel Selection

- Boiler 1 fuel selection can be made using popup 31211 if LOCAL/REMOTE switch on the local boiler panel is Selected to AUTO (WP704NDA19FB013).

2. BOILER 1 Start/Stop

- Pop-up window Diagram 31211 is used to control START/STOP functions of Boiler 1.
- Start/Stop Control
 - Manual START/STOP functions
- Start Permissives:
 - HOR Switch in Remote (WP704NDA19FB011)
 - Boiler 1 Circulation Pump Running (WP704NDJ19FC011)
 - Boiler LSG Pressure not Low-Low (WP-70405A-PI16HA011ALL)
- Stop Permissives:
 - HOR Switch in Remote (WP704NDA19FB011)
- Trips:
 - Boiler 1 Fail (WP704XAD19FA011)
 - Boiler 1 LSG Pressure Low-Low (WP-70405A-PI16HA011ALL)
 - Boiler 1 Circulation Pump Not Running (WP704NDJ19FC011) [override stop]
- Manual Rejects:
 - None
- Other Alarms:
 - N/A

3. Boiler 1 Circulation Pump

- Pop-up window Diagram 31211 is used to control START/STOP functions of Boiler 1 Circulation Pump.
- Start/Stop Control
 - Manual START/STOP functions
- Start Permissives:
 - HOR Switch in Remote (WP704NDA19FC011)
- Stop Permissives:
 - HOR Switch in Remote (WP704NDA19FC011)
- Trips:

- 1) None
- f. Manual Rejects:
 - 1) None
- g. Other Alarms:
 - 1) N/A
- 4. Boiler 1 Mixing Valve
 - a. The mixing valve is controlled manually using manual loading station on Popup 31216.

B. BOILER 2

- 1. Boiler 2 Fuel Selection
 - a. Boiler 2 fuel selection can be made using popup 31216 if the LOCAL/REMOTE switch on the local boiler panel is Selected to AUTO (WP704NDA19FB022).
- 2. BOILER 2 Start/Stop
 - a. Pop-up window Diagram 31216 is used to control START/STOP functions of Boiler 2.
 - b. Start/Stop Control
 - 1) Manual START/STOP functions
 - c. Start Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FB021)
 - 2) Boiler 2 Circulation Pump Running (WP704NDJ19FC021)
 - 3) Boiler 2 LSG Pressure not Low-Low (WP-70405B-PI16HA011ALL)
 - d. Stop Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FB021)
 - e. Trips:
 - 1) Boiler 2 Fail (WP704XAD19FA021)
 - 2) Boiler 2 LSG Pressure Low-Low (WP-70405B-PI16HA011ALL)
 - 3) Boiler 2 Circulation Pump Not Running (WP704NDJ19FC021) [override stop]
 - f. Manual Rejects:
 - 1) None
 - g. Other Alarms:
 - 1) N/A
- 3. Boiler 2 Circulation Pump
 - a. Pop-up window Diagram 31216 is used to control START/STOP functions of Boiler 2 Circulation Pump.
 - b. Start/Stop Control
 - 1) Manual START/STOP functions
 - c. Start Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FC021)
 - d. Stop Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FC021)
 - e. Trips:
 - 1) None
 - f. Manual Rejects:
 - 1) None
 - g. Other Alarms:
 - 1) N/A
- 4. Boiler 2 Mixing Valve
 - a. The mixing valve position is controlled manually using the manual loading station on Popup 31216.

C. BOILER 3

- 1. Boiler 3 Fuel Selection
 - a. Boiler 3 fuel selection can be made by the operator using popup 31221 if the LOCAL/REMOTE switch on the local boiler panel is Selected to AUTO (WP704NDA19FB032).
- 2. Boiler 3 Start/Stop
 - a. Pop-up window Diagram 31221 is used to control START/STOP functions of Boiler 3.
 - b. Start/Stop Control

- 1) Manual START/STOP functions
 - c. Start Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FB031)
 - 2) Boiler 3 Circulation Pump Running (WP704NDJ19FC031)
 - 3) Boiler 3 LSG Pressure not Low-Low (WP-70405C-PI16HA011ALL)
 - d. Stop Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FB031)
 - e. Trips:
 - 1) Boiler 3 Fail (WP704XAD19FB031)
 - 2) Boiler 3 LSG Pressure Low-Low (WP-70405C-PI16HA011ALL)
 - 3) Boiler 3 Circulation Pump Running (WP704NDJ19FC031) [override stop]
 - f. Manual Rejects:
 - 1) None
 - g. Other Alarms:
 - 1) N/A
 - 3. Boiler 3 Circulation Pump
 - a. Pop-up window Diagram 31222 is used to control START/STOP functions of Boiler 1 Circulation Pumps.
 - b. Start/Stop Control
 - 1) Manual START/STOP functions
 - c. Start Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FC031)
 - d. Stop Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FC031)
 - e. Trips:
 - 1) None
 - f. Manual Rejects:
 - 1) None
 - g. Other Alarms:
 - 1) N/A
 - 4. Boiler 3 Mixing Valve
 - a. The mixing valve position is controlled manually using manual loading station on Popup 31221.
- D. BOILER 4
- 1. Boiler 4 Fuel Selection
 - a. Boiler 2 fuel selection can be made using popup 31216 if the LOCAL/REMOTE switch on the local boiler panel is Selected to AUTO (WP704NDA19FB042).
 - 2. BOILER 4 Start/Stop
 - a. Pop-up window Diagram 31216 is used to control START/STOP functions of Boiler 4.
 - b. Start/Stop Control
 - 1) Manual START/STOP functions
 - c. Start Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FB041)
 - 2) Boiler 4 Circulation Pump Running (WP704NDJ19FC041)
 - 3) Boiler 4 LSG Pressure not Low-Low (WP-70405B-PI16HA011ALL)
 - d. Stop Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FB041)
 - e. Trips:
 - 1) Boiler 4 Fail (WP704XAD19FA021)
 - 2) Boiler 4 LSG Pressure Low-Low (WP-70405B-PI16HA011ALL)
 - 3) Boiler 4 Circulation Pump Not Running (WP704NDJ19FC041) [override stop]
 - f. Manual Rejects:
 - 1) None
 - g. Other Alarms:
 - 1) N/A
 - 3. Boiler 4 Circulation Pump

- a. Pop-up window Diagram 31216 is used to control START/STOP functions of Boiler 2 Circulation Pump.
- b. Start/Stop Control
 - 1) Manual START/STOP functions
- c. Start Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FC041)
- d. Stop Permissives:
 - 1) HOR Switch in Remote (WP704NDA19FC041)
- e. Trips:
 - 1) None
- f. Manual Rejects:
 - 1) None
- g. Other Alarms:
 - 1) N/A
- 4. Boiler 4 Mixing Valve
 - a. The mixing valve position is controlled manually using the manual loading station on Popup 31216.

1.06 DCS AUTOMATIC OPERATION

A. Boiler 1

- 1. Boiler 1 Start/Stop
 - a. Boiler control via the DCS is accomplished using popup 31211 and consists of:
 - 1) Starting and Stopping the Boiler Hotwater Circulation Pump
 - 2) Starting and Stopping the Boiler based on the LEAD/LAG sequence control. LEAD lag assignments are set by the operator using 31211,
 - 3) Modulating the Boiler Firing Rate based on the Heat Loop Master Temperature Controller (see CS 704-06).
 - b. The hot water mixing valve position is only controlled manually via the DCS using popup 31211 and will normally be set at 100% unless the boiler is out of service.
 - c. Boiler Operation is divided into the following phases:
 - 1) OFF with Energy Save Disabled – Boiler start command is FALSE. Hot water circulation pump will run continuously if in selected to AUTO on Popup 31211.
 - 2) OFF with Energy Save Enabled – Boiler start command is FALSE. The hot water circulation pump will run on a timed cycle if pump is selected to AUTO on popup 31211.
 - 3) STARTING: This phase starts when the start command (WP704MNJ19FB011) is sent to the local boiler control panel and initiates the boiler internal startup sequence. This phase ends when the boiler control panel activates the boiler running feedback (WP704NDJ19FB011). (note: the boiler start command is maintained until a boiler stop command is issued)
 - 4) LOW FIRE: This phase starts when the boiler running feedback is received and the run command is still active. The DCS then starts a low fire timer. The Low Fire Timer Set point (WP704XLFA011-LFRTMRSP, initial value 0.5 minutes) is operator adjustable using popup 31213. This phase ends normally when the timer times out. It will also end if the run command or the boiler run feedback becomes FALSE. A low fire status point (WP704XLDA011-LFR) is set when this phase is initiated and is reset when the phase ends. When the LOW FIRE phase ends, the boiler is now considered fully operational and ready to accept external Firing Rate Demand signal via the DCS in either MANUAL or AUTO modes.
 - 5) RAMP UP: This phase starts when the Low Fire timer times out and ends when the boiler internal temperature reaches an operator adjustable initial or ramp up setpoint value (WP704XLFA011-ISP, initial value 155 deg F). This phase will also end if the start command or the boiler running feedback become FALSE. A ramping status point (WP704XLDA011-RAM) is set when this phase is initiated and is reset when the phase ends.

- d. When the RAMP UP phase ends, the boiler is now considered fully operational and the Firing Rate will be controlled via the DCS in either MANUAL or AUTO modes.
 - e. In full AUTO mode, the boiler will automatically start and stop based on the auto sequence control (see Section 1.06.H below and the firing rate will be controlled by the PHW Heat Loop Master Controller.
2. Boiler 1 Firing Rate Control
- a. When the DCS issues a START command (WP708MNJ19FB011), the DCS Boiler 1 firing rate controller output is set to 0% and the firing rate is controlled by the local boiler field panel. When the boiler startup sequence is complete, the field panel activates the Boiler running feedback signal (WP708NDJ19FB011).
 - b. When the boiler running feedback is activated, the DCS takes over firing rate control with a LOW FIRE phase. During the LOW FIRE phase, the DCS Boiler 1 firing rate controller output is set to an engineer adjustable value (initial value 5%).
 - c. The LOW FIRE phase duration is controlled by an operator adjustable timer setpoint (WP704XLA19FA011-LFRTMRSP value entered on popup 31213).
 - d. After the startup and low fire phases are completed, The Boiler firing rate will be controlled by PHW Master Temperature Controller (see CS 704-06) that uses PHW loop temperature as the process variable.
 - e. Boiler 1 Firing Rate Controller (equivalent to speed controller for a variable speed pump) can be operated in 2 modes:
 - 1) MANUAL: With the Firing Rate Controller in MANUAL, the operator can directly set the firing rate by entering the output using Popup 31211 (firing rate manual loading station).
 - 2) AUTO: With the Firing Rate Controller in AUTO, the firing rate will be modulated by the Heat Loop Master control PID algorithm to maintain the selected PHW loop temperature.
 - a) The process variable for this controller is one of the 4 PHW loop temperatures. See CS 704-06.
 - b) The DCS provides an operator adjustable set point (WP704XLA19FA011-STPT, initial value 160 degrees F) that can be entered using Popup 31211.
 - c) The output (WP704TC19FA011-DMD) from this controller is sent to the boiler 1 Firing Rate controller. When the Boiler 1 Firing Rate Controller is in AUTO, the output is sent to Boiler 1 as WP704TC19FA011.
3. Boiler 1 Hot Water Circulation Pump
- a. The AUTO/MANUAL status of the circulation pump is selected using popup 31211.
 - b. When selected to MANUAL, the pump can be started and stopped as described above.
 - c. An Energy Saver mode can be ENABLED or DISABLED using popup 31211
 - d. When selected to AUTO, the pump will be called to run and will run continuously if Energy Saver mode is DISABLED.
 - e. When selected to AUTO and Energy Saver mode is ENABLED, the pump will run intermittently on a timed cycle controlled by two timers. The timer values are set by two operator adjustable setpoints using popup 31211:
 - 1) Cycle Timer Set Point (WP-70405A-CYCTIME-SP, initial value 0 hours).
 - 2) On Timer Set Point (WP-70405A-ONTIME-SP, initial value 2 minutes)
- B. Boiler 2
1. Boiler 2 Start/Stop
- a. Boiler control via the DCS is accomplished using popup 31216 and consists of:
 - 1) Starting and Stopping the Boiler Hotwater Circulation Pump
 - 2) Starting and Stopping the Boiler based on the LEAD/LAG sequence control. LEAD lag assignments are set by the operator using 31216,
 - 3) Modulating the Boiler Firing Rate based on the Heat Loop Master Temperature Controller (see CS 704-06).
 - b. The hot water mixing valve position is only controlled manually via the DCS using popup 31216 and will normally be set at 100% unless the boiler is out of service.
 - c. Boiler Operation is divided into the following phases:
 - 1) OFF with Energy Save Disabled – Boiler start command is FALSE. Hot water circulation pump will run continuously if in selected to AUTO on Popup 31216.

- 2) OFF with Energy Save Enabled – Boiler start command is FALSE. The hot water circulation pump will run on a timed cycle if pump is selected to AUTO on popup 31216.
 - 3) STARTING: This phase starts when the start command (WP704MNJ19FB021) is sent to the local boiler control panel and initiates the boiler internal startup sequence. This phase ends when the boiler control panel activates the boiler running feedback (WP704NDJ19FB021). (note: the boiler start command is maintained until a boiler stop command is issued)
 - 4) LOW FIRE: This phase starts when the boiler running feedback is received and the run command is still active. The DCS then starts a low fire timer. The Low Fire Timer Set point (WP704XLAFA021-LFRTMRSP, initial value 0.5 minutes) is operator adjustable using popup 31213. This phase ends normally when the timer times out. It will also end if the run command or the boiler run feedback becomes FALSE. A low fire status point (WP704XL DFA021-LFR) is set when this phase is initiated and is reset when the phase ends. When the LOW FIRE phase ends, the boiler is now considered fully operational and ready to accept external Firing Rate Demand signal via the DCS in either MANUAL or AUTO modes.
 - 5) RAMP UP: This phase starts when the Low Fire timer times out and ends when the boiler internal temperature reaches an operator adjustable initial or ramp up setpoint value (WP704XLAFA021-ISP, initial value 155 deg F). This phase will also end if the start command or the boiler running feedback become FALSE. A ramping status point (WP704XL DFA021-RAM) is set when this phase is initiated and is reset when the phase ends.
 - d. When the RAMP UP phase ends, the boiler is now considered fully operational and the Firing Rate will be controlled via the DCS in either MANUAL or AUTO modes.
 - e. In full AUTO mode, the boiler will automatically start and stop based on the auto sequence control (see Section 1.06.H below and the firing rate will be controlled by the PHW Heat Loop Master Controller.
2. Boiler 2 Firing Rate Control
- a. When the DCS issues a START command (WP708MNJ19FB021), the DCS Boiler 2 firing rate controller output is set to 0% and the firing rate is controlled by the local boiler field panel. When the boiler startup sequence is complete, the field panel activates the Boiler running feedback signal (WP708NDJ19FB011).
 - b. When the boiler running feedback is activated, the DCS takes over firing rate control with a LOW FIRE phase. During the LOW FIRE phase, the DCS Boiler 1 firing rate controller output is set to an engineer adjustable value (initial value 5%).
 - c. The LOW FIRE phase duration is controlled by an operator adjustable timer setpoint (WP704XLA19FA021-LFRTMRSP value entered on popup 31213).
 - d. After the startup and low fire phases are completed, The Boiler firing rate will be controlled by PHW Master Temperature Controller (see CS 704-06) that uses PHW loop temperature as the process variable.
 - e. Boiler 2 Firing Rate Controller (equivalent to speed controller for a variable speed pump) can be operated in 2 modes:
 - 1) MANUAL: With the Firing Rate Controller in MANUAL, the operator can directly set the firing rate by entering the output using Popup 31216 (firing rate manual loading station).
 - 2) AUTO: With the Firing Rate Controller in AUTO, the firing rate will be modulated by the Heat Loop Master control PID algorithm to maintain the selected PHW loop temperature.
 - a) The process variable for this controller is one of the 4 PHW loop temperatures. See CS 704-06.
 - b) The DCS provides an operator adjustable set point (WP704XLA19FA011-STPT, initial value 160 degrees F) that can be entered using Popup 31212.
 - c) The output (WP704TC19FA021-DMD) from this controller is sent to the boiler 1 Firing Rate controller. When the Boiler 2 Firing Rate Controller is in AUTO, the output is sent to Boiler 2 as WP704TC19FA021.
3. Boiler 2 Hot Water Circulation Pump
- a. The AUTO/MANUAL status of the circulation pump is selected using popup 31216.
 - b. When selected to MANUAL, the pump can be started and stopped as described above.

- c. An Energy Saver mode can be ENABLED or DISABLED using popup 31216
- d. When selected to AUTO, the pump will be called to run and will run continuously if Energy Saver mode is DISABLED.
- e. When selected to AUTO and Energy Saver mode is ENABLED, the pump will run intermittently on a timed cycle controlled by two timers. The timer values are set by two operator adjustable setpoints using popup 31216:
 - 1) Cycle Timer Set Point (WP-70405B-CYCTIME-SP, initial value 2 hours).
 - 2) On Timer Set Point (WP-70405B-ONTIME-SP, initial value 2 minutes)

C. Boiler 3

1. Boiler 3 Start/Stop

- a. Boiler control via the DCS is accomplished using popup 31221 and consists of:
 - 1) Starting and Stopping the Boiler Hotwater Circulation Pump
 - 2) Starting and Stopping the Boiler based on the LEAD/LAG sequence control. LEAD lag assignments are set by the operator using popup 31221,
 - 3) Modulating the Boiler Firing Rate based on the Heat Loop Master Temperature Controller (see CS 704-06).
- b. The hot water mixing valve position is only controlled manually via the DCS using popup 31221 and will normally be set at 100% unless the boiler is out of service.
- c. Boiler Operation is divided into the following phases:
 - 1) OFF with Energy Save Disabled – Boiler start command is FALSE. Hot water circulation pump will run continuously if in selected to AUTO on Popup 31221.
 - 2) OFF with Energy Save Enabled – Boiler start command is FALSE. The hot water circulation pump will run on a timed cycle if pump is selected to AUTO on popup 31221.
 - 3) STARTING: This phase starts when the start command (WP704MNJ19FB031) is sent to the local boiler control panel and initiates the boiler internal startup sequence. This phase ends when the boiler control panel activates the boiler running feedback (WP704NDJ19FB03). (note: the boiler start command is maintained until a boiler stop command is issued)
 - 4) LOW FIRE: This phase starts when the boiler running feedback is received and the run command is still active. The DCS then starts a low fire timer. The Low Fire Timer Set point (WP704XLFA031-LFRTMRSP, initial value 0.5 minutes) is operator adjustable using popup 31213. This phase ends normally when the timer times out. It will also end if the run command or the boiler run feedback becomes FALSE. A low fire status point (WP704XLDA031-LFR) is set when this phase is initiated and is reset when the phase ends. When the LOW FIRE phase ends, the boiler is now considered fully operational and ready to accept external Firing Rate Demand signal via the DCS in either MANUAL or AUTO modes.
 - 5) RAMP UP: This phase starts when the Low Fire timer times out and ends when the boiler internal temperature reaches an operator adjustable initial or ramp up setpoint value (WP704XLFA031-ISP, initial value 155 deg F). This phase will also end if the start command or the boiler running feedback become FALSE. A ramping status point (WP704XLDA031-RAM) is set when this phase is initiated and is reset when the phase ends.
- d. When the RAMP UP phase ends, the boiler is now considered fully operational and the Firing Rate will be controlled via the DCS in either MANUAL or AUTO modes.
- e. In full AUTO mode, the boiler will automatically start and stop based on the auto sequence control (see Section 1.06.H below and the firing rate will be controlled by the PHW Heat Loop Master Controller.

2. Boiler 3 Firing Rate Control

- a. When the DCS issues a START command (WP708MNJ19FB031), the DCS Boiler 1 firing rate controller output is set to 0% and the firing rate is controlled by the local boiler field panel. When the boiler startup sequence is complete, the field panel activates the Boiler running feedback signal (WP708NDJ19FB031).

- b. When the boiler running feedback is activated, the DCS takes over firing rate control with a LOW FIRE phase. During the LOW FIRE phase, the DCS Boiler 1 firing rate controller output is set to an engineer adjustable value (initial value 5%).
 - c. The LOW FIRE phase duration is controlled by an operator adjustable timer setpoint (WP704XLA19FA031-LFRTMRSP value entered on popup 31213).
 - d. After the startup and low fire phases are completed, The Boiler firing rate can be controlled by the PHW Master Temperature Controller (see CS 704-06) if the Boiler 3 Firing Rate Controller is selected to AUTO.
 - e. Boiler 3 Firing Rate Controller (equivalent to speed controller for a variable speed pump) can be operated in 2 modes:
 - 1) MANUAL: With the Firing Rate Controller in MANUAL, the operator can directly set the firing rate by entering the output using Popup 31211 (firing rate manual loading station).
 - 2) AUTO: With the Firing Rate Controller in AUTO, the firing rate will be modulated by the Heat Loop Master control PID algorithm to maintain the selected PHW loop temperature.
 - a) The process variable for this controller is one of the 4 PHW loop temperatures. See CS 704-06.
 - b) The DCS provides an operator adjustable set point (WP704XLA19FA031-STPT, initial value 160 degrees F) that can be entered using Popup 31211.
 - c) The output (WP704TC19FA031-DMD) from this controller is sent to the boiler 3 Firing Rate controller. When the Boiler 1 Firing Rate Controller is in AUTO, the output is sent to Boiler 3 as WP704TC19FA031.
3. Boiler 3 Hot Water Circulation Pumps
- a. Boiler 3 has two hot water circulation pumps: main circulation pump and auxiliary circulation pump
 - b. The AUTO/MANUAL status of the main and auxiliary circulation pumps is selected using popup 31221.
 - c. When selected to MANUAL, the pumps can be started and stopped as described above.
 - d. An Energy Saver mode can be ENABLED or DISABLED using popup 31221
 - e. When selected to AUTO, the main circulation pump will be called to run and will run continuously if Energy Saver mode is DISABLED.
 - f. When selected to AUTO and Energy Saver mode is ENABLED, the Auxiliary Circ pump will run intermittently on a timed cycle controlled by two timers. The timer values are set by two operator adjustable setpoints using popup 31211:
 - 1) Cycle Timer Set Point (WP-70405C-CYCTIME-SP, initial value 2 hours).
 - 2) On Timer Set Point (WP-70405C-ONTIME-SP, initial value 2 minutes)

D. Boiler 4

1. Boiler 4 Start/Stop

- a. Boiler control via the DCS is accomplished using popup 31214 and consists of:
 - 1) Starting and Stopping the Boiler Hotwater Circulation Pump
 - 2) Starting and Stopping the Boiler based on the LEAD/LAG sequence control. LEAD lag assignments are set by the operator using 31214,
 - 3) Modulating the Boiler Firing Rate based on the Heat Loop Master Temperature Controller (see CS 704-06).
- b. The hot water mixing valve position is only controlled manually via the DCS using popup 31214 and will normally be set at 100% unless the boiler is out of service.
- c. Boiler Operation is divided into the following phases:
 - 1) OFF with Energy Save Disabled – Boiler start command is FALSE. Hot water circulation pump will run continuously if in selected to AUTO on Popup 31214.
 - 2) OFF with Energy Save Enabled – Boiler start command is FALSE. The hot water circulation pump will run on a timed cycle if pump is selected to AUTO on popup 31214.
 - 3) STARTING: This phase starts when the start command (WP704MNJ19FB014) is sent to the local boiler control panel and initiates the boiler internal startup sequence. This phase ends when the boiler control panel activates the boiler running feedback (WP704NDJ19FB014). (note: the boiler start command is maintained until a boiler stop command is issued)

- 4) LOW FIRE: This phase starts when the boiler running feedback is received and the run command is still active. The DCS then starts a low fire timer. The Low Fire Timer Set point (WP704XLFA014-LFRTMRSP, initial value 0.5 minutes) is operator adjustable using popup 31213. This phase ends normally when the timer times out. It will also end if the run command or the boiler run feedback becomes FALSE. A low fire status point (WP704XLDFA014-LFR) is set when this phase is initiated and is reset when the phase ends. When the LOW FIRE phase ends, the boiler is now considered fully operational and ready to accept external Firing Rate Demand signal via the DCS in either MANUAL or AUTO modes.
- 5) RAMP UP: This phase starts when the Low Fire timer times out and ends when the boiler internal temperature reaches an operator adjustable initial or ramp up setpoint value (WP704XLFA014-ISP, initial value 155 deg F). This phase will also end if the start command or the boiler running feedback become FALSE. A ramping status point (WP704XLDFA014-RAM) is set when this phase is initiated and is reset when the phase ends.
- d. When the RAMP UP phase ends, the boiler is now considered fully operational and the Firing Rate will be controlled via the DCS in either MANUAL or AUTO modes.
- e. In full AUTO mode, the boiler will automatically start and stop based on the auto sequence control (see Section 1.06.H below and the firing rate will be controlled by the PHW Heat Loop Master Controller.
2. Boiler 4 Firing Rate Control
 - a. When the DCS issues a START command (WP708MNJ19FB014), the DCS Boiler 1 firing rate controller output is set to 0% and the firing rate is controlled by the local boiler field panel. When the boiler startup sequence is complete, the field panel activates the Boiler running feedback signal (WP708NDJ19FB014).
 - b. When the boiler running feedback is activated, the DCS takes over firing rate control with a LOW FIRE phase. During the LOW FIRE phase, the DCS Boiler 4 firing rate controller output is set to an engineer adjustable value (initial value 5%).
 - c. The LOW FIRE phase duration is controlled by an operator adjustable timer setpoint (WP704XLA19FA014-LFRTMRSP value entered on popup 31213).
 - d. After the startup and low fire phases are completed, The Boiler firing rate will be controlled by PHW Master Temperature Controller (see CS 704-06) that uses PHW loop temperature as the process variable.
 - e. Boiler 4 Firing Rate Controller (equivalent to speed controller for a variable speed pump) can be operated in 2 modes:
 - 1) MANUAL: With the Firing Rate Controller in MANUAL, the operator can directly set the firing rate by entering the output using Popup 31214 (firing rate manual loading station).
 - 2) AUTO: With the Firing Rate Controller in AUTO, the firing rate will be modulated by the Heat Loop Master control PID algorithm to maintain the selected PHW loop temperature.
 - a) The process variable for this controller is one of the 4 PHW loop temperatures. See CS 704-06.
 - b) The DCS provides an operator adjustable set point (WP704XLA19FA014-STPT, initial value 160 degrees F) that can be entered using Popup 31214.
 - c) The output (WP704TC19FA014-DMD) from this controller is sent to the boiler 1 Firing Rate controller. When the Boiler 4 Firing Rate Controller is in AUTO, the output is sent to Boiler 4 as WP704TC19FA014.
3. Boiler 4 Hot Water Circulation Pump
 - a. The AUTO/MANUAL status of the circulation pump is selected using popup 31214.
 - b. When selected to MANUAL, the pump can be started and stopped as described above.
 - c. An Energy Saver mode can be ENABLED or DISABLED using popup 31214
 - d. When selected to AUTO, the pump will be called to run and will run continuously if Energy Saver mode is DISABLED.
 - e. When selected to AUTO and Energy Saver mode is ENABLED, the pump will run intermittently on a timed cycle controlled by two timers. The timer values are set by two operator adjustable setpoints using popup 31214:
 - 1) Cycle Timer Set Point (WP-70405A-CYCTIME-SP, initial value 0 hours).

- 2) On Timer Set Point (WP-70405A-ONTIME-SP, initial value 2 minutes)

E. Automatic Boiler Sequencing

- a. Boiler 1, 2, 3 and 4 can be started/stopped and their firing rate modulated in an automatic sequence controlled by the DCS.
- b. Boilers 1, 2, 3 and 4 will be started/stopped automatically by the DCS in a LEAD/LAG sequence when the boilers are selected to AUTO mode on popup 31211 and 31216
- c. The operator can select whether Boiler 1, 2, 3 or 4 is the lead boiler using popup 31212 or 31217
- d. The operator can select which primary hot water loop temperature to use as the process variable for controlling the sequence and boiler firing rates. The temperatures available are:
 - 1) PHW (ext) Temperature Upstream of RSP Heat Recovery (WP704TI19AF011)
 - 2) PHW (ext) Temperature Downstream of RSP Heat Recovery (WP704TI19FA011)
 - 3) PHW Temperature Downstream of Boilers (WP704TI19JJ011)
 - 4) PHW Temperature Upstream of Boilers (WP704TI19JJ011) [note this transmitter currently is not an AI to Ovation and will need to be added to VC contract?]
- e. Boiler sequencing set points for the AUTO SEQUENCE mode are entered on Popup 33213.
 - 1) Lead Boiler will be called to Start when the selected PHW Temperature falls below (Setpoint minus an adjustable Deviation Value) for an operator adjustable time increment (initial value 720 seconds).
 - 2) Lag Boiler will be called to Start when the temperature controller output exceeds an operator adjustable value (initial value 95%) for an operator adjustable time increment (initial value 720 seconds)
 - 3) When the lag boiler is called to start, the lead Boiler output will be ramped down to and operator adjustable target output setpoint (initial value 40%) while the Lag Boiler is ramped up to the same target. When both boilers reach the target, the firing rate of both boilers will be put back in temperature control and modulated together.
 - 4) Lag Boiler will be called to Stop when the temperature controller output falls below an operator adjustable setpoint (initial value 30%) for an operator adjustable time increment (initial value 720 seconds)
 - 5) Lead Boiler will be called to Stop when the temperature controller output falls below an operator adjustable setpoint (initial value 0%) for an operator adjustable time increment (initial value 720 seconds).
 - 6) If the Lead Boiler fails, the Lag Boiler will replace it in the sequence automatically. If the lead boiler was running, the Lag Boiler will be started

1.07 MISCELLANEOUS DCS CONTROL

- A. The DCS will provide totalizers for the following flow signals:
 1. None
- B. The DCS will provide run timers for the following miscellaneous status signals:
 1. None

1.08 ALARMS

- A. Refer to the I/O Listing for I/O alarms. Other calculated alarms provided for this Strategy are as follows:
 1. Boiler 1 Temperature Alarms based on WP704TI19FB011:
 - a. High-High Temperature WP704TI19FB011-TAHH. Engineer adjustable value of 215 degrees F.
 - b. High Temperature WP704TI19FB011-TAH. Engineer adjustable value of 205 degrees F.
 - c. Low Temperature WP704TI19FB011-TAL. Engineer adjustable value of 150 degrees F.
 - d. Low-Low Temperature WP704TI19FB011-TALL. Engineer adjustable value of 145 degrees F.
 2. Boiler 2 Temperature Alarms based on WP704TI19FB021:
 - a. High-High Temperature WP704TI19FB021-TAHH. Engineer adjustable value of 215 degrees F.
 - b. High Temperature WP704TI19FB021-TAH. Engineer adjustable value of 205 degrees F.
 - c. Low Temperature WP704TI19FB021-TAL. Engineer adjustable value of 150 degrees F.

- d. Low-Low Temperature WP704TI19FB021-TALL. Engineer adjustable value of 145 degrees F.
- 3. Boiler 3 Temperature Alarms based on WP704TI19FB031:
 - a. High-High Temperature WP704TI19FB031-TAHH. Engineer adjustable value of 215 degrees F.
 - b. High Temperature WP704TI19FB031-TAH. Engineer adjustable value of 205 degrees F.
 - c. Low Temperature WP704TI19FB031-TAL. Engineer adjustable value of 150 degrees F.
 - d. Low-Low Temperature WP704TI19FB031-TALL. Engineer adjustable value of 145 degrees F.
- 4. Boiler 4 Temperature Alarms based on WP704TI19FB041:
 - a. High-High Temperature WP704TI19FB041-TAHH. Engineer adjustable value of 215 degrees F.
 - b. High Temperature WP704TI19FB041-TAH. Engineer adjustable value of 205 degrees F.
 - c. Low Temperature WP704TI19FB041-TAL. Engineer adjustable value of 150 degrees F.
 - d. Low-Low Temperature WP704TI19FB041-TALL. Engineer adjustable value of 145 degrees F.
- 5. Boiler LSG Pressure Alarms based on WX-S02-PIT16HA011PVR (vertical point will be WP708PI16HA011)
 - a. Boiler 1 Low LSG pressure (WP-70505A-PI16HA011AL).Engineer adjustable, initial value 8 inches.
 - b. Boiler 1 Low Low LSG pressure (WP-70505A-PI16HA011ALL). Operator adjustable set point (WP-70505A-PI16HA011LLSP, initial value 4 inches) using popup 31213.
 - c. Boiler 2 Low LSG pressure (WP-70505B-PI16HA011AL).Engineer adjustable, initial value 8 inches.
 - d. Boiler 2 Low Low LSG pressure (WP-70505B-PI16HA011ALL). Operator adjustable set point (WP-70505B-PI16HA011LLSP, initial value 4 inches) using popup 31213.
 - e. Boiler 3 Low LSG pressure (WP-70505C-PI16HA011AL).Engineer adjustable, initial value 8 inches.
 - f. Boiler 3 Low Low LSG pressure (WP-70505C-PI16HA011ALL). Operator adjustable set point (WP-70505A-PI16HA011LLSP, initial value 4 inches) using popup 31213.
 - g. Boiler 4 Low LSG pressure (WP-70505B-PI16HA011AL).Engineer adjustable, initial value 8 inches.
 - h. Boiler 4 Low Low LSG pressure (WP-70505B-PI16HA011ALL). Operator adjustable set point (WP-70505B-PI16HA011LLSP, initial value 4 inches) using popup 31213.

1.09 GRAPHICS

All Ovation DCS graphics will conform to existing OWNER system standards. All graphical additions outlined within Control Strategies 40 65 01 through 40 65 09 are to be subject of at least one (1) full day workshop will be conducted with OWNER stakeholders to review draft developed screens, graphics, and pop-up dialogs. Comments and adjustments outlined by OWNER will be incorporated for final approval before implementation into Ovation DCS.

All developed Ovation DCS graphics will be fully developed to meet OWNER established standards to implement intent and function stated within this Control Strategy. The following graphic examples may be used as a basis for some of the process screens but may not reflect all requirements. Development of process screens, additions, pop-up dialogs and graphics are the responsibility of the SPCS Programmer.

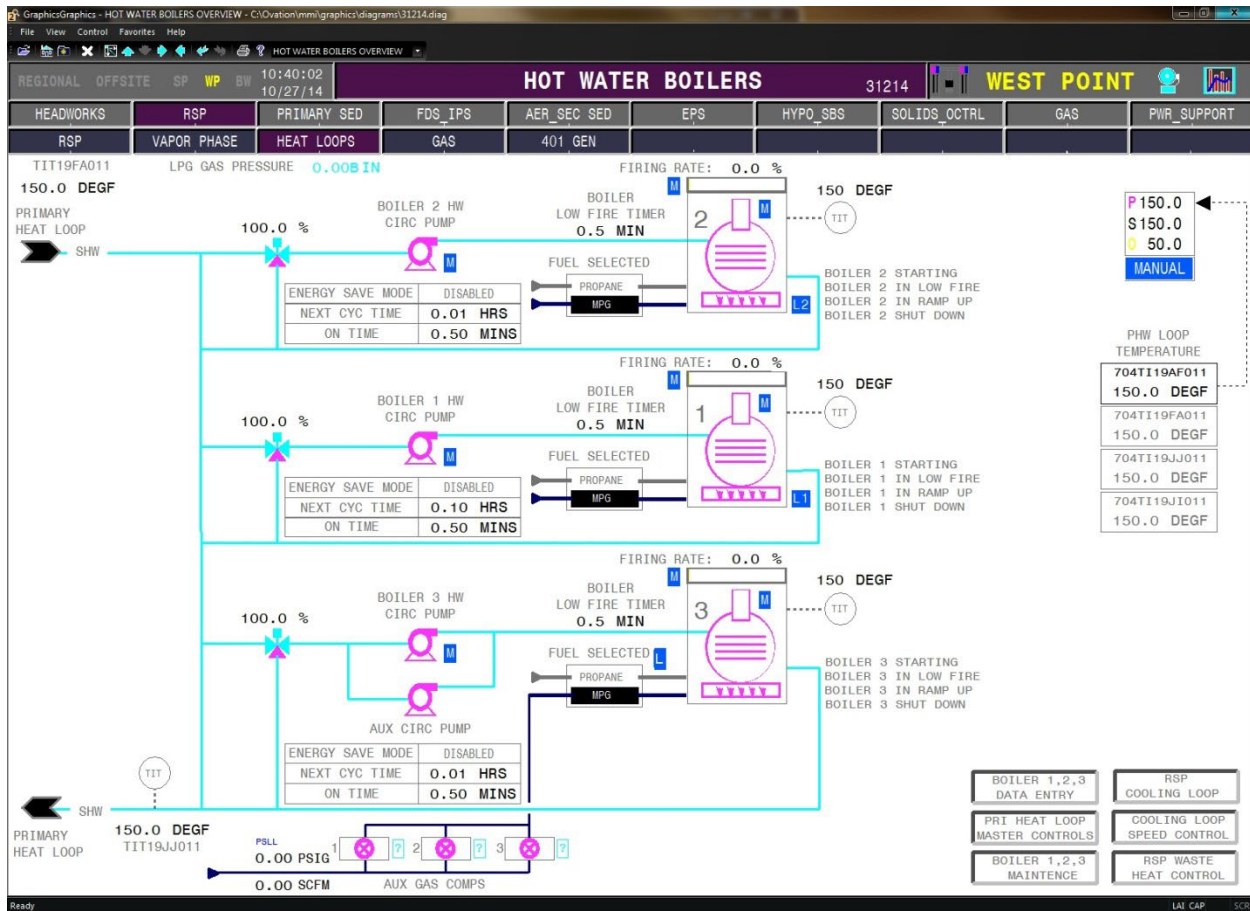
A. Diagram 31207 – BOILER 1,2,3,4 MAINTENANCE DATA ENTRY

W2 Graphics Window 1

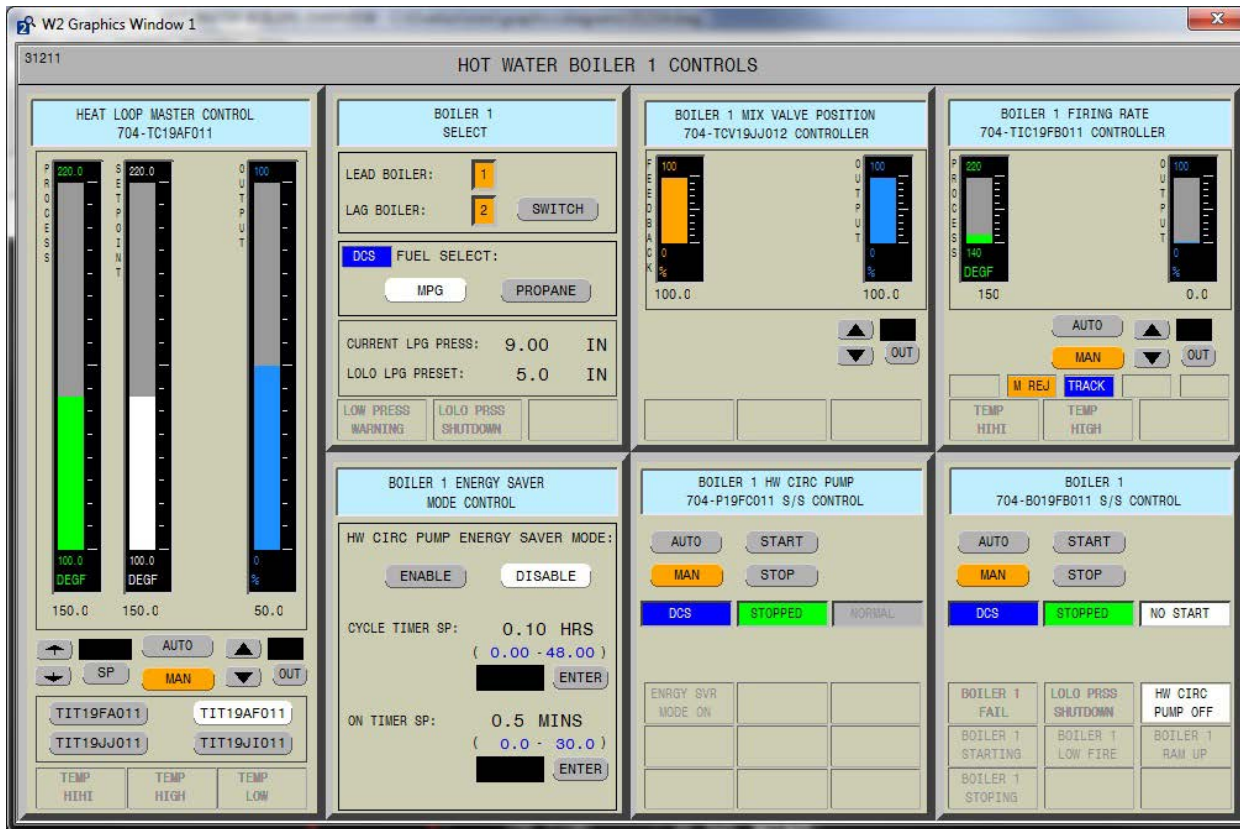
31207 BOILER 1,2,3 MAINTENANCE DATA ENTRY

<p>RSP REC RAD LOOP PUMPS ALARMS SETPOINTS</p> <p>RAD CIRC PUMP 1 FAIL START/STOP</p> <p>1.0 MIN 0.0 - 5.0</p> <p>ENTER</p> <p>RAD CIRC PUMP 2 FAIL START/STOP</p> <p>1.0 MIN 0.0 - 5.0</p> <p>ENTER</p>	<p>RSP REC RAD LOOP FANS ALARMS SETPOINTS</p> <p>RAD FAN 1 FAIL START/STOP</p> <p>1.0 MIN 0.0 - 5.0</p> <p>ENTER</p> <p>RAD CIRC PUMP 2 FAIL START/STOP</p> <p>1.0 MIN 0.0 - 5.0</p> <p>ENTER</p>	<p>HOT WATER BOILERS MISC ALARMS SETPOINTS</p> <p>HEAT LOOP BELOW STPT ALRM TIME</p> <p>1.0 HR 0.0 - 165.0</p> <p>ENTER</p>
<p>HOT WATER BOILER 1 ALARMS SETPOINTS</p> <p>BOILER FAIL-START/STOP</p> <p>5.0 MIN 0.0 - 10.0</p> <p>ENTER</p> <p>BOILER CIRC PUMP FAIL-START/STOP</p> <p>5.0 MIN 0.0 - 5.0</p> <p>ENTER</p>	<p>HOT WATER BOILER 2 ALARMS SETPOINTS</p> <p>BOILER FAIL-START/STOP</p> <p>5.0 MIN 0.0 - 10.0</p> <p>ENTER</p> <p>BOILER CIRC PUMP FAIL-START/STOP</p> <p>5.0 MIN 0.0 - 5.0</p> <p>ENTER</p>	<p>HOT WATER BOILER 3 ALARMS SETPOINTS</p> <p>BOILER FAIL-START/STOP</p> <p>5.0 MIN 0.0 - 10.0</p> <p>ENTER</p> <p>BOILER CIRC PUMP FAIL-START/STOP</p> <p>5.0 MIN 0.0 - 5.0</p> <p>ENTER</p> <p>BOILER AUX CIRC PMP FAIL-STRT/STP</p> <p>5.0 MIN 0.0 - 5.0</p> <p>ENTER</p>

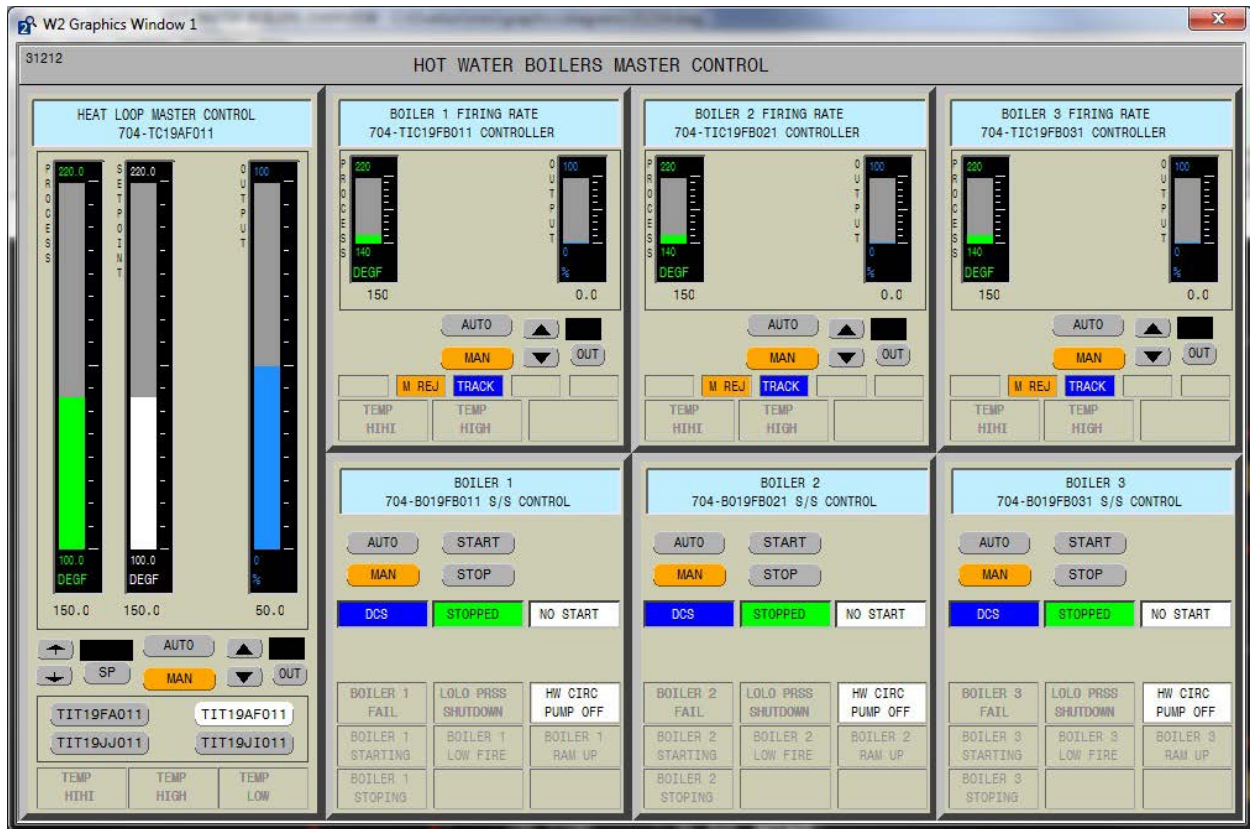
B. Diagram 31214 – HOT WATER BOILERS



C. Diagram 31211 – HOT WATER BOILER 1 CONTROLS



D. Diagram 31212 – HOT WATER BOILERS MASTER CONTROL



E. Diagram 31213 – BOILER 1,2,3,4 DATA ENTRY

W2 Graphics Window 1
X

31213
BOILER 1, 2, & 3 DATA ENTRY

HOT WATER BOILERS 1 & 2
AUTO SEQUENCE DATA ENTRY

<div>LEAD BOILER START SETPOINT: 145.0 DEGF</div> <div>[HEAT LOOP TC19AF011 SP]-[OFFSET]</div> <div>LEAD BOILER START SP OFFSET: 5.0 DEGF <input type="text"/></div> <div>LEAD BOILER START DELAY TIMER: 0.5 MIN <input type="text"/></div>	<div>PRE-RELEASE TO MASTER CNTRL LEAD & LAG OUTPUT % TARGET SP: 85.0 % <input type="text"/></div> <div>LAG % SP(LEAD INIT RAMP DWN): 45.0 MIN <input type="text"/></div> <div>LEAD BOILER STOP SP: (LEAD'S CONTROL OUTPUT %) 1.0 % <input type="text"/></div> <div>LEAD BOILER STOP DELAY TIMER: 1.0 MIN <input type="text"/></div>	<div>LAG BOILER START SP: (LEAD'S CONTROL OUTPUT %) 90.0 % <input type="text"/></div> <div>LAG BOILER START DELAY TIMER: 0.5 MIN <input type="text"/></div> <div>LAG BOILER STOP SP: (LEAD'S CONTROL OUTPUT %) 20.0 % <input type="text"/></div> <div>LAG BOILER STOP DELAY TIMER: 0.1 MIN <input type="text"/></div>
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BOILER 1 SETPOINTS
704-B019FB011

LOW LSG PRESET
5.0 IN
0.0 - 20.0

BOILER LOW FIRE TIME
0.5 MIN
0.0 - 120.0

BOILER INITIAL/NORMAL TEMP
155.0 DEGF
100.0 - 220.0

BOILER 2 SETPOINTS
704-B019FB021

LOW LSG PRESET
5.0 IN
0.0 - 20.0

BOILER LOW FIRE TIME
0.5 MIN
0.0 - 120.0

BOILER INITIAL/NORMAL TEMP
155.0 DEGF
100.0 - 220.0

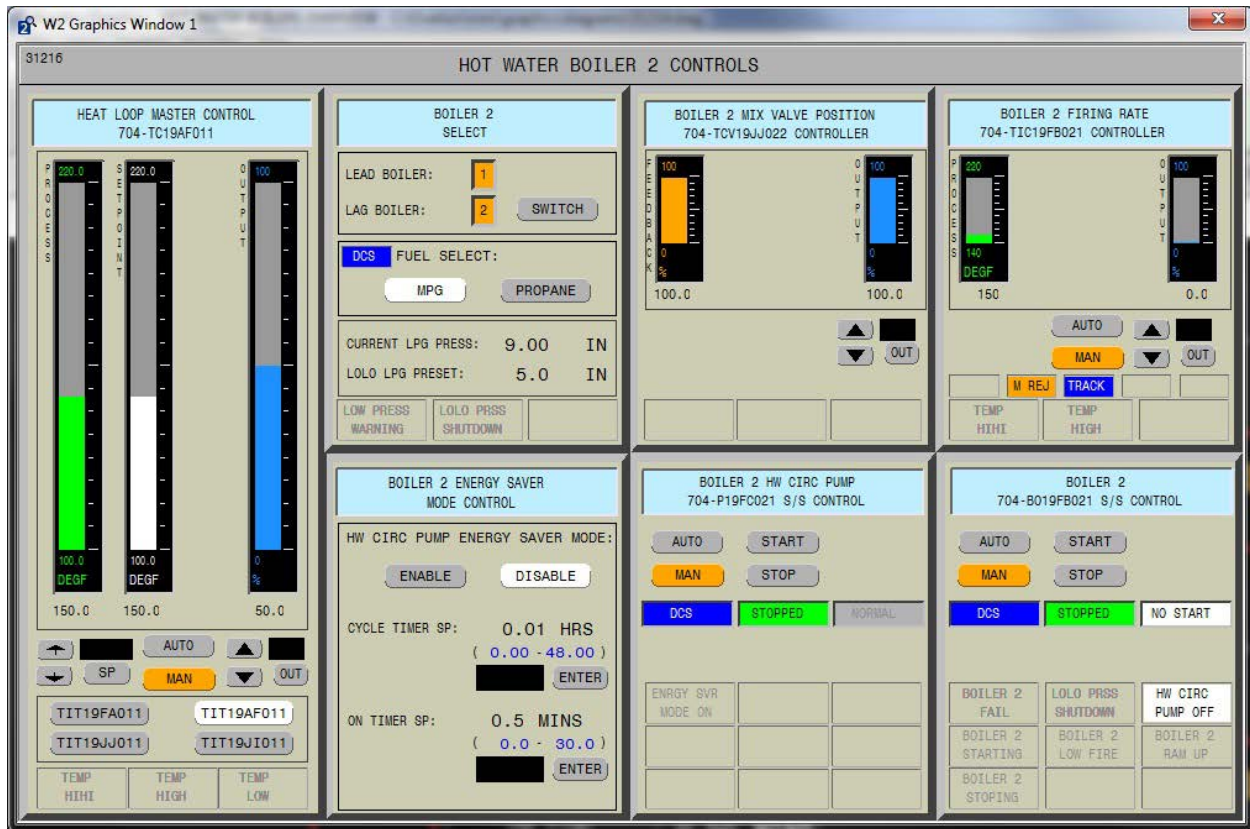
BOILER 3 SETPOINTS
704-B019FB031

LOW LSG PRESET
6.0 IN
0.0 - 20.0

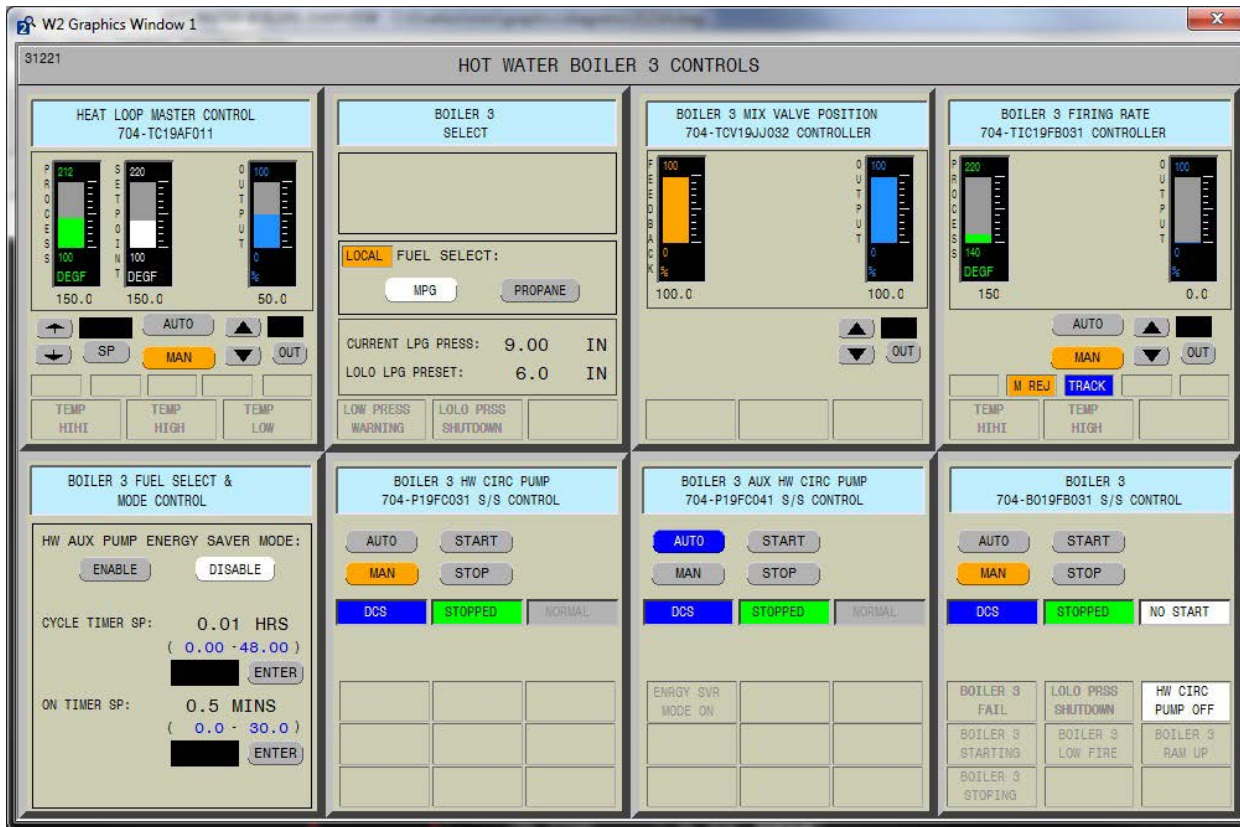
BOILER LOW FIRE TIME
0.5 MIN
0.0 - 120.0

BOILER INITIAL/NORMAL TEMP
170.0 DEGF
140.0 - 220.0

F. Diagram 31216 – HOT WATER BOILER 2 CONTROLS



G. Diagram 31221 – HOT WATER BOILER 3 CONTROLS



H. Diagram XX – HOT WATER BOILER 4 CONTROLS

1. No example graphic provided at this time. Same as Boilers 1, 2, and 3.

END OF SECTION

SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for panels, cabinets, consoles, and racks for instrumentation and communication equipment. Additional requirements are specified in sections specifying the various instrumentation and communication systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
FED STD 595A	Federal Standard Colors
IEC 60947-7-1	Low Voltage Switchgear and Controlgear - Terminal blocks for copper conductors
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 79	Electrical Standards for Industrial Machinery
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels – Standard
UL 698A	Industrial Control Panels – Classified Areas

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Dimensioned front view drawings.
- C. Dimensioned internal equipment layout drawings.
- D. Panel assembly drawings shall include sections showing clearances between face and rear mounted equipment and keyed Bills of Materials.
- E. Nameplate engraving schedule showing engraving by line, character size, and nameplate size.
- F. Enclosure manufactures' drawings.
- G. Panel seismic calculations in accordance with the requirements of Section 01 73 00.
- H. Panel wiring diagram for each panel. The diagram shall meet the requirements as set forth in the NFPA 79 Electrical standards for industrial machinery.
- I. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 78 39 upon completion of Operational Testing per Section 01 75 20.

1.04 DESIGN REQUIREMENTS

- A. Enclosures shall be limited to the following NEMA 250 types:

Type	Location
NEMA 12	Switchboard and MCC rooms, and control rooms
NEMA 4X SS	All other locations and applications
NEMA 7D	Classified Locations

- B. Panel Design:

1. General:
 - a. Section 40 06 71 specifies major panels and equipment on those panels.
 - b. Panel size and equipment layout requirements are specified on the Drawings.
2. No panel mounted operator interface devices, such as selector switches, will be mounted greater than 72" or less than 36" above the finished plant floor, with the exception of annunciators.
3. No panel mounted instruments, such as recorders, will be mounted greater than 66" or less than 40" above the finished plant floor, with the exception of the annunciator panel as described below.
4. Annunciators: unless shown otherwise, each panel containing alarm points shall be provided with one or more annunciators per Section 40 78 33. Annunciators shall not be mounted with the top frame in excess of 90" above the finished plant floor.
5. Power supplies:
 - a. The main control panel shall contain a dual redundant DC power supply system as shown on the Drawings.
 - b. Other panels containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall obtain the DC power from the main control panel's DC power supply system.
 - c. The DC power supply system shall be per Section 40 63 53.

- C. Labeling:

1. Panels shall be manufactured and labeled in accordance with UL 508A and/or UL 698A and shall bear the UL label.
2. Design shown on Drawings is for reference and shall be altered as required to make the panels UL 508A compliant.

- D. Panel Schedule. Refer to Divisions 21 through 26 for additional panels which may cross-reference Div. 40 for panel requirements.

Panel number	Description	NEMA rating	Status
704-ICP0301	ACC1 OVATION CONTROLLER PANEL DROP 11/71	NEMA 12	EXISTING
704-ICP0302	ACC1 OVATION CONTROLLER PANEL DROP 12/72	NEMA 12	EXISTING
704-FP0331	RSP-PUMP 1 REMOTE I/O PANEL OVATION DROP 011/071 NODE 1	NEMA 12	NEW
704-FP0332	RSP-PUMP 2 REMOTE I/O PANEL OVATION DROP 011/071 NODE 2	NEMA 12	NEW
704-FP0333	RSP-PUMP 3 REMOTE I/O PANEL OVATION DROP 012/072 NODE 1	NEMA 12	NEW
704-FP0334	RSP-PUMP 4 REMOTE I/O PANEL OVATION DROP 012/072 NODE 2	NEMA 12	NEW
704-BP0308	RSP-PUMP ROOM SUMP BUBBLER PANEL	NEMA 4X	NEW
704-FP0336	RSP-RAW SEWAGE SAMPLER PANEL	NEMA 4X	NEW
704-QA03AY041	GO/NO-GO PNL NW OUTSIDE ENTRANCE	NEMA 4X	NEW
704-QA03AY42	GO/NO-GO PNL NW CORNER EXIT	NEMA 4X	NEW

Panel number	Description	NEMA rating	Status
704-QA03AY043	GO/NO-GO PNL SW CORNER EXIT	NEMA 4X	NEW
704-QA03AY044	GO/NO-GO PNL SW TOOL ROOM ENTRANCE	NEMA 4X	NEW
704-QA03AY045	GO/NO-GO PNL ELECTRICAL ROOM 411 SOUTH CENTER	NEMA 4X	NEW
704-QA03AY046	GO/NO-GO PNL SE CORNER	NEMA 4X	NEW
704-QA03AY047	GO/NO-GO PNL NE CORNER EXIT	NEMA 4X	NEW
704-QA03AY048	GO/NO-GO PNL NE OUTSIDE ENTRANCE	NEMA 4X	NEW
704-QA03AY049	GO/NO-GO PNL N BATTERY ROOM 409	NEMA 4X	NEW
704-QA03AY050	GO/NO-GO PNL S BATTERY ROOM 408	NEMA 4X	NEW
704-QA03AY054	GO/NO-GO PNL N/S BATTERY ROOM ENTRANCE	NEMA 4X	NEW
704-QA03AY031	GO/NO-GO PNL NW GALLERY ENTRANCE	NEMA 4X	NEW
704-QA03AY032	GO/NO-GO PNL NW CORNER	NEMA 4X	NEW
704-QA03AY033	GO/NO-GO PNL SW CORNER	NEMA 4X	NEW
704-QA03AY034	GO/NO-GO PNL SW ELECT ROOM	NEMA 4X	NEW
704-QA03AY035	GO/NO-GO PNL COLUMN C4	NEMA 4X	NEW
704-QA03AY039	GO/NO-GO PNL EAST WALL	NEMA 4X	NEW
704-QA03AU036	GO/NO-GO PNL SOUTH WALL	NEMA 4X	NEW
704-QA03AY037	GO/NO-GO PNL COLUMN C6	NEMA 4X	NEW
704-QA03AY021	GO/NO-GO PNL EAST STAIRWAY TO EAST FAN ROOM	NEMA 4X	NEW
704-QA03AY011	GO/NO-GO PNL NORTHWEST CORNER	NEMA 4X	NEW
704-QA03AY012	GO/NO-GO PNL SOUTH CENTER	NEMA 4X	NEW
704-QA03AY013	GO/NO-GO PNL NORTHEAST CORNER	NEMA 4X	NEW
704-QA03AY051	GO/NO-GO PNL SW ACC1 ENTRANCE	NEMA 4X	NEW
704-QA03AY052	GO/NO-GO PNL ACC1 BREAKROOM	NEMA 4X	NEW
704-QA03AY053	GO/NO-GO PNL ACC1 HALLWAY	NEMA 4X	NEW

PART 2 PRODUCTS

2.01 MATERIALS AND QUALITY

A. General:

1. Panel work shall be designed for seismic requirements per Section 01 73 00.
 - a. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.
2. Cutouts for future equipment shall be blanked off with suitable metal covers.
3. Instrument tag numbers shall be identified on the panel rear per Section 40 67 00.
4. Nameplates shall identify face-mounted instruments per Section 40 67 00.
5. Instruments shall be mounted in a manner that allows ease of access to components and ease of removal.
6. Face-mounted instruments that are more than six inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
7. Face-mounted equipment shall be flush or semi-flush with escutcheons.
8. Floor mounted cabinets less than 60 inches high shall be provided with floor stands to raise the top of the panel to at least 60 inches above the floor or work platform. Or, if panel weighs less than 100 pounds and wall space is available, wall mounting may be used in lieu of a floor stand.

9. Except for stainless steel and fiberglass panels, all panels and cabinets shall be painted inside and out. Exterior finish shall be per manufacturer's standard gray enamel. Interior panel finish shall be per manufacturer's standard white enamel.
- B. Fabrication of NEMA Type 12 Industrial Use, Indoor Cabinets with Front Doors:
1. Fabricate enclosure from 16-gauge minimum thickness sheet steel for enclosures smaller than 24"X24", and 14-gauge minimum for larger enclosures.
 2. Provide an interior frame or otherwise form the enclosure so as to provide a rigid structure.
 3. Mount face-mounted instruments in the door.
 4. Doors:
 - a. Hang door on full-length continuous (piano-type) hinges.
 - b. Provide a vault type latch capable of accepting a 3/8-inch shackle padlock.
 - c. If greater than 48 inches high, provide three-point latch hardware.
 - d. Unless shown on panel Drawings, door width shall not exceed 34 inches.
- C. Fabrication of NEMA Type 4X Cabinets:
1. Comply with NEMA 250, Type 4X requirements.
 2. Fabricate from 14 gauge (minimum thickness) Type 316L stainless steel (fiberglass when specified) and provide with an interior frame or otherwise formed to provide a rigid structure.
 3. Where face-mounted instruments are specified, mount on an interior sub-panel. Provide a gasketed Plexiglass window to allow visibility for displays and indicators.
 4. Doors:
 - a. Hang door on full-length continuous (piano-type) hinges.
 - b. Provide a vault type latch capable of accepting a 3/8-inch shackle padlock.
 - c. If greater than 48 inches high, provide three-point latch hardware.
 - d. Unless shown on panel drawings, door width shall not exceed 36 inches.
 5. For cabinets located outdoors, equip with rain and sun shields.

2.02 HEATING AND VENTILATING

- A. Provide cooling to maintain the internal panel temperature below 104 degrees F (40 °C) when all equipment is operating at its maximum heat load and the ambient temperature is 86 degrees F (30 °C).
1. Calculate heat flow through unmodified enclosure to determine if active cooling is required.
 2. Provide filtered forced air ventilation for NEMA 12 cabinets, as required.
 3. Provide glycol closed loop heat exchange system on a mechanical refrigeration system for NEMA 4X and NEMA 7 enclosures, as required.
- B. For OVATION RIO panel ventilation fans, temperature monitoring of the interior of the panel shall be used to control the included fan's operation by an adjustable setpoint available to operators on the DCS screen. Alarming for HI, HIHI, LO, and LOLO panel temperatures will be configurable where applicable.
- C. Equip fans with UL-approved washable filters and provide at least 240 CFM. Do not exceed 60 db noise level at 3 feet from exterior wall of enclosures and 30° off axis.
- D. Do not insulate outdoor or below grade enclosures and provide with thermostatically controlled space heaters.
- E. Provide heater wattage sufficient to maintain the air temperature inside the cabinet above the dew point or 50° F (10° C), whichever is higher, at all times.
- F. If space heater surface temperature exceeds 122° F (50° C), provide an expanded metal guard.
- G. When a strip type heater is used, provide a 240 VAC heater and connected to 120 VAC. Size the heater to produce the required heat at 120 VAC.

- H. Thermostat Acceptable Manufacturer:
 - 1. Hoffman Engineering TWR60
 - 2. Eaton B-Line EST Series
 - 3. Approved Equal.

2.03 NAMEPLATES AND LABELS

- A. Provide machine engraved laminated black phenolic nameplates 1/16-inch thick with white lettering for the panel and its face mounted equipment. Nameplate minimum size: 3/4-inch high by 2.0-inch long.
- B. Engrave nameplates with 3/32-inch (2.4 mm) minimum size lettering as shown on the Drawings.
- C. Attach nameplates to the panel with a high tack acrylic transfer tape.
- D. Wording may be changed if changes are made prior to commencement of engraving.
- E. Identify tag number of instruments and equipment inside the panels with machine-printed laminated adhesive labels.
- F. Attach nameplates and labels to panel surfaces, not to instruments.

2.04 WIRING AND ELECTRICAL DEVICES

- A. Wiring:
 - 1. Power, control and signal wiring inside panels:
 - a. Power and control conductors:
 - 1) Type MTW, minimum size: 16AWG.
 - 2) Conductor insulation rated for 600 volts and 90° C in dry locations.
 - 3) Conductors: Stranded copper
 - b. Wiring for instrumentation analog signals:
 - 1) Aluminum foil shielded twisted pairs, minimum 18 AWG, stranded copper conductors with drain.
 - 2) Conductor insulation: PE in black and white or clear with overall jacket of grey PVC.
 - 3) Type CM rated 300V and 60° C in dry locations.
 - 4) Belden type 8760, Alpha 2422C, Approved Equal.
 - 5) Run continuously from measuring instrument to control cabinet terminal strips without splices.
 - c. Conductor size vs. fuse rating for conductors inside panels:

Wire	Fuse
18 AWG	≤1 AMP
16 AWG	≤5 AMPS
14 AWG	≤15 AMPS
12 AWG	≤20 AMPS

- 2. Support wiring independent of terminations by slotted flame retardant plastic wiring channels. Comply with UL94, Type V.

- B. Wire Naming and Marking
 - 1. Wiring shall be marked at terminations with machine printed plastic sleeves per Section 26 05 00-2.02.
 - 2. Wire numbers shall consist of three parts, or as shown on the Drawings.
 - 3. Unless shown otherwise, the prefix of the wire number shall be the instrument loop number.
 - 4. If an instrument loop number is not available, the lowest mechanical equipment number of all final drives in the circuit shall be used.

5. Following the prefix shall be a code letter. The third part of the wire number shall be a number that identifies wires in a circuit that are electrically identical.
 6. Label each control and instrumentation wire as follows:
 - a. FFF, LLL-CC-NNN, Where:
 - FFF = facility number or process number
 - LLL = equipment, panel or loop number
 - CC = wire code from table
 - NNN = wire number
- Note FFF, facility number, is only required if multiple facilities are involved or within a treatment plant with multiple processes.

C. Color Coding

1. Color coding of wires within control panels shall be as follows (subject to restriction by UL 508A and/or UL 698A):

WIRE COLOR CODES				
Code	Type	Color	Use	Volts
S1	TSP	BLACK	SIGNAL (+)	5-24 VDC
S2	TSP	WHITE or CLEAR	SIGNAL (-)	5-24 VDC
SG	TSP	BARE	SHIELD DRAIN	5-24 VDC
S1	TRIAD	BLACK	SIGNAL	0-24 VDC
S2	TRIAD	WHITE	SIGNAL	0-24 VDC
S3	TRIAD	RED	SIGNAL	0-24 VDC
SG	TRIAD	BARE	SHIELD DRAIN	0-24 VDC
24P	SINGLE	BLUE	POWER (+)	24 VDC
24C	SINGLE	WHITE/BLUE	COMMON (-)	24 VDC
D	SINGLE	BLUE	CONTROL	24 VDC
125P	SINGLE	BLUE	POWER	125 VDC
125C	SINGLE	WHITE/BLUE	COMMON	125 VDC
B	SINGLE	BLUE	CONTROL	125 VDC
L	SINGLE	BLACK	POWER	120 VAC
L	SINGLE	RED	CLASS 2 POWER	24 VAC
N	SINGLE	WHITE	NEUTRAL	120 VAC
C	SINGLE	RED	CONTROL	120 VAC
C	SINGLE	RED	CLASS 2 POWER	24 VAC
PG	SINGLE	GREEN	POWER GND	EARTH GND
SG	SINGLE	GREEN/YELLOW	SIGNAL GND	EARTH GND
UL	SINGLE	BLACK/WHITE	UPS POWER	120 VAC
UN	SINGLE	WHITE/GREY	UPS NEUTRAL	120 VAC
M	SINGLE	YELLOW	FOREIGN PWR	120 VAC
MN	SINGLE	WHITE/YELLOW	FOREIGN NEUT.	120 VAC GND'D
A	SINGLE	BLACK OR BLUE	ANNUNCIATOR	120 VAC/24VDC
IO	SINGLE	BLACK OR BLUE	ISOL I/O	120 VAC/24VDC
R	SINGLE	BLUE	RTU	12 VDC
IS	SINGLE	BLUE	INTRINSIC SAFE	<12 VDC

2. Power and control wiring shall be carried in covered wiring channels separate from low voltage analog signal circuits.

D. Terminal blocks and accessories:

1. UL listed.
 2. DIN rail mounted. Compliant with IEC 60947-7-1.
 3. 22 AWG to 12 AWG copper wire size range.
 4. Mark using marker carrier and preprinted marker bars for the terminal numbers.
 - a. Each terminal strip shall be labeled per this specification with sequential numbers, i.e. 'TB-01'.
 - b. Each terminal shall be numbered sequentially starting at 01.
 5. Connect field wiring to individual terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel.
 6. Any circuits entering the panel shall be fused.
 7. Feed through terminal blocks:
 - a. Compression clamp type terminals rated for 600 Volts and 30 Amperes.
 - b. Acceptable manufacturers:
 - 1) Phoenix Contact series UT IEC
 - 2) Allen-Bradley series 1492 IEC
 - 3) Approved Equal.
 8. Fused terminal blocks:
 - a. Compression clamp type terminals rated for 600 Volts and 10 Amperes
 - b. Blown fuse indicator lamp.
 - c. Acceptable manufacturers:
 - 1) Phoenix Contact series UT IEC
 - 2) Allen-Bradley series 1492 IEC
 - 3) Approved Equal.
- E. Circuit breakers:
1. Thermal magnetic, miniature case type with the ampere rating as specified..
 2. Circuit breaker interrupting rating shall be 10,000 amperes symmetrical minimum for service at 240 volts and below.

2.05 PANEL GROUNDING

- A. Each panel shall be provided with two copper ground bars. One bar shall be bonded to the panel frame or sheet metal and to the station ground system. The second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the frame ground bar at one point only.
- B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.
- C. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

PART 3 EXECUTION

3.01 GENERAL

- A. Wired as shown on the wiring diagrams.
- B. Control room cabinets:
 1. Mount on channel iron sills as specified.
 2. Sills shall be leveled so panel structures will not be distorted.
 3. Panels shall be shimmed to precise alignment so doors operate without binding.
 4. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.
 5. Mount field panels and cabinets in compliance with Section 01 73 00.
 6. Floor-mounted cabinets except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified
 7. Store record drawings for wiring, connection, and interconnection diagrams inside the panel door document pocket.

3.02 COATING

- A. Paint cutouts to prevent corrosion using manufacturer's recommended paint.

END OF SECTION

SECTION 40 68 71

SUPERVISORY PROCESS CONTROL SYSTEM PROGRAMMING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies programming requirements for the Supervisory Process Control System (SPCS) Distributed Control System (DCS).
- B. The operation of the West Point Treatment Plant System under SPCS control and operation via Ovation shall be per the Contract Document as defined in Section 40 65 01 and Section 40 61 13.
- C. Be fully cognizant of the existing Ovation logic programs and include all those functions that are required to operate and monitor the West Point Treatment Plant System using the SPCS.
- D. Programmer qualifications per Section 40 61 13. Coordinate with various sub-contractors in order to provide a functional program conforming to Section 40 65 01 and this Section.

1.02 SPCS PROGRAMMING STANDARD

- A. This Section incorporates the current County SPCS programming standard. This standard is attached as Attachment A. Comply with all requirements.

Reference	Title
King County	Supervisory Process Control System Programming Requirements

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00 and Section 40 61 13.
- B. Software programming submittals shall be in the electronic format as follows:
 - 1. Section 40 06 73 serves as the basis for the hardware I/O ; submit in Microsoft Excel®. Take each point and follow Attachment A.
 - 2. Detailed internal points list in Microsoft Excel®. Take each point and follow Attachment A.
 - 3. Detailed list of third party communication data points list shall be submitted in Microsoft Excel®.
 - 4. A database export of the control strategy points (.exp format)
 - 5. Graphic programming as follows:
 - a. jpeg graphics, including a list of point names used on the graphics, in Microsoft Word®.
 - b. Native files of the process graphics in .src format
 - 6. Control Logic sheets programming as a .pdf file of the Control Strategy (Ovation Publish)
- C. Formal revision tracking procedure for all software.
- D. Software Programming Submittals - Phase 1, Phase 2, Phase 3, and Phase 4 per this Section.
- E. All software programming submittals shall include:
 - 1. Database programming shall include detailed I/O list with pertinent fields populated; detailed list of internal points including Long Analog Points, Long Digital Points, Long Packed Points, Algorithm Points, and Module Points with pertinent fields populated; and detailed list of third party communication data points including Long Analog Points, Long Digital Points, and Long Packed Points with pertinent fields populated.
 - 2. Database export for each Control Strategy

3. Graphics source files for all graphics. Provide a list of all point names used on each graphic. Provide printouts of all graphics including Overview Graphic Screens, Process Graphic Screens, and Faceplate Graphic Screens.
4. Programming Control Sheets export including macros and an Ovation Publish.

F. Proposed training syllabus

G. Form 01 79 00-B

H. Form 01 79 00-C

1.04 PROGRAMMING

- A. Utilize the same Ovation software version currently running the existing programs. Any software upgrade or latest patches need to be approved by the Project Representative. No exceptions.
- B. Emerson Ovation has standardized function block algorithms for programming the DCS. All programs shall be intuitive graphical interface enabling the County to configure and maintain the programming. Written text descriptions shall be provided in the programming as to guide the County on the purpose and function of the logic.
- C. Programming shall include point assignments to hardware modules and channels, conversion coefficient configurations, and alarm properties.
- D. Include Overview Graphic Screens, Process Graphic Screens, and Faceplate Graphic Screens. Provide graphics programming with comments if special functions are involved.
- E. Completed graphic screens with graphic conditional programming for process points and equipment. Poke fields to call Faceplate graphic screens and navigation to other graphic screens.
- F. Include temporary graphic screens in order to transition to final configurations as required.
- G. Control Logic Sheet programming shall include all the functions described in Section 40 65 01 through 40 65 09. Includes valves, flow totalizers, run times, power fail restart, and cutout alarm logic.
- H. Ovation program with fully commented logic and all support information necessary for review.

1.05 SOFTWARE REVISIONS

- A. Provide a formal revision tracking procedure for all software. The revision tracking procedure shall contain information necessary to track all changes, ensure revisions are properly tested, documented, and incorporated into the final program. The revision tracking procedure shall track submitted programs, reference Project Representative's comments, show date program was saved, date of all revisions, and reference the material used for the program revisions.
- B. The revision tracking procedure shall ensure that only fully tested, fully documented, and properly revised software is loaded into the Ovation DCS.

1.06 SOFTWARE FUNCTIONS

- A. Provide common functions and software structures among programs. An export of the Ovation program sample copy can be obtained from the Project Representative.
- B. Provide Ovation programs capable of performing the following functions:
 1. Analog input processing and conversion to engineering units.

2. Analog output processing for control loop outputs to other equipment.
3. Discrete input processing for status, alarms, and interlocks.
4. Discrete output processing for control to other equipment.
5. Control algorithm processing per the Control Strategies, with setpoints and manual stations entered at the workstations.
6. Provisions for bumpless transfer, anti-windup, and tracking for manual and auto mode.
7. Use function blocks to perform simple math functions such as multiplication, addition, subtraction and division. Limit the use of Calc Blocks to iterative calculations (e.g., time averaging).
8. Real-time clock for scheduling of control functions and tasks.
9. Display of alarms.
10. Display of process data on workstations.

PART 2 PRODUCTS

2.01 PROGRAMS

- A. Provide a functioning program that is without error, does not perform abnormal stops or actions, is fully documented, and passes all testing per Section 01 75 20 and Section 40 61 22.
- B. Workstations displays shall include both text and simple graphical process representations

2.02 SPCS SUBMITTALS

- A. Provide a schedule showing program development tasks including milestones. Include the following:
 1. Phase 1: Software Programming Submittal.
 - a. Functional program per the Control Strategy Sections 40 65 01 through 40 65 08.
 - b. FAT step by step procedures.
 - c. Unwitnessed Factory Acceptance Test (FAT) results
 - d. Witnessed FAT results
 2. Phase 2: Software Programming Submittal
 - a. Completed software programming per the Control Strategy.
 - b. FAT step by step procedures
 - c. Unwitnessed FAT results
 - d. Witnessed FAT results
 3. Phase 3: Software Programming Submittal
 - a. See Section 40 61 22 for Site Acceptance Test (SAT). Once SAT has been completed, provide a final complete software programming documentation.

2.03 PROGRAMMING DOCUMENTATION

- A. Provide clear and concise point names for all active components within the logic. Point names to be descriptive in nature.
- B. Fully utilize all record fields for all the record types used for the programming provided by the programming software; include a complete list of record fields.
- C. The graphics source file should have comments to describe the complex conditional programming for status and display.
- D. Provide complete descriptors and comments for elements used in the Control sheets. Include the following:
 1. Display parameter fields for function blocks on the Control sheet.
 2. Note order of algorithm if the Control sheet is algorithm execution dependent.
 3. Add notes to Control sheets for temporary and/or interim of future control logic.

4. Provide a narrative for complex logic or where a function is not readily understood without clarification.
5. Fully comment on calc blocks equations displayed on the Control sheets.

PART 3 EXECUTION

3.01 PROGRAM INSTALLATION

- A. Install application program in coordination with the County.
- B. When editing the DCS software, comply with the following:
 1. Coordinate the changes, edits or reloading of the programs with the Project Representative. Make changes to the program to correct deficiencies or incorrect operation.
 2. The Project Representative shall approve all changes before loading the program into the DCS. The Project Representative shall be present at the facility when changes are loaded into the DCS.
 3. All programming changes shall be loaded locally, not transmitted over a network.
 4. All documentation, drawings, and copies of the program and narratives shall be revised by the Contractor and be reviewed and approved by the Project Representative to reflect the edits to the program.

3.02 PROGRAM TESTING

- A. Per Section 01 75 20 and Section 40 61 22.

3.03 TRAINING

- A. Procedures: Section 01 79 00.
- B. Provide a minimum of 12 hours per training.

END OF SECTION

ATTACHMENT A

SUPERVISORY PROCESS CONTROL SYSTEM PROGRAMMING REQUIREMENTS

**SUPERVISORY PROCESS CONTROL SYSTEM
(SPCS)
PROGRAMMING REQUIREMENTS**

Rev 0
July 2020

The contents of this document are proprietary to King County and shall not be disseminated without prior approval.

King County Dept. of Natural Resources
201 South Jackson St. - M/S KSC-NR-0508
Seattle, WA 98104

SPCS Programming Requirements

Document Issue Register

Issue	Date	Author	Description	Issued to
Rev 0	07/07/2020	King County WTD – R. Tumbokon	Original Issue	All

SPCS Programming Requirements

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1.0 INTRODUCTION

1.1 PURPOSE OF MANUAL

Supervisory Process Control System (SPCS) configuration, testing, and commissioning projects usually take place in each Wastewater treatment Division projects. Several different entities and personnel may be involved in some or all aspects of the SPCS. In order to have an efficient way of configuring and maintaining the SPCS, this guideline will standardize and provide enforceable procedures for these entities and personnel to follow.

2.0 ABBREVIATIONS AND ACRONYMS

KC – King County

SPCS - Supervisory Process Control Systems

OCB – Ovation Control Builder

SID – System Identification

RIO – Remote I/O Panel

3.0 OVATION PROGRAMMING

The Ovation Developer Studio is a comprehensive software application that manages the configuration of the entire Ovation system. As a fully integrated advanced software program, the Developer Studio creates and maintains Ovation drop types, control strategies, process graphics, point records, and system-wide configurations, including integrated security features.¹

There are various functions and configuration as part of the Ovation programming. But three major configuration activities for Ovation programming will be described here:

- Creating Points
- Creating control logic that runs on the Ovation Controller
- Creating process diagrams that display on the Operation Station

4.0 CREATING POINTS

A point is a record in the global database that contains a value and other related data. Points include inputs and outputs from field devices, calculated values, and internal system information. A name and a unique System ID number identify each point, and this information is stored in the Ovation Master Database.

The Ovation control system scans or processes the inputs/outputs. The control system converts incoming information to engineering units then stores it in the point records. A point record stores the set of information that defines the attributes of the point. Point records are used within each drop, and to communicate over the Ovation Network to other drops. There are eleven types of point records in Ovation control system. King County uses eight out of eleven points.

¹ Ovation Developer Studio User Guide OVMAN60 Version 3, May 2020, Section 1.1

Point records are constructed of record fields. Some fields can be defined by the user, while other fields store information the system needs to process the point value.

Point names are defined early in the system configuration process by Engineering and plant personnel. Only fully qualified points should be used in the King County Ovation System.

4.1 CREATING POINTS GUIDELINES

1. Use Fully qualified point names
2. Follow the examples and conventions in this section.
3. Do not use OCB points created by Control Builder when displaying them on graphics. Instead create point names for them.
4. Change default descriptions, set/reset fields and other fields with @OCB or blanks are changed.
5. Consult with the Alarm Committee for assigning alarm priorities, characteristics, limits and alarm descriptions.
6. Configuration/status register information fields are entered for Node points and Module points. See Ovation Manual OVREF1150.

4.2 FULLY QUALIFIED POINT NAME

A fully qualified point name in the Ovation system uses the following format:

“name.unit@network”

This format consists of three parameters:

- A 24-character maximum point name.
- A six-character maximum unit name.
- An eight-character maximum network name.

The “.” and “@” are required and are reserved characters. They are part of a fully qualified point name but are not allowed in the name portion of the fully qualified point name. Therefore, the maximum number of characters in a fully qualified point name is 40.

For example, SP146NDJ146001.PLANT@SP would reference point SP146NDJ146001

located in the unit whose name is PLANT and in the network whose name is SP.

This allows for the use of the same point name in different units or networks. Ovation is able to identify each point since a unique SID was assigned to each point as it was entered into the system. SID is distinct from the point name and unique to the point.

In a multiple network implementation, the network name segment shall be one of the following:

- For each plant use these network names: @SP, @WP, or @BW
- Any of the defined network aliases (the alias for the remote or local network)

4.2.2 Use the following rules when creating fully qualified point names:

1. Characters in the name portion may be any combination of alphabetic, numeric (0 - 9), or special punctuation characters. The only characters that are not allowed in the name are *, @, ., %, \$, ~, \, “, ‘, comma, space.
2. Point names are to be entered using all capital letters like this:
“TESTPOINT.PLANT@SP”.
3. A point name cannot be a reserved word (refer to the Ovation Graphics Language Reference Manual for information on reserved words).
4. Do not begin user-defined point names with designation OCB because Control Builder default point names contain OCB designation.

4.3 POINT NAMES - HARDWARE ASSOCIATION

4.3.1 I/O Points

- Shall be qualified point name
- Follow the I/O list provided for the project
- Follow the Control system point naming standard. See Appendix A T0.9.1 Ovation Point Name document
- Fill in all the fields as required by the Point Name field spreadsheet. See Appendix G for the spreadsheet.

4.3.2 Drop Points

- Shall be qualified point name
- Fill in all the fields as required by the Point Name field spreadsheet. See Appendix G for the spreadsheet.
- Follow the convention
 - DROPx – for drops from 1-9
 - DROPxx – for drops 10-99
 - DROPxxx – for drop 100 and above

4.3.3 Node Points

- Shall be qualified point name
- Fill in all the fields as required by the Point Name field spreadsheet. See Appendix G for the spreadsheet.
- Follow the convention
 - DxxxP0 – use the convention Local IOIC points
 - xxx corresponds to Drop Numbers
 - use 0 as buffers

- P0 corresponds to the processor
 - example, D001P0, D051P0
- DxxxP1ByLzP# – use the convention for card modules port number
 - Use for Fieldbus and DeviceNet ports
 - xxx corresponds to Drop Numbers
 - use 0 as buffers
 - P1 corresponds to RIO panel 1, P2 corresponds to RIO panel 2...etc.
 - y corresponds to branch numbers
 - z corresponds to slot numbers
 - # corresponds to port numbers
 - example, D051P1B2L1P1, D051P1B3L8P2
- AAxxxXLPxxxyyy-FFSTAT – use the convention for Foundation Fieldbus device status
 - AA corresponds to Plant Identifier Prefix, see 0.9.1 Ovation point name document
 - xxx corresponds to Facility Area Code
 - XLP – use for this for fieldbus device status
 - xxxyyy – corresponds to the loop number
 - -FFSTAT – use for Foundation Fieldbus device status
- AAxxxXLPxxxyyy-DNSTAzzz – use the convention for DeviceNet device status
 - AA corresponds to Plant Identifier Prefix, see 0.9.1 Ovation point name document
 - xxx corresponds to Facility Area Code
 - XLP – use for this for foundation DeviceNet device status
 - xxxyyy – corresponds to the loop number
 - -DNSTA – use for DeviceNet device status
 - zzz – for type of device
 - IO – for DeviceNet IO Momentum Block
 - OL – for DeviceNet Overload Block
 - T – for DeviceNet device
 - If other type of device is needed, please consult with the Technical Standard Committee.

4.3.4 Module Points

- DxxxP1ByLz – use the convention for card modules
 - xxx corresponds to a Drop Number
 - use 0 as buffers
 - P1 corresponds to RIO panel 1, P2 corresponds to RIO panel 2...etc.
 - y corresponds to branch numbers
 - z corresponds to slot numbers
 - example, D051P1B2L1, D051P1B3L8

4.4 POINT NAMES - INTERNAL

Refer to Appendix H for Ovation internal point naming scheme.

4.4.1 Equipment – Packed points

- Create two packed points for equipment i.e. Pumps, Valves, Blower, Fans, Compressors
 - Format example: BW156XLP156111-B00
 - BW corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 156 corresponds to area number
 - XLP internal packed group point
 - 111 corresponds to equipment sequence number
 - B00 corresponds to first packed point assigned to a particular equipment. This packed point is used to interface with graphic macros and faceplates.
 - see Appendix H for bit descriptions.
 - Format example: BW156XLP156111-B01
 - BW corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 156 corresponds to area number
 - XLP internal packed point name
 - 111 corresponds to equipment sequence number
 - B01 corresponds to first packed point assigned to a particular equipment. This packed point is used to interface with graphic macros and faceplates.
 - See Appendix H for bit descriptions.

4.4.2 Equipment - Algorithms

Algorithms for equipment shall be named as shown in example below.

- Format example: SP180XAG180520-KB01
 - SP corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 180 corresponds to area number
 - XAG internal algorithm
 - 520 corresponds to equipment sequence number
 - KB01 corresponds to equipment algorithm assigned to a particular equipment. KB stands for keyboard. 01 stands for first keyboard. This algorithm point is used to interface with faceplates. For example, KB can be replaced MA, AV, and SP. KB, MA, and AV various types of algorithms.

Point names for algorithms for equipment shall be named as shown in example below.

- Format example: SP180XLP180520-K01
 - SP corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 180 corresponds to area number
 - XLP internal algorithm packed point
 - 520 corresponds to equipment sequence number
 - K01 corresponds to equipment algorithm assigned to a particular equipment. K stands for keyboard. 01 stands for first keyboard.

- Other examples
 - BW310XLP310311-M (MA MODE)
 - BW310XLA310311-MACO (MA OUTPUT)
 - BW310XLA310311-BIAS
- See Appendix H for examples of point names.

4.4.3 Control strategy - Packed Points

- BW-12101Z-P? – use this convention for lead/lag supervisory logic
 - BW corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 12101 corresponds to KC Control Strategy number
 - Z corresponds to multiple Control Strategies. Note: Valid characters to use are A-Z.
 - P corresponds to a packed point
 - Refer to King County’s WTD Standard T0.9.1 - Ovation Point Name (PN) to name “?” extension code. If none found in pre-defined table in the Standard, then programmer to create a meaningful extension code.

4.4.4 Control strategy - Analog Points

- Format example: BW-12101Z-A?
 - BW corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 12101 corresponds to KC Control Strategy number
 - Z corresponds to multiple Control Strategies. Note: Valid characters to use are A-Z.
 - A corresponds to an analog type point
 - Refer to King County’s WTD Standard T0.9.1 - Ovation Point Name (PN) to name “?” extension code. If none found in pre-defined table in the Standard, then programmer to create a meaningful extension code.

4.4.5 Control strategy - Digital Points

- Format example: BW-12101Z-D?
 - BW corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 12101 corresponds to KC Control Strategy number
 - Z corresponds to multiple Control Strategies. Note: Valid characters to use are A-Z.
 - D corresponds to digital type point

- Refer to King County's WTD Standard T0.9.1 - Ovation Point Name (PN) to name "?" extension code. If none found in pre-defined table in the Standard, then programmer to create a meaningful extension code.

4.4.6 Control Strategy - Algorithms

Keyboard Algorithms (NOTE: Keyboard algorithms shall be named in the Control Sheet for them to be used in Graphics.)

- Keyboard algorithms shall be named as example shown below:
 - Example: SP-12101A-KB01 is a Keyboard algorithm name. Number '01' in the name refers to the first algorithm number. Additional algorithm names shall be in increment of 01; the next number being '02'.

Setpoint algorithms (NOTE: Setpoint algorithms shall be named in the Control Sheet for them to be used in Graphics.)

- Setpoint algorithms shall be named
 - Setpoint algorithms shall be named as example shown below:
 - Example: SP-12101A-SP01 is a Setpoint algorithm name. Number '01' in the name refers to the first algorithm number. Additional algorithm names shall be in increment of 01; the next number being '02'.
- Setpoint algorithm outputs shall be named
 - Create an analog point name for each setpoint algorithm output
 - Format example: SP-12101Z-A?
 - SP corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 12101 corresponds to KC Control Strategy number
 - Z corresponds to multiple Control Strategies. Note: Valid characters to use are A-Z.
 - A corresponds to analog type point
 - ? corresponds to programmers choice of name appropriate for the setpoint

Avalgen algorithms (NOTE: Avalgen algorithm is named in the Control Sheet)

- Avalgen algorithms shall be named
 - Avalgen algorithms shall be named as example shown below:
 - Example: SP-12101A-AV01 is a Avalgen algorithm name. Number '01' in the name refers to the first algorithm number. Additional algorithm names shall be in increment of 01; the next number being '02'.
- Avalgen algorithm outputs shall be named
 - Create an analog point name for each setpoint algorithm output
 - Format example: SP-12101Z-A?
 - SP corresponds to Plant Identifier Prefix, see KC WTD Standard T0.9.1 – Ovation Point Name (PN).
 - 12101 corresponds to KC Control Strategy number

- Z corresponds to multiple Control Strategies. Note: Valid characters to use are A-Z.
- A corresponds to analog type point
- ? corresponds to programmers choice of name appropriate for the setpoint

5.0 Creating Control logic

Control sheets are developed in Developer Studio. Control sheets are created inside controllers that it will reside in. The control sheets can run in different task areas in the controller. The task areas are a container for the control logics that are created to program control strategies. There are two task areas by default in the controller. Task 1 by configured to run at 0.1 second. The control sheets are usually running in Task 2, which is running 1 second scans.

When creating a new control sheet, Developer Studio will present a dialog box for fields to enter. The fields that shall be enter are Sheet name, Sheet Number and Sheet Component. The first two shall be populated and the last field needs to be left blank. Sheet names should follow the control strategy name, device equipment description, or the function of the control sheet. Creating control logic that runs on the Ovation controller.

5.1 CONTROL SHEETS

The control logic programming guidelines for Control Sheets are described below:

4.6.1 Control Sheet Title Block

- Sheet Numbers
- Title name should be the name of the Control Strategy

4.6.2 Control Sheet Allocation

Control sheet name shall follow the control strategy number:

Control strategy has the following convention 510-01 Aeration Basin. The control sheets allocation will follow the convention 51001xxx. See the table below for sheet number.

Example, for the first equipment for this strategy should be placed in control sheet 51001700.

Control Sheets numbering has the following:

Sheet Numbers	Allocated for	Notes
001-099	Constants, Common sheet for controller	
100-199	Emergency shutdown, Plant Restart, Fieldbus, DeviceNet interface, cutouts	

200-299		
300-699	Control strategy	Separate control strategies can be split between this range or sub-strategy
700-899	Devices, pumps, valves, equipment	
900-999	Runtimers, flow totalizers	

4.6.3 Control Sheet Layout

By laying out the design for the control, create a comprehensive and consistent picture of how the control functions throughout the system. The control scheme will be better organized and the inputs and outputs will be clearer.

Follow these best practices to create Control Sheets:

- Do not force too much control strategy on one sheet. Spread it out so it can be easily read, understood, and modified. Troubleshooting a sheet is much easier if the information about the sheet is well organized with enough space for changes and additions.
- Segment the various control functions.
 - Separate self-contained control functions.
 - Minimize off-page functions.
- Logic is executed in ascending order of the algorithm numbers that are assigned in a sheet. Typically, build logic from top to bottom and left to right.
 - Review the execution order and override it, as needed. Add notes to the control sheet if the logic is execution order is critical for the logic to solve/operate.
 - Logically group functions (for example, put all the temperature logic on a sheet).
- Analog and digital algorithms on a sheet can be mixed.
 - Analog signals should flow top to bottom. As much as possible, all inputs should be brought in on the extreme top of the sheet. Outputs should be extended to and shown on the extreme bottom of the sheet. The logic should be drawn from top to bottom.
 - Digital signals should flow left to right. As much as possible, all inputs should be brought in on the extreme left of the sheet. Outputs should be extended to and shown on the extreme right of the sheet. The logic should be drawn from left to right.

- Allow room for descriptions for all signals.
- Provide descriptions that allow to trace logic destinations.
- Implementation will be simpler if the BALANCER algorithm and all the downstream balanced algorithms are on the same sheet.
- Segregate the control into specific Controllers based on hardware and available points.
- Logic segments that have multiple interlocks should be on different sheets. Segments that do not have multiple interlocks can be mixed on one sheet.
- Typically, tracking from algorithms that have a single track output is out of the IN1 line.
- Name all algorithms that will be used in custom graphics.
- Name all points that will be used on custom graphics, alarm points, or points that leave a sheet (output page connectors). Default point names cannot be used in output page connectors.
- When creating internal point names, only create point names for generated (output) points. If a point name is needed for an undefined input point, create and use ADUMMY (for analogs) and DDUMMY (for digitals). This approach helps to avoid the scenario where two different points get created for the same signal and then the logic will not work.
- Use dynamic text to specify tuning parameters on sheets.
- Always use the MAMODE algorithm with MASTATIONS. The MAMODE algorithm provides a “mode word” which provides consistent indication of the status of the associated M/A Station on all graphics.
- Use comments on the sheets to identify the logic path and the functionality between sheets.
- Use a linear approach when designing a sheet. This keeps the logic organized and makes the graphics easier to follow.
- Use the Synchronize Online function [297] to view control sheets in the Signal Diagram viewer without loading those sheets in the Controller first. This function saves time, since it can be used to view sheets in Signal Diagrams for accuracy before they are loaded to the Controller.

4.6.4 Control Sheets Tracking

Refer to the following guidelines when using tracking:

- Tracking is typically done upstream.
- Do not unnecessarily use the GAINBIAS algorithm.
- Use MAMODE priority raise/lower instead of external transfers below MASTATION algorithms.
- Tracking signals are always visible (except for BALANCER signals) and are typically shown in green.
- If downstream tracking can come from more than one source, then the initial building order determines the source unless manually changed. The exception to this is the BALANCER algorithm, which can accept tracking from up to 16 downstream algorithms.
- Tracking may be broken after the signal wires are drawn.
- If non-tracking algorithms are inserted between tracking algorithms, then the designer is responsible for tracking across the “gaps.” Typically, the TRANSFER algorithm is used above the gap to insert the user-computed tracking.
- Reset Windup limiting is performed by tracking algorithms if:
 1. They are properly configured for tracking.
 2. The scale limits (TPSC and BTSC) are set to reflect the accepted signal range.
 3. In addition, the PID and PIDFF algorithms provide for enhanced windup limiting in the cascade configuration.
- Cross sheet tracking is implemented by passing a tracking point “upstream” through the same page connectors that pass control signals downstream.
- Tracking points are fully managed by OCB except when tracking crosses between sheets, and when tracking from a downstream algorithm into a BALANCER algorithm. Since the BALANCER algorithm tracks from many downstream algorithms, tracking connections between a BALANCER algorithm and any downstream algorithms are not graphically visible.
- Typically, there is only one tracking input (IN1) to an algorithm, except for TRANSFER and SELECTOR algorithms.
- The Track Ramp Rate (TRAT) referred to in the algorithm descriptions is used by the algorithm when tracking action is terminated and normal control begins. It is the time in units per second for the output to decay or ramp to the value dictated by the inputs under normal (non-tracking) operation. The default Track Ramp Rate value is 2.5 units.

4.6.5 Control Sheets Documentation

4.6.5.1 Display on the control sheet tuning value

- PID algorithm
 - Display parameters: PGAIN, INTG, PVG, SPTG, TPSC, BTSC
- Transfer Block
 - Display parameters: SLEW RATE, TRR1, TRR2 if enable.
- LOW/HIGH Signal Monitors
 - Display parameters: LOW, HIGH

4.6.5.2 Add label/description on the control sheet for the algorithm

- Setpoint algorithm
 - Add label/description for the algorithm
- Avalgen algorithm
 - Add label/description for the algorithm

5.2 CONTROL TEMPLATES AND MACROS

There are prebuilt control templates and macros that have been tested and currently in use in the treatment plants. Use of these templates provides consistency of the layout and operation of the control logic.

Please refer to Appendix I Control System Standards: T2.4.1 Control Templates and Macros

5.3 SUPERVISORY CONTROL STANDARDS

There are prebuilt control templates and macros that have been tested and currently in use in the treatment plants. Use of these templates provides consistency of the layout and operation of the control logic.

Please refer to Appendix J Control System Standards: T2.4.2 Supervisory Control Standards

5.4 ALARMS

5.4.1 Equipment Alarms

Control templates for equipment have alarms predefined and their priorities. These common alarms are defined below along with their alarm priorities:

1. FAIL TO START- alarm priority 3
2. FAIL TO RUN- alarm priority 2
3. FAIL TO STOP- alarm priority 3
4. DISCREPANCY ALARM- alarm priority 3
5. FAIL TO OPEN- alarm priority 3
6. VALVE TRIP- alarm priority 2
7. FAIL TO CLOSE- alarm priority 3

Please consult with the Alarm Committee for alarm configuration guidance. Alarm properties will be reviewed during the software submittal process.

5.4.2 Alarm Suppression

As part of the control logic programming, it is required to create alarm suppression logic. Please see the control strategy for alarm suppression requirements. If not described, Alarms related to equipment shall be CUTOFF when the equipment is placed out of service. The alarms shall also be CUTOFF if the equipment is part of the unit/group process. Please see alarm committee for clarification.

5.5 POWER FAIL RESTART

As part of the control logic programming for Bright Water, it is required to create power fail restart sequence for the control strategy. Please see the control strategy for power fail restart sequence description and CS 100-01.

5.6 FLOW TOTALIZERS

As part of the control logic programming, it is required to create flow totalizers for each flow input listed on the I/O List and defined in the control strategies.

5.7 RUNTIMES

As part of the control logic programming, it is required to create total runtime and lube times for each RUN input listed on the I/O List and defined in the control strategies.

6.0 Creating process diagrams

The Process Diagrams shall display on the Operation Station. Refer to Ovation Graphics Standards.

7.0 References:

Obtain latest version of these references from project representative.

Appendix	Company	WTD Standard Number	Standard Description
A	King County	Tier 0.9.1	Ovation Point Name (PN)
B	King County	Tier 0.9.2	Abbreviations Table for Equipment and Process Descriptions
C	King County	Tier 0.9.3	Engineering Units
D	King County	Tier 0.9.4	Off-site Pumping Stations Table

E	King County	Tier 0.9.5	Digital I/O State Descriptors Table
F	King County	Tier 0.9.6	Motor I/O ISA Table
G	King County		Point Name Fields
H	King County		Ovation Internal Point Naming
I	King County	Tier 2.4.1	Control Templates and Macros
J	King County	Tier 2.4.2	Supervisory Control Standards
K	King County	Tier 3.13.1	KC Graphics Standards

SECTION 40 70 10

PROCESS TAPS AND PRIMARY ELEMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
API RP 551	Process Measurement Instrumentation
ASTM A269	Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	Specification for Stainless Steel Bars and Shapes
ASTM A479	Specification for Stainless Steel Bars and Shapes for use in Boilers and Other Pressure Vessels
ASTM D1248	Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable
ASME PTC 19.3 TW	Thermowells

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. All submittals shall be per Section 40 61 13.
- C. Flow calculation for each differential-type flow element.

PART 2 PRODUCTS

2.01 VALVES

- A. Isolation Valves:
1. Full port ball valves with ASTM A276, 316 stainless steel trim and body.
 2. Teflon seats and packing.
 3. Acceptable manufacturer:
 - a. Parker Hannifin.
 - b. Whitey.
 - c. Hoke.
 - d. Approved Equal.
- B. Gage Valves:
1. Machined from ASTM A276 bar stock.
 2. Use with 1/2-inch NPT connections and integral bleed valve.
 3. Acceptable manufacturer:
 - a. Anderson Greenwood M9530.

- b. Hoke 6801L8Y.
- c. Approved Equal.

C. Root Valves:

- 1. ASTM A276, Type 316 stainless steel bar stock.
- 2. 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections.
- 3. One instrument connection shall be provided with an ASTM A276, Type 316 stainless steel bleed valve.
- 4. ASTM A276, Type 316 stainless steel plugs for unused ports.
- 5. Lagging type units shall be provided for insulated vessels and pipes.
- 6. Acceptable manufacturer:
 - a. Anderson Greenwood M5 AVS-44.
 - b. Hoke 6802L8Y.
 - c. Approved Equal.

D. Manifolds:

- 1. Three-valve bar-stock type.
- 2. Body: Type 316 stainless steel.
- 3. Valves shall be globe configuration with 316 SS ball seats and Teflon stem packing.
- 4. Designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished.
- 5. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable.
- 6. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified on Drawings.
- 7. Acceptable manufacturer:
 - a. Anderson Greenwood M4TVS.
 - b. Hoke 8123F8Y.
 - c. Approved Equal.

2.02 TUBING AND TUBING FITTINGS

A. Instrument tubing:

- 1. Rigid Tubing: 1/2-inch x 0.065-inch seamless annealed ASTM A269, Type 316 stainless steel between the process connection and instruments.
- 2. Plastic tubing:
 - a. Tubing within enclosures shall be ¼ inch high molecular weight polyethylene or nylon, per ASTM D3350, 0.035 inch minimum wall thickness, and rated for 120 PSIG.
 - b. Tubing within raceways shall be ½ inch or greater as required by Instruspec LBE.

B. Tubing fittings:

- 1. Type 316 stainless steel.
- 2. Swage ferrule design with components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer.
- 3. Flare and ball sleeve compression type are not acceptable.
- 4. Acceptable manufacturer:
 - a. Parker Hannifin.
 - b. Swagelok.
 - c. Hoke.
 - d. Approved Equal.

2.03 CHEMICAL SEALS

A. Diaphragm:

- 1. Unless otherwise specified, seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body.
- 2. Diaphragm: Type 316 stainless steel.

3. Unless otherwise specified, fill fluid shall be DC200 silicone oil.
 4. Acceptable manufacturer:
 - a. Ashcroft Type 100/101 – No substitutions.
- B. Annular:
1. Seal shall be the in-line full stream captive sensing liquid type.
 2. Metallic wetted parts: Type 316 stainless steel.
 3. Unless otherwise specified, flexible cylinder shall be Buna-N.
 4. Rated 200 psig with not more than 5-inch WC hysteresis.
 5. Unless otherwise specified, fill fluid shall be DC200 silicone oil.
 - a. Factory filled and assembled.
 6. Acceptable manufacturer:
 - a. Ashcroft Series 80 – No substitutions.

2.04 BUSHINGS AND THERMOWELLS

- A. Comply with SAMA PMC17-10.
- B. Unless otherwise specified, machined from Type 316 stainless steel bar stock.
- C. On insulated vessels or pipes, temperature taps with 1/2-inch NPT, and lagging extensions.

2.05 PURGE ASSEMBLIES

- A. Air purge assembly:
 1. One rotameter shall be provided for each level-measuring loop.
 2. The rotameter shall have the following features:
 - a. Type 304 stainless steel body.
 - b. Type 316 stainless steel end fittings.
 - c. Viton O-rings.
 - d. Removable borosilicate glass metering tube with polycarbonate shield.
 - e. 3-inch meter scale with direct reading etched scale in SCFH, minimum air flow capacity 0.2 to 1.9 SCFH at 70°F and 14.7 psia.
 - f. Minimum operating pressure 14.7 psia plus maximum water level pressure.
 - g. Maximum pressure / temperature rating 250 psig/100°F.
 - h. Integral stainless steel control valve.
 3. Differential pressure regulator shall have the following features:
 - a. Capability to maintain a constant flow rate with varying downstream pressures.
 - b. Type 316 stainless steel body.
 - c. Viton diaphragm.
 - d. Type 316 stainless steel ball valve.
 - e. Type 316 stainless steel springs.
 - f. Stainless steel regulator piping.
 - g. Maximum pressure rating 200 psi.
 - h. Maximum differential pressure rate 100 psi.
 4. Acceptable manufacturer:
 - a. Fischer & Porter Series 10A6100 Purgemaster w/optional d.p. regulator and low flow range needle valve.
 - b. Wallace/Tiernan model 32-A056 flowmeter w/optional low capacity outlet flow regulator.
 - c. Approved Equal.

- B. Water purge assembly:
1. Strainer, constant-differential regulator, needle valve, check valve, and 20 to 200 cc/m rotameter.
 2. Acceptable manufacturer:
 - a. Assembly:
 - 1) Moore Products 63BD4A.
 - 2) Fischer & Porter 10A3137N-53BR2110.
 - 3) Approved Equal.
 - b. Strainer: 155 micron wye-type:
 - 1) ASCO 8600A002.
 - 2) Crane.
 - 3) Approved Equal.

2.06 FLEXIBLE AIR HOSE AND CLAMPS

- A. Hose:
1. Flexible.
 2. Resistant to petroleum oils, kerosene, fuel and lubricating oils.
 3. Nonconductive to 1000 volts DC.
 4. Temperature rating: -minus 40 to +212 degrees F.
 5. Red, modified nitrile cover.
 6. Acceptable manufacturer:
 - a. Gates Corporation, Premo Flex®.
 - b. Approved Equal.
- B. Hose Clamps:
- a. All Type 300-series stainless steel.
 - b. Lined.
 - c. Liner and mechanical housing mechanically interlocked, no spot welds.
 - d. Designed for use with silicone hose.
 - e. Marine grade.
 - f. 9/16-inch wide band.
 - g. Slotted hex head screw.
 - h. Acceptable manufacturer:
 - a. Grainger series 54235K.
 - b. Approved Equal.

2.07 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

- A. General requirements for primary elements specified in this Section are listed on INSTRUSPEC sheets in this Section.

2.08 INSTRUSPEC SHEETS

- A. The following INSTRUSPEC sheets are included in this Article:

INSTRUSPEC Symbol	Instrument Description	Instrument Function
FVA	Rotameter	Flow Measurement
FVA1	Rotameter with Flow Switch and/or Analog Transmitter	Flow Measurement
LBE	Bubbler assembly	Level measurement
PDI	Differential pressure indicator	Pressure differential indication
PG	Pressure gauge	Pressure measurement
PLG	Low range pressure gauge	Pressure measurement
TG	Temperature gauge	Temperature measurement

Instrument Identification:	FVA
Instrument Description:	Rotameter
Instrument Function:	Flow measurement
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	None
Process:	Wastewater
Process Connection:	NPT
Product Requirements:	<ol style="list-style-type: none"> 1. Type: Plain tapered tubes with rod guided float. 2. Tube: Glass. 3. Accuracy: ± 2 percent full scale. 4. Connections: Rotatable 360-degree to 90-degree intervals. 5. Scale: Detachable metal scale. 6. Repeatability: 0.5 percent full scale. 7. Fluid Temperature Limit: 33 to 250 degrees F. 8. Orientation: Vertical. 9. Inlet/Outlet Pipe Size: As indicated in the Drawings. 10. Operating Pressure: Per Instrument Schedule, Section 40 06 71. 11. Operating Temperature: 32 to 250 degrees F, unless otherwise noted. 12. Scale Range: Per Instrument Schedule, Section 40 06 71. 13. Float/Fittings: Type 316 stainless steel. 14. Acceptable Manufacturers: <ol style="list-style-type: none"> a. Brooks; Series 1110. b. Approved Equal.

Instrument Identification:	FVA1
Instrument Description:	Rotameter with Flow Switch and/or Analog Transmitter
Instrument Function:	Flow measurement
Power Supply:	24VDC loop powered
Signal Input:	N/A
Signal Output:	Discrete and/or 4-20mA as required.
Process:	Wastewater
Process Connection:	NPT
Product Requirements:	15. Type: Plain tapered tubes with rod guided float. 16. Tube: Glass. 17. Accuracy: ± 2 percent full scale. 18. Connections: Rotatable 360-degree to 90-degree intervals. 19. Scale: Detachable metal scale. 20. Repeatability: 0.5 percent full scale. 21. Fluid Temperature Limit: 33 to 250 degrees F. 22. Orientation: Vertical. 23. Inlet/Outlet Pipe Size: As indicated in the Drawings. 24. Operating Pressure: Per Instrument Schedule, Section 40 06 71. 25. Operating Temperature: 32 to 250 degrees F, unless otherwise noted. 26. Scale Range: Per Instrument Schedule, Section 40 06 71. 27. Float/Fittings: Type 316 stainless steel. 28. Additional Options (as required) a. Field adjustable High/Low switch b. 4-20mA signal transmitter 29. Acceptable Manufacturers: a. Brooks; Series 3809. b. Approved Equal.

Instrument Identification:	LBE
Instrument Description:	Bubbler assembly
Instrument Function:	Level measurement
Power Supply:	24VDC, loop powered
Signal Input:	Water column pressure
Signal Output:	4-20 mA DC
Process Connection:	Bubbler pipe assembly
Product Requirements:	
Bubbler Assembly:	Each bubbler system shall consist of a bubbler panel, bubbler pipe assembly and transmission lines as shown.
Bubbler Panel:	<ol style="list-style-type: none"> 1. Each bubbler enclosure shall comply with Section 40 67 00. 2. Each bubbler panel shall include one, two or three level measuring loops as shown. 3. Unless shown otherwise, for each level measuring loop the instruments mounted on the door shall include a pressure gauge, an air purge assembly with a rear-of-door mounted rotameter, and a three-position hand operated air switch. 4. Unless shown otherwise, for each level measuring loop, the instruments mounted on the back panel shall include an adjustable air filter regulator with output gauge, and pressure sensing instrumentation such as a differential pressure transmitter. (See Section 40 70 20)
Pressure Gauge:	<ol style="list-style-type: none"> 1. Minimum 4- inch dial size; ANSI grade A (1.5 percent of span accuracy) Bourdon tube or diaphragm measurement element; wetted materials shall be 316 stainless steel; range shall be zero based and selected to be as close to the maximum water depth measurement range as possible by using a standard gauge range; case shall be black epoxy coated aluminum or stainless steel designed for flush mounting in the door of the bubbler panel with a rear-mounted pressure connection. 2. Special Scale: It shall be a combination type with psig red outer scale and feet of H₂O black inner scale. The inner scale shall be marked with the actual elevation. Refer to Section 40 06 71. The outer scale shall be marked with the actual scale range of the pressure gauge. 3. Acceptable manufacturer: <ol style="list-style-type: none"> a. Tel-Tru Model 4037. b. Winters model P430x. c. WIKA model 232.50. d. Approved Equal.
Flow Indicator Rotameter	<ol style="list-style-type: none"> 1. Type: Plain tapered tubes with rod guided float. 2. Tube: Glass. 3. Fluid: Compressed Air 4. Accuracy: ± 3 percent full scale. 5. Connections: Rotatable 360-degree to 90-degree intervals. 6. Scale: Detachable metal scale. 7. Repeatability: 0.5 percent full scale.

Instrument Identification:	LBE
	8. Fluid Temperature Limit: 33 to 250 degrees F. 9. Orientation: Vertical. 10. Inlet/Outlet Pipe Size: As indicated in the Drawings. 11. Operating Pressure: as required. 12. Operating Temperature: 32 to 250 degrees F, unless otherwise noted. 30. Scale Range: Per Instrument Schedule, Section 40 06 71. 13. Float/Fittings: Type 316 stainless steel. 14. Acceptable Manufacturers: c. Brooks; Series 1350. d. Approved Equal.
Constant Differential Air Purge Assembly:	1. Reference the requirements of this Section.
High Pressure Purge Valve:	One air valve shall be furnished for each level measuring loop. 316 stainless steel. 3-position 4-way valve for normal level measuring, instrument calibration, and bubbler pipe purging. Provide nameplate to define each position. Acceptable Manufacturer: Swagelock. Hoke 71 Series. Whitey 44 Series. Approved Equal.
Filtered Regulator:	1. Consist of service regulator and 10 micron filter of capacity to at least serve 200 percent of the final element load, provided with a 2-inch gauge. 2. Acceptable manufacturer: a. Norgren model B38. b. Fairchild model 65AF. c. Approved Equal.
Accessories:	3. Bulkhead fittings. a. Acceptable manufacturer: b. Swagelok. c. Parker Hannifin. d. Approved Equal. 4. Shutoff valves: Quarter-turn full-port ball valves with Type 316 stainless steel body and trim, Teflon seats and seals. a. Acceptable Manufacturer: b. Hoke. c. Nupro. d. Approved Equal. 5. Tubing: a. Plastic Tubing: Refer to this Section. b. Rigid tubing: Refer to this Section, except the size shall be 1/4" I.D. 6. Fittings: Shall be per the requirements of this Section. 7. Any other accessories not described here shall be Type 316 stainless steel.
Dip Tube Assembly:	1. All piping and fittings shall be 3/4-inch schedule 40, 316 stainless steel.

Instrument Identification:	LBE
	<ol style="list-style-type: none"> 2. Provide with one or two pipe tees, as indicated in the Drawings. 3. Top opening of the tee shall be provided with threaded plug for rodding out the bubble pipe. 4. The bottom of the dip tube shall be notched approximately 3/4-inch deep x 1/2-inch wide as indicated in the Drawings.
Transmission Lines:	<ol style="list-style-type: none"> 1. Transmission lines refer to the tubing between bubbler panels and dip tube assembly. 2. Plastic Tubing: Refer to this Section. No splices shall be allowed within embedded sections. 3. Tubing size for ≤100 feet: 1/2". 4. Tubing size for >100 feet: Calculate the size according to the pressure drop per the equation below: <ol style="list-style-type: none"> a. pressure drop as follow: $P = (K) (F) (L)$ b. Where: c. P = pressure drop, inches of H₂O d. F = Flow, ACFH e. L = Length of Line in feet/1000 f. $K = 1/(62 \times ID^4)$ [with line ID in inches] g. Pressure drop shall not exceed 0.25 inches of H₂O. 5. Fittings shall be per Accessories Section. 6. Provide pull boxes at exposed ends and at right angle bends to facilitate removal and replacement of embedded flexible tubing sections.
Installation:	Per detail Drawings.
Calibration:	Top of the notch in dip tube shall be set at specified elevation with an accuracy of 0.1 inch or better.

Instrument Identification:	PDI
Instrument Description:	Pressure differential indicator.
Instrument Function:	Differential pressure measurement.
Power Supply:	None.
Process:	Air and noncombustible compatible gases.
Process Connection:	1/8-inch FNPT (two pairs – one side pair and one back pair for multiple style mounting).
Product Requirements:	<ol style="list-style-type: none"> 1. Size: 4-inch dial. 2. Scale: 270 degrees. 3. Scale Range: Per Instrument Schedule, Section 40 06 71. 4. Wetted Material: Factory standard. 5. Housing: Die cast aluminum case and bezel, with acrylic cover. 6. Accuracy: ± 2 percent of full scale. 7. Pressure Limit: <ol style="list-style-type: none"> a. Standard: 20-inch Hg to 15 psig. b. Medium pressure: 20-inch Hg to 35 psig. c. High pressure: 20-inch Hg to 80 psig. 8. Overpressure Protection: Relief plug opens at approximately 25 psig (standard pressure limit only). 9. Temperature Limit: 20 to 140 degrees F. 10. Mounting: As noted on Drawings. 11. Transparent Overlays: Furnished in red and green to highlight and emphasize critical pressure, as noted in Section 40 06 71. 12. Acceptable Manufacturers: <ol style="list-style-type: none"> a. Dwyer, Magnehelic 2000 b. Approved Equal

Instrument Identification:	PG
Instrument Description:	Pressure gauge
Instrument Function:	Pressure measurement
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2-inch male NPT
Product Requirements:	
Pressure gages:	<ol style="list-style-type: none"> 1. 4-1/2-inch premium grade, glycerin filled units with bourdon tube element, 270-degree milled stainless steel movement, phenolic case, and shatterproof glass window. 2. Accuracy: ANSI grade 2A (+0.5% of span). 3. The range of the measuring element shall be as shown in the Instrument Schedule, Section 40 06 71. The dial scale shall be equivalent to the measuring element range, but displayed in the engineering units shown as Scale in the instrument index. 4. Acceptable manufacturer: <ol style="list-style-type: none"> a. WIKA model 233.34, no substitutions.
Installation:	<ol style="list-style-type: none"> 1. Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements. 2. Root valves shall be provided at all process pressure taps except taps made for safety instruments. 3. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap. 4. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance.
Application/Calibration:	<ol style="list-style-type: none"> 1. Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform. 2. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed. 3. Application, calibration, and set points shall be as specified in Section 40 06 71.

Instrument Identification:	PLG
Instrument Description:	Low range pressure gauge
Instrument Function:	Pressure measurement
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2-inch male NPT
Product Requirements:	
Pressure Gauges:	<ol style="list-style-type: none"> 1. Gauges shall be 4-1/2-inch phenolic turret case construction with shatterproof glass window and 270-degree milled stainless steel movement. 2. Unless otherwise specified, element shall be ASTM A269, Type 316 stainless steel bellows. 3. Accuracy: ANSI Grade A (+2.5% of span). 4. Provide with a porous metal type snubber with ASTM A276, Type 303 stainless steel body and Type 316 stainless steel filter disc. 5. Acceptable manufacturer: <ol style="list-style-type: none"> a. WIKA model 632.34, no substitutions.
Installation:	<ol style="list-style-type: none"> 1. Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements. 2. Root valves shall be provided at all process pressure taps except taps made for safety instruments. 3. Gage valves shall be provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap. 4. Unless otherwise specified, pressure instruments shall be located as close as practical to the process tap but shall be positioned to permit observation and maintenance. 5. Pressure gages may be supported from the process tap if this location permits observation from the floor or a permanent work platform. 6. Pressure instruments shall be installed in such a manner that blowout discs are not obstructed.
Application/Calibration:	Application, calibration, and set points shall be as specified in Section 40 06 71.

Instrument Identification:	TG
Instrument Description:	Temperature gauge
Instrument Function:	Temperature measurement
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2-inch male NPT
Product Requirements:	
Temperature gages:	<ol style="list-style-type: none"> 1. 5-inch premium grade, inert gel filled units with stainless steel case, and shatterproof glass window. 2. Hermetically sealed case with standard IP66 (NEMA 4X) ingress protection enables use within harsh external conditions 3. Accuracy: $\pm 1.0\%$ full scale value per ASME B40.3 Grade A. 4. Insertion Length: Pipe 2" and less, middle of the pipe. Pipe greater than 2", 2 inches into process fluid. 5. Threaded for use with thermowell, see Installation. 6. The range of the measuring element shall be as shown in the Instrument Schedule, Section 40 06 71. The dial scale shall be equivalent to the measuring element range, but displayed in the engineering units shown as Scale in the instrument index. 7. Acceptable manufacturer: <ol style="list-style-type: none"> a. WIKA model TG51, no substitutions.
Installation:	<ol style="list-style-type: none"> 1. Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements. 2. Thermowell shall be used. <ol style="list-style-type: none"> a. Materials to be compatible with the process fluid. b. Length and extension to be as required for temperature gauge installation. c. Installed in properly sized NPT threaded half-coupling on pipe. 3. Back Mount to side of pipe, or Lower Mount to top of pipe when installed between 3 and 6 feet above standing position. 4. Back Mount to top of pipe when installed below 3 feet above standing position.
Application/Calibration:	<ol style="list-style-type: none"> 1. Temperature instruments shall be installed in such a manner that blowout discs are not obstructed. 2. Application, calibration, and set points shall be as specified in Section 40 06 71.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Process Connections:
 - 1. Unless otherwise specified, process taps shall comply with API RP550.
 - 2. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps.
 - 3. Arrange, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels.
 - a. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
 - b. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.
- B. Electrical Connections: final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of two feet.
- C. Flexible Tubing:
 - 1. Flexible tubing shall not be direct buried. Where flexible tubing is routed underground it shall be installed in a conduit to prevent crushing, kinks, or other impingements which may inhibit flow in the tube.
 - 2. Flexible tubing whether installed in a conduit or not for services other than underground shall not be subjected to damage such as crushing, kinks, or other impingements which may inhibit flow in the tube
 - 3. Where flexible tubing is turned or routed around a corner, it shall be supported such that it will not be crushed, kinked, or impinged upon. Conduits with long radius elbows, or other components subject to the County's approval, may be used for this purpose.
- D. Rigid Tubing:
 - 1. Rigid tubing when installed above ground or when routed around a corner shall not be subject to damage such as crushing, kinks, or other impingements which may inhibit flow in the tube.
 - 2. Flexible or rigid transmission lines:
 - a. Bubbler tubing shall be supported to prevent sagging or other low points that may block flow or prevent drainage.
 - b. Bubbler tubing shall be continuous (e.g. without cuts, breaks, fittings) between the bubbler panel and air discharge point.
 - c. If the transmission lines require routing through manholes, it shall be protected in the manhole with a rigid half open conduit. The half open conduit shall match the contour of manholes.

3.02 TESTING

- A. Testing requirements per Sections 40 61 13 and 01 75 20.

END OF SECTION

SECTION 40 70 20

TRANSMITTERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for transmitters.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.5	Pipe Flanges and Flanged Fittings
API RP551	Process Measurement Instrumentation
ASTM A276	Stainless Steel Bars and Shapes
NEMA 250	Enclosures for Electrical Equipment
ANSI/UL913	Intrinsically Safe Apparatus and Associated Apparatus
ANSI/UL60079-11	Explosive Atmospheres – Part 11: Equipment Protection by Intrinsic Safety “I”

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts and product data as required in Section 40 61 13.
- C. Calibration and test data per Section 40 61 13.
- D. Operations and Maintenance information per Section 01 78 23.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise specified, measuring elements and transmitters shall comply with the following requirements:
1. Transmitters:
 - a. Load variations within the range of 0 to 500 ohms with the power supply at 24 volts DC.
 - b. Output shall be galvanically isolated.
 - c. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.0 to 5.0 seconds.
 - d. Output shall increase with increasing measurement.
 - e. When located outdoors, provide with surge protectors: Rosemount Model 470A, Approved Equal.

2.02 INTRINSIC SAFETY

- A. Intrinsic safety barrier: For use with two-wire transmitters. Barrier shall be of the active, isolating, loop powered 24VDC or external isolated 120VAC powered HART protocol compatible. Mounting: DIN rail.

- B. Listings: UL or FM approval for use in Class I, Div. 1&2, Groups A, B, C, D, Class II, Div. 1&2, Groups E, F, G.
- C. Acceptable Manufacturer:
1. Stahl 9160/13-11 series.
 2. Pepperl + Fuchs KFD2 series.
 3. Approved Equal.

2.03 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

- A. Requirements for instruments specified in this Section are listed on INSTRUSPEC sheets. Installation application requirements are specified in Section 40 06 71, and/or on the Drawings.

2.04 INSTRUSPEC SHEETS

- A. Instruments used for Machine Monitoring are included in Section 40 79 56.
- B. The following INSTRUSPEC sheets are included in this Section

INSTRUSPEC Symbol	Instrument Description	Instrument Function
AE/AIT1	Combustible Gas Analyzer Display, and Alarms	Combustible Gas Detection
AE/AIT2	Hydrogen Sulfide Gas Analyzer	Hydrogen Sulfide Gas Detection
AE/AIT4	Ph/Temperature Analyzer	Ph and Temperature Detection
AE/AIT5	Conductivity Analyzer	Conductivity Detection
FM	Display, and Alarms Magnetic flowmeter	Flow Measurement
FT	Thermal Mass Flow Meter	Flow Measurement
PDT	Differential pressure transmitter	Pressure Measurement
PGT	Gage pressure transmitter	Pressure Measurement
TT	Temperature Transmitter	Temperature Measurement

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

Process:

Process Connections:

Product Requirements:

General:

Sensor:

Transmitter:

Cable:

Special requirements:

Manufacturer & Model:

Execution:

Installation:

Calibration:

AE/AIT1

Panel mounted combustible gas LEL analyzer

Analysis of gas for combustible hydrocarbons (C1-C7)

24VDC nominal, 18-27 VDC, 10 VA maximum

Aspirated ambient air sample

4-20 mA

Waste water or Odor Control

Per installation detail

The gas detector shall be a designed for fixed installation and shall include sensor, transmitter, and accessories mounted on an open back plane

1. Design: NDIR Optical sensor; optimized for CH₄ and combustibles, corrosion-resistant contacts
2. Range: 0-100% LEL based on methane
3. Connection: Flow cell with aspirator
4. Temperature limit: -4° to 122°F (-20 to 50 C)
5. Humidity range: 15 to 95% RH, non-condensing

1. Housing: NEMA 7 per detail specifications
2. Housing material: Epoxy-coated Aluminum
3. Temperature limit: -4° to 122°F (-20 to 50C)
4. Calibration: Non-intrusive method, Microprocessor-based, able to retain configuration through power outage
5. Analog Output signals: 4-20 mA into 600 ohms at 24 VDC.
6. Response time: <30 seconds to 90% full scale
7. Linearity: +/-3% LEL below 40% LEL
8. Repeatability: +/- 2% LEL below 40% LEL
9. Display: LCD (% LEL), WARN and HIGH Alarm icons
10. Approval: UL/FM/CSA
11. Rating: Class 1, Div. 1, Groups B to D

1. 3-Cond. shielded plus conforming ground. Maximum separation between sensor and transmitter: 50 ft.

1. Provide electrical sampling module with flow switch capable of drawing a sample of 2.0 SCFH through analyzer sample chamber.
2. Provide ¼-inch diameter 316 SS or Teflon sample tubing and end-of-line filters.

Acceptable Manufacturer:

MSA Model Ultima x5000, No Substitutions.

Sample pump: MSA model sampler, No Substitutions.

Mount the unit on a tri-gas panel per I-Drawing.

Install in accordance with manufacturer's instructions and the recommendations of API RP551.

Application, calibration and set point requirements per Section 40 06 71.

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

Process:

Process Connections:

Product Requirements:

General:

Sensor:

Transmitter:

Cable:

Special requirements:

Manufacturer & Model:

Execution:

Installation:

Calibration:

AE/AIT2Panel mounted toxic gas H₂S analyzerAnalysis of gas for toxic H₂S

24VDC nominal, 18-27 VDC, 10 VA maximum

Aspirated ambient air sample

4-20 mA

Waste water or Odor Control

Per installation detail

The gas detector shall be a unit designed for fixed installation and shall include sensor, transmitter, and accessories mounted on an open back plane

1. Design: Catalytic bead sensor; corrosion-resistant contacts
2. Range: 0-50 ppm H₂S
3. Connection: Flow cell with aspirator
4. Temperature limit: -4° to 122°F (-20 to 50 C)
5. Humidity range: 15 to 95% RH, non-condensing

1. Housing: NEMA 7 per detail specifications
2. Housing material: Epoxy-coated Aluminum
3. Temperature limit: -4° to 122°F (-20 to 50C)
4. Calibration: Non-intrusive method, Microprocessor-based, able to retain configuration through power outage
5. Analog Output signals: 4-20 mA into 600 ohms at 24 VDC.
6. Response time: <30 seconds to 90% full scale
7. Display: LCD (ppm H₂S), WARN and HIGH Alarm icons
8. Approval: UL/FM/CSA
9. Rating: Class 1, Div. 1, Groups B to D

1. 3-Cond. shielded plus conforming ground. Maximum separation between sensor and transmitter: 50 ft.

1. Provide electrical sampling module with flow switch capable of drawing a sample of 2.0 SCFH through analyzer sample chamber.
2. Provide ¼-inch diameter 316 SS or Teflon sample tubing and end-of-line filters

Acceptable Manufacturer:

MSA Model Ultima X5000, No Substitutions.

Mount the unit on a tri-gas panel per I-Drawing.

Install in accordance with manufacturer's instructions and the recommendations of API RP551.

Application, calibration and set point requirements per Section 40 06 71.

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

Process:

Process Connections:

Product Requirements:

General:

Sensor:

Transmitter:

Cable:

Special requirements:

Manufacturer & Model:

Execution:

Installation:

Calibration:

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

Process:

Process Connections:

Product Requirements:

General:

Sensor:

AE/AIT4

Analyzer monitoring pH and Temperature

Analysis of liquid pH and Temperature

AC powered: 100 to 240V ac plus or minus 10 percent, 50/60 Hz; 15W with 7W sensor/network card load, 37W with 25W sensor/network card load

Side Stream Sample Basin

Analog 0/4 to 20 mA outputs with a maximum impedance of 500 ohms

Waste water or Odor Control

Per installation detail

Sensor that continuously measures pH in aqueous solutions

Measurement range: 0 to 14 pH

Sensitivity: 0.01 pH

Stability: 0.03 pH per 24 hours, non-cumulative

Temperature range: 23 to 158 °F (-5 to 70 °C)

Sample flow rate: 3 meters (10 feet) per second, maximum

Pressure: 100 pounds per square inch at 158 °F (6.9 bar at 70 °C)

Transmission distance: 1000 meters (3240 feet), maximum

Range:

pH: per Instrument Index.

Temperature: per Instrument Index

Interconnecting Cable: Length as required

Acceptable Manufacturer:

Hach: pHD-SC pH Sensor for connection to a HACH SC200 controller No Substitutions.

Install in accordance with manufacturer's instructions and the recommendations of API RP551.

Application, calibration and set point requirements per Section 40 06 71.

AE/AIT5

Analyzer monitoring Conductivity

Analysis of liquid Conductivity

AC powered: 100 to 240V ac plus or minus 10 percent, 50/60 Hz; 15W with 7W sensor/network card load, 37W with 25W sensor/network card load

Side Stream Sample Basin

Analog 0/4 to 20 mA outputs with a maximum impedance of 500 ohms

Waste water or Odor Control

Per installation detail

Sensor continuously measures conductivity in aqueous solutions.

Measurement range:

Conductivity: 250 µS/cm – 2.5 S/cm

Instrument Identification:**AE/AIT5**

Temperature: -5 to 50 °C (23 to 122 °F)

Operating temperature: -20 to 50 °C (-4 to 122 °F)

Max. immersion depth / pressure for the sensor: 20 m / 2 bar (29 psi)

Flow rate: 13 ft./s (4 m/s), maximum

Range: per Instrument Index.

Transmitter:

Cable:

Interconnecting Cable: Length as required

Special requirements:

Manufacturer & Model:

Acceptable Manufacturer:

Hach: Digital Inductive Conductivity Sensor for connection to a HACH SC200 controller No Substitutions.

Execution:

Installation:

Install in accordance with manufacturer's instructions and the recommendations of API RP551.

Calibration:

Application, calibration and set point requirements per Section 40 06 71.

Instrument Identification:**FM**

Instrument Function:

Flow measurement.

Instrument Description:

Magnetic flow metering system.

Power Supply:

120 VAC (transmitter).

Signal Input:

Process.

Signal Output:

4 – 20 mA DC.

Process Connection:

Flange, ANSI B16.5 Class 150, raised face for sizes below 24"; AWWA Class D for sizes above 24".

Product Requirements:

General:

1. Magnetic flow meter shall be provided as a system consisting of a flow tube and remotely mounted converter/transmitter complete with all necessary interconnecting cables for the flow tube to transmitter separation shown.
2. System shall be suitable for measuring raw sewage flow.
3. Provide grounding rings for both upstream and downstream connections with the process piping.
4. Provide mechanical protection for the flow tube flanges and liner during installation or removal of the flow tube.
5. Provide pipe reducer and expander where pipe run size is different from specified flow tube size. The reducer and expander shall be uniformly diverging and converging swages with a total reducing angle not exceeding 8 degrees. Locate per manufacturer's instructions for upstream and downstream obstructions.

Flow Tube:

1. Inside diameter of the flow tube: As indicated in the Drawings.
2. Flow tube construction: NEMA 4X construction. Measuring tube material 304 stainless steel; liner material: Hard rubber.

Instrument Identification:**FM**

3. Pulsed D.C. field excitation with automatic zero point correction.
4. Field coil insulation class E.
5. Electrode material: 316 stainless steel.
6. Grounding ring material: 316 stainless steel.
7. Rating: FM Class I, Division 2
8. Acceptable Manufacturer:
 - a) Rosemount – Emerson Process Management, no substitutions. Sole source waiver 2017-025.

Transmitter:

1. Signal converter/transmitter shall be suitable for an adjustable full-scale flow within the limits of from 1 to 30 feet per second.
2. Signal converter / transmitter features: remotely mounted from flow tube; microprocessor based.
3. Bi-directional flow and totalization measurement.
4. Integral high-contrast LCD display; integral control panel.
5. Accuracy of 0.3% of Rate.
6. Signal output 4 – 20 mA DC galvanically isolated and internally powered. Minimum 500 Ohm driving capability.
7. Low-flow cutoff: adjustable from 0% to 20% of range
8. Signal converter shall be compatible with all types and sizes of flow tubes and replaceable without recalibration. Upgradeable to future software and communications versions.
9. Adjustable dampening: 0.2 to 256 seconds
10. Power 120 VAC.
11. Flow rate calibration as per 40 06 71, Instrument Index.
12. Digital Communications: Smart transmitter sub-carrier compatibility with HART protocol
13. Certification: CSA, FM - Class 1, Division 2
14. Acceptable manufacturer:
 - a) Rosemount – Emerson Process Management. No substitutions. Sole source waiver 2017-025.

Execution:

1. Install in accordance with manufacturer's instructions, API RP551, and the specified functional requirements.
2. Install ground rings upstream and downstream of the flow tube.
3. Install the transmitter on the wall in nearby room remotely from the flow tube.

Installation:**Cable:**

1. Install power and signal cables in separate conduits.
2. A sufficient length of cables shall be provided for installation of a continuous run between the primary element and the remotely mounted transmitter.

Calibration:

Application, calibration and set point requirements per Section 40 06 71.

Instrument Identification:

Instrument Function:

Instrument Description:

Power Supply:

Signal Input:

Signal Output:

Process Connection:

Product Requirements:

General:

FT

Flow measurement.

Thermal mass flow metering system, gas systems.

120 VAC (transmitter).

Process.

4 – 20 mA DC.

Flange, ANSI B16.5 Class 150, raised face for sizes below 24"; AWWA Class D for sizes above 24".

1. Thermal mass flow meter shall be provided as a system consisting of a flow tube and mounted converter/transmitter complete with all necessary interconnecting cables for the flow tube to transmitter separation shown.
2. System shall be suitable for measuring propane and digester gas.
3. Provide grounding rings for both upstream and downstream connections with the process piping.
4. Provide mechanical protection for the flow tube flanges and liner during installation or removal of the flow tube.
5. Provide pipe reducer and expander where pipe run size is different from specified flow tube size. The reducer and expander shall be uniformly diverging and converging swages with a total reducing angle not exceeding 8 degrees.
6. Locate per manufacturer's instructions for upstream and downstream obstructions.

Transmitter:

1. Signal converter/transmitter shall be suitable for an adjustable full-scale flow within the limits of from 1 to 30 feet per second.
2. Signal converter / transmitter features: remotely mounted from flow tube; microprocessor based.
3. Integral high-contrast LCD display; integral control panel.
4. Accuracy of 0.3% of Rate.
5. Signal output 4 – 20 mA DC galvanically isolated and internally powered. Minimum 500 Ohm driving capability.
6. Low-flow cutoff: adjustable from 0% to 20% of range
7. Signal converter shall be compatible with all types and sizes of flow tubes and replaceable without recalibration. Upgradeable to future software and communications versions.
8. Adjustable dampening: 0.2 to 256 seconds
9. Power 120 VAC.
10. Digital Communications: Smart transmitter sub-carrier compatibility with HART protocol
11. Certification: CSA, FM - Class 1, Division 2
12. Acceptable manufacturer:
 - a. FCI ST100AL
 - b. Kurz 454 FTB-WGF (For Wet Gas applications)
 - c. Approved Equal.

Installation:

1. Install in accordance with manufacturer's instructions, API RP551, and the specified functional requirements.

Cable:

1. Install power and signal cables in separate conduits.

Instrument Identification:**FT**

Calibration:

2. A sufficient length of cables shall be provided for installation of a continuous run between the primary element and the remotely mounted transmitter.
1. For Propane applications, flow meter parameters shall be set for appropriate gas properties for accurate measurement.
2. For Digester Gas (MSG or EGG), digester gas constituent report will be used to set gas properties for accurate measurement. Gas Constituent report must be generated from process gas sample no earlier than 12 months prior to meter installation.
3. Application, calibration and set point requirements per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC**Instrument
Identification:****PDT**

- Instrument Function: Differential Pressure (Level) measurement.
Instrument Description: Differential pressure transmitter.
Power Supply: 9-30 VDC
Signal Input: Process.
Signal Output: 4-20 mA
Process Connection: 1/2-inch NPT
Product Requirements:
1. Pressure transmitter shall be capacitance or Silicon piezo-
 2. Resistive bridge type.
 3. Wetted parts: 316 SS unless otherwise specified in 40 06 71
 4. Fill fluid shall be DC 200 Silicone oil
 5. Adjustable damping time: 0.5 to 10 seconds
 6. External zero adjustment
 7. Accuracy: ± 0.1 percent of span.
 8. Provide differential pressure transmitters with a three-valve manifold with four 1/4-inch drain/vent ports, two plugged and two provided with bleed valves.
 9. Maximum working pressure rating: 2000 psig or greater.

- Acceptable Manufacturer:
1. Rosemount – Emerson Process Management, no substitutions.
Sole source waiver 2017-025.

Execution:

- Installation:
1. Install in accordance with manufacturer's instructions and the recommendations of API RP551.
 2. Provide root valves at all process pressure taps.
 3. Locate pressure instruments as close as practical to the process tap and position to permit observation and maintenance from grade or work platform unless otherwise specified.
 4. Do not support pressure instruments from process piping, unless otherwise specified.

- Calibration:
- Application, calibration and set point requirements per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET – INSTRUSPEC

Instrument Identification: PGT

Instrument Function: Pressure measurement.
Instrument Description: Gage pressure transmitter.
Power Supply: 9-30 VDC.
Signal Input: Process.
Signal Output: 4-20 mA HART.
Process Connection: 1/2-inch NPT or optional flange adapters.
Product Requirements:

1. Pressure transmitter shall be capacitance or Silicon piezo resistive bridge type.
2. Wetted parts: 316 SS unless otherwise specified in 40 06 71.
3. Fill fluid shall be DC 200 Silicone oil.
4. Adjustable damping time: 0.5 to 10 seconds
5. External zero adjustment
6. Accuracy: ± 0.1 percent of span.
7. Maximum working pressure rating: 2000 psig or greater.

Acceptable Manufacturers:

1. Rosemount – Emerson Process Management, no substitutions. Sole source waiver 2017-025.

Execution:

Installation:

1. Install in accordance with manufacturer's instructions and the recommendations of API RP551.
2. Provide root valves at all process pressure taps.
3. Provide gage valves at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
4. DO NOT connect safety instruments to the same process tap as instruments used for control, indication, or recording.
5. Locate pressure instruments as close as practical to the process tap and position to permit observation and maintenance from grade or a maintenance platform, unless otherwise specified.
6. DO NOT support pressure instruments from process piping.

Calibration: Application, calibration and set point requirements per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification: TT

Instrument Function: Temperature measurement.
Instrument Description: Temperature transmitter
Power Supply: 24 VDC Two-wire transmitter; 8 VA maximum
Signal Input: 2, 3, or 4-wire RTD 100 Ohm Platinum, or T/C type J, K, E, N, R, S, T, or B, as specified
Signal Output: 4-20 mA
Process Connection: 1/2" NPT
Product Requirements:
Sensor:

1. Provide a sensor in accordance with Section 40 06 71
2. Acceptable manufacturer:
 - a. Rosemount – Emerson Process Management, no substitutions. Sole source waiver 2017-025.

- Transmitter:
1. Transmitter shall convert the sensor resistance or mV output to a milliampere transmission signal output with an accuracy of ± 0.1 percent of range or better.
 2. Accuracy and stability: $\pm 0.1\%$ of range or $0.1\text{ }^{\circ}\text{C}$, whichever is greater, for 2 years with RTD sensor and 1 year with T/C sensor.
 3. Isolation: Input/Output/Power 500 VAC minimum
 4. Transmitter shall provide output power for sensor or Cold Junction compensation for sensor, as required
 5. Display: 3-1/2 digit integral LCD display w/decimal point, minus sign, and $^{\circ}\text{C}/^{\circ}\text{F}$ indicator
 6. Provide: HART
 7. Approvals: FM Explosion-proof and/or Intrinsically safe, as required
 8. Enclosure: Aluminum cast w/polyurethane baked enamel coating, NEMA 4X
 9. Environmental:
Operating Temperature: $-20\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$
Humidity: 5% – 85%, non-condensing
 10. Acceptable Manufacturers:
 - a. Rosemount – Emerson Process Management, no substitutions. Sole source waiver 2017-025.
- Installation: Install per manufacturer's instructions and recommendations of API RP-551.
- Calibration: Application, calibration and set point requirements per Section 40 06 71.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation requirements per Section 40 61 13.

3.02 TESTING

- A. Testing requirements per Section 01 75 20.

END OF SECTION

SECTION 40 70 30

PROCESS SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for process-activated switches.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
API RP551	Process Measurement Instrumentation
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	Industrial Control Devices, Controllers and Assemblies
NEMA ICS 6	Industrial Control and Systems: Enclosures
ANSI/UL913	Intrinsically Safe Apparatus and Associated Apparatus
ANSI/UL 60079-11	Explosive Atmospheres – Part 11: Equipment Protection by Intrinsic Safety “I”

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Operation and Maintenance Information: Section 01 78 23.
- C. Product Data: Section 40 61 13.
- D. Calibration and Test Results: Section 40 61 13.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise specified, switches shall comply with the following requirements:
1. Switch contacts used for alarm actuation shall be normally closed and shall open to initiate the alarm.
 2. Switch contact used to operate equipment shall be normally open and shall close to start the equipment.
 3. Switch contacts monitored by solid-state equipment (such as process and programmable logic controllers or remote terminal units) or annunciators shall be designed for switching currents from 20 to 100 mA at 24 VDC.
 4. Switch contacts used to energize electromagnetic devices such as relays, contactor or solenoids shall be rated NEMA ICS 2, designation B300.
 5. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
 6. Contacts in Class 1, Divisions 1 and 2 areas and monitored by solid-state circuits shall be made safe by suitable intrinsic-safety barriers.

2.02 INTRINSIC SAFETY

- A. Intrinsic safety relay:
1. Isolates field contacts in classified location from control circuits in non-classified location.
 2. Input:
 - a. Maximum field contact current/voltage: 10 mA/11 VAC
 - b. Turn-on sensitivity: < 100K Ohms
 - c. Turn-off sensitivity: > 1 Mega ohm
 3. Output:
 - a. SPST N.O./N.C. switching action field programmable
 - b. Rating: 0.4 A resistive at 24 VDC or 1 A resistive at 120 VAC, minimum
 4. Power: 120 VAC, 50-60 Hz, 4 VA maximum
 5. Listings: UL recognized or FM approved for use in Class I, Div. 1&2, Groups A, B, C, D Class II, Div. 1&2, Groups E, F, G
 6. Acceptable manufacturers:
 - a. Pepperl+Fuchs KFD
 - b. Stahl IS Isolator Type 9170
 - c. Approved Equal.

2.03 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

- A. General requirements for instruments specified in INSTRUSPEC sheets in this Section. Application requirements are specified in Section 40 06 71.

2.04 INSTRUSPEC SHEETS

- A. The following INSTRUSPEC sheets are included below.

INSTRUSPEC Symbol	Instrument Description	Instrument Function
FS	Flow Switch, Thermal Dispersion	Flow of process fluids
LFS1	Float level switch	Level measurement
LFS2	Float level switch	Level measurement
LS1	Level Control Sensor	Multi-level measurement
LS2	Level Control Sensor	RF Capacitance level measurement
PDS	Differential Pressure switch, low range	Differential pressure measurement
PS	Differential Pressure switch, low range	Pressure measurement
TS	Temperature switch	Temperature Monitor (Fluid immersion)
VS	Vibration switch	Motor or pump vibration monitor
ZS1	Position Switch	Magnetic reed switch
ZS2	Position Switch	Magnetic reed switch

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	FS
Instrument Function:	Sense low flow of process fluids
Instrument Description:	Flow Switch, Thermal dispersion
Power Supply:	120 VAC, 60 Hz. as specified, 20 VA max.
Signal Input:	Detect either a high flow or a low flow condition for both gases and liquids.
Signal Output:	DPDT relay, contacts rated 8A at 120 VAC
Process Connection:	1" 150# ANSI raised face flange
Product Requirements:	<ol style="list-style-type: none"> 1. Sensor (Probe): <ol style="list-style-type: none"> a. Consists of a self-contained heated element and reference thermal element immersed in process flow with processing electronics b. All wetted surfaces: 316 SS c. Probe: Standard, twin tip, Insertion length: Refer to Mechanical Drawings for duct size d. Ambient temperature: -100° to +400°F e. Normal pressure rating: 1850 psig @ 100°F f. FM approved for use in Class I, Division 1 Groups B, C, D; Class II, Division 1, Groups E, F, G. 2. Electronics: <ol style="list-style-type: none"> a. Ambient temperature: -40° to +158°F b. Time delay: 0-100 seconds adjustable c. Set point range: 0.1 to 500 fps d. Set point: Field adjustable e. Repeatability: <1% at constant temperature f. Enclosure: NEMA 4X, IP66, material 316 SS, with 3/4" FNPT dual conduit entry 3. Acceptable Manufacturer: <p>STI/Magnetrol Thermatel sensor TEC with TD-2 switch, no exceptions</p>
Installation:	<ol style="list-style-type: none"> 1. Mount and connect per manufacturer's instructions and as shown in the Contract Drawings.
Application/Calibration:	Application, calibration, and set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	LFS1
Instrument Description:	Float level switch.
Instrument Function:	Level measurement.
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	Contacts N.O. or N.C. as required in Section 40 06 71
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none">1. Switch shall consist of a SPST mercury tilt switch enclosed in a 304 or 316 stainless steel, non-stick coated, float housing.2. 14-AWG wire type SO cable with PVC outer jacket.3. Mercury tilt switch shall be rated for two amps at 120 VAC.4. Cable length shall be as specified and as required to meet the application needs.5. Acceptable manufacturer:<ol style="list-style-type: none">a. Siemens Model 9G Direct Acting Float Switch (B100)b. Anchor Scientific Roto-Float-SSTc. Approved Equal.
Execution:	
Installation:	Install per manufacturer's instructions and Contract Detail Drawings.
Calibration:	Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	LFS2
Instrument Description:	Float level switch.
Instrument Function:	Level measurement.
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	Contacts as specified within this Section.
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none">1. Switch shall consist of a SPST or SPDT non-mercury tilt switch enclosed in a 304 or 316 stainless steel, Non-stick coated, float housing.2. 16-AWG wire type SO cable with PVC outer jacket.3. Magnetic reed tilt switch shall be rated for 100 VA at up to 250 Volts.4. Cable length shall be as specified and as required to meet the application needs.5. Acceptable manufacturer:<ol style="list-style-type: none">a. Siemens Model 9G-EF Direct Acting Float Switch (B100)b. Anchor Scientific Roto-Float-SSc. Approved Equal.
Execution:	
Installation:	Install per manufacturer's instructions and Contract Documents.
Calibration:	Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	LS1
Instrument Description:	Level Measurement
Instrument Function:	Multi-level measurement
Power Supply:	120VAC
Process:	Waste water; Water
Signal Input:	Process
Signal Output:	Contacts as specified within this Section.
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none">1. SPST2. Number of floats: 13. Lead wire length: 24 inches4. Mounting: Tank top, flanged5. Mount and stem material: 316 SS6. Overall length of stem: per Contract Documents7. Set points: per Section 40 06 71.8. Float material: 316 SS9. Float operating temperature: up to 150°F10. Float operating maximum pressure: 100 PSI11. Electrical connection junction box: NEMA 4X12. Approval: FM, UL, or CSA13. Acceptable manufacturer:<ol style="list-style-type: none">a. GEMS Model LS700b. Barksdale BLS-800c. Approved Equal.
Execution:	
Installation:	Install per manufacturer's instructions and Contract Detail Drawings.
Application/Calibration:	Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

LS2

Instrument Description:	Level Measurement
Instrument Function:	RF Capacitance level measurement
Power Supply:	120VAC
Process:	Wastewater or Water
Signal Input:	Process
Signal Output:	2 to 4 DPDT Relay outputs.
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none">1. Relays: DPDT 10 Amp at 120/240 VAC or 30 VDC2. All relays fully programmable for Low-High trip set points and time delay (0 – 90sec.).3. Probe: Teflon® (TFE) insulated rigid.4. Probe insertion length: as required by the application, per Contract Drawings, and in accordance with manufacturer's requirements.5. Actuation set points: per Section 40 06 71.6. Microprocessor-based user interface.7. 3-button/4-digit LED data entry and display of all parameters.8. Mounting: tank top and flanged9. Electrical connection junction box shall be NEMA 4X, with 3/4" NPT single conduit.10. Certification: UL, FM, or CSA11. Acceptable manufacturer:<ol style="list-style-type: none">a. Magnetrol Kotron® Model 800 series, no substitutions.

Execution:

Installation:	Install per manufacturer's instructions and Contract Detail Drawings.
Application/Calibration:	Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

Instrument Description: Differential pressure switch, low range
Instrument Function: Differential pressure measurement
Power Supply: N/A
Signal Input: Process
Signal Output: Contacts Normally Open or Normally Closed as required in 40 06 71
Process Connection: 1/4-inch NPT high and low pressure taps
Product Requirements:

PDS

1. Pressure element:
 - a. Type: Buna-N diaphragm.
 - b. Overpressure: Capable of withstanding higher pressure surges (within the maximum allowable pressure rating of the switch) up to 10 per day without affecting calibration.
2. Switch:
 - a. SPDT
 - b. Rating: 10 A @ 120 VAC
 - c. Adjustable set-point and dead band of approximately 10% to 90% of operating range
 - d. Pilot lights
3. Range: Set point should fall between 30% and 70% of operating range. Set point and reset point shall be indicated on calibrated scales.
4. Accuracy: $\pm 1\%$ of full scale
5. Enclosure:
 - a. Epoxy coated aluminum NEMA 4X
 - b. Two 3/4-inch conduit connections
6. Certification: UL or CSA
7. Acceptable Manufacturers:
 - a. Ashcroft series LDA, PDA. No substitutions allowed.

Execution:

- Installation:
1. Install per manufacturer's instructions and the recommendations of API RP551 to the specified requirements.
 2. Provide gage valves at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
 3. Unless otherwise specified, locate as close as practical to the process tap and position to permit observation and maintenance.

Application/Calibration: Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	PS
Instrument Description:	Pressure switch
Instrument Function:	Pressure measurement
Power Supply:	N/A
Signal Input:	Process
Signal Output:	Contacts Normally Open or Normally Closed as required in 40 06 71
Process Connection:	1/4-inch NPT high and low pressure taps
Product Requirements:	<ol style="list-style-type: none"> 1. Pressure element: <ol style="list-style-type: none"> a. Type: Buna-N diaphragm. b. Overpressure: Capable of withstanding higher pressure surges (within the maximum allowable pressure rating of the switch) up to 10 per day without affecting calibration. 2. Switch: <ol style="list-style-type: none"> a. SPDT b. Rating: 10 A @ 120 VAC c. Adjustable set-point and dead band of approximately 10% to 90% of operating range d. Pilot lights 3. Range: Set point should fall between 30% and 70% of operating range. Set point and reset point shall be indicated on calibrated scales. 4. Accuracy: $\pm 1\%$ of full scale 5. Enclosure: <ol style="list-style-type: none"> a. Epoxy coated aluminum NEMA 4X b. Two 3/4-inch conduit connections 6. Certification: UL or CSA 7. Acceptable Manufacturers: <ol style="list-style-type: none"> a. Ashcroft series LDA, PDA. No substitutions allowed.
Execution:	
Installation:	<ol style="list-style-type: none"> 1. Install per manufacturer's instructions and the recommendations of API RP551 to the specified requirements. 2. Provide gage valves at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap. 3. Unless otherwise specified, locate as close as practical to the process tap and position to permit observation and maintenance.
Application/Calibration:	Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

TS

Instrument Description:

Temperature switch

Instrument Function:

Temperature monitor (Capillary-type Fluid immersion)

Power Supply:

N/A

Signal Input:

Process temperature

Signal Output:

Contacts Normally Open or Normally Closed as required in 40 06 71.

Process Connection:

1/2" NPT

Product Requirements:

1. Bulb and capillary: Stainless steel. Length per field requirements.
2. Thermo-well per Section 40 70 10.
3. Switch:
 - a. General purpose SPDT, unless otherwise specified.
 - b. Rated 10 A at 120 VAC; 0.5 A at 120 VDC.
 - c. Adjustable set-point between 15% and 100% of nominal range on increasing or decreasing temperature.
 - d. Fixed or adjustable dead band as specified in Section 40 06 71.
 - e. Pilot Lights.
4. Accuracy: Accuracy: $\pm 1\%$ of full scale.
5. Enclosure:
 - a. Epoxy coated aluminum NEMA 4X.
 - b. 3/4-inch conduit connections
6. Certification: UL or FM.
7. Acceptable Manufacturers:
 - a. Ashcroft series LT, PT. No substitutions allowed.

Execution:

Installation:

Install per manufacturer's instructions and Contract Documents.

Application/Calibration:

Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

VS

Vibration Switch, Electronic

Sense Vibration of Process Equipment

120 VAC, 60 Hz or 24 VDC, as specified.

Acceleration

1. AC powered units: Solid-state triac, rated 2 A at 120 VAC.
2. DC powered units: Power FET, rated 3 A at 24 VDC.
3. Analog output: 4-20 mA into 0 to 500 Ohms.

Process Connection:

Machined surface w/fasteners

Product Requirements:

1. Construction: Consists of a self-contained seismic vibration sensor, electronic signal processing and alarm circuitry with two alarm relays.
2. Operation:
 - a. Intended to protect rotating machinery from damage due to mechanical malfunction and vibration. Signal processing electronics shall convert seismic sensor output into velocity signal, test for alarms, and transmit analog velocity signal.
 - b. Include an alarm inhibit feature that prevents the switch from tripping during machine start up, as indicated by contact closure. After the inhibit period, the switch shall function normally.
 - c. Include an alarm delay feature that prevents the switch from tripping during short term transient vibration conditions. Under continued high vibration the switch shall trip after the delay period. Alarm delay period shall be programmable from 3 to 10 seconds.
3. Range:
 - a. Danger alarm set-point: 0.15 to 1.5 inches/sec.
 - b. Warning alarm set-point: 10% to 100% of Danger set-point.
 - c. Analog signal: 0 to 150% of Danger set-point
4. Accuracy: +5% FS
5. Power: 120 VAC, 5 VA maximum, or as specified.
6. Enclosure:
 - a. Cast aluminum or cast iron NEMA 4X or NEMA 7, as required.
 - b. Conduit fittings: 3/4-inch conduit opening for power and signal wiring.
7. Acceptable Manufacturer:
 - a. Robertshaw model 566.
 - b. Balmac Model 500-X.
 - c. Rochester model VT-1215.
 - d. Approved Equal.

Instrument Identification:

VS

Execution:

Installation:

Install per manufacturer's instructions and Contract Documents.

Application/Calibration:

Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

ZS1

Instrument Description:

Position Switch

Instrument Function:

Magnetic Reed Switch

Power Supply:

N/A

Signal Input:

Door opening

Signal Output:

Contacts Normally Closed

Process Connection:

Recessed or inserted for metal door installation.

Product Requirements:

1. Provide industrial grade switch suitable for harsh environments. NEMA rating as required by the installation environment, or as otherwise specified.
2. Use magnetic reed switch SPDT Form C contacts.
3. Designed to prevent sticking or freezing between the two switch plates that form the magnetic field.
4. Electrical components hermetically sealed.
5. Warranted for a minimum of 10 years for workmanship, material and factory defects.
6. Acceptable manufacturers:
 - a. George Risk Industries, 190 Series.
 - b. General Electric, 1078/1076 Series.
 - c. Approved Equal.

Execution

Installation:

Install per manufacturer's instruction and Contract Documents.

Application/Calibration

Application and calibration/set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

ZS2

Instrument Description:

Position Switch

Instrument Function:

Magnetic Reed Switch

Power Supply:

N/A

Signal Input:

Door opening

Signal Output:

Contacts Normally Closed

Process Connection:

Surface mounted for existing metal door installation.

Product Requirements:

1. Industrial grade switch, NEMA rating as required by the installation environment, or as otherwise specified.
2. Use magnetic reed switch, SPDT (Form C) contacts.
3. Designed to prevent sticking or freezing between the two switch plates that form the magnetic field.
4. Electrical components hermetically sealed.
5. Warranted for a minimum of 10 years for workmanship, material and factory defects.
6. Acceptable manufacture:
 - a. George Risk Industries, 402 Series.
 - b. General Electric/Sentrol, Series 2757/2767.
 - c. Approved Equal.

Execution

Installation:

Install per manufacturer's instructions and Contract Documents.

Application/Calibration

Application and calibration/set points shall be per Section 40 06 71.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation requirements per Section 40 61 13.

3.02 TESTING

- A. Testing requirements per Sections 40 61 13.

END OF SECTION

SECTION 40 78 00

PANEL MOUNTED INSTRUMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies panel mounted devices used to provide process control and the operator interface.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revision of the following documents. It is a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
UL 508	Industrial Control Equipment

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Calibration and Test Results per Section 40 61 13.
 2. Operation and Maintenance Information per Section 01 78 23.

PART 2 PRODUCTS

2.01 GENERAL

- A. Devices covered by this Section shall comply with all requirements for installation in a control panel bearing the UL 508 label.
- B. Panel instruments shall comply with the following requirements:
1. Analog instruments shall be miniature-case draw-out type, standard DIN dimensions, and not more than 20 inches deep.
 2. Operator, tuning, and configuration adjustments shall be accessible without disconnecting the instrument from the process.
 3. Analog signal indicators shall be solid-state, LED, or gas-discharge type, 4-digit numerical display or bar-graph displays with not less than 100 segments, as specified.
 4. Analog signal inputs shall be 1 to 5 VDC into not less than 250K ohms.
 5. Analog signal outputs shall be 1 to 5 VDC into >10K ohms except where instrument provides final output signal to field in which case output shall be 4 to 20 mA current regulated into 0 to 600 ohms.
 6. Unless otherwise specified, power supply shall be 120 VAC plus or minus 10 percent.
 7. Signal and power supply connections shall be isolated from the instrument case.
- C. Panel instruments specified in this Section shall be the product of a single manufacturer and shall match and line up to form an integrated appearance and operator interface strategy.

2.02 INSTRUMENTATION SPECIFICATION (INSTRUSPEC) SHEETS

- A. General requirements for instruments specified in this Section are listed on INSTRUSPEC.

2.03 INSTRUSPEC SHEETS

- A. The following INSTRUSPEC sheets are included in this Section.

INSTRUSPEC Symbol	Instrument Description	Instrument Function
XXS	Selector Switches	Operator Interface
XXL	Pilot Light	Operator Interface
XIC	PID Controller	Miniature-case process control station
XIK	Manual/Auto Station	Miniature-case manual/auto control station
UR	Paperless Recorder	Miniature-case process recorder
XI1	Bar Graph Indicator	Dual Bar Graph process indicator
XI2	Digital Indicator	Digital panel indicator

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

Process Connection:

Product Requirements:

XXS

Selector Switch

Operator Interface

120 VAC, 60 Hertz

N/A

Contact

N/A

1. Main Control Panel switches shall be four-quadrant style as described.
2. Up to four control positions that can be configured as: (1) selector switches, (2) selector push-type switches, (3) pushbuttons, and/or (4) segmented indicating light units.
3. Provide up to four separate energized indicating lights with legend plates and colored lenses as shown on the Drawings.
4. Indicating lights, pushbuttons and selector switches shall be oil tight heavy-duty units. Conforming to NEMA 250 Type 4 or better, as required.
5. Contacts in signal circuits shall be gold, for electronic solid-state dry circuits and rated for 28 VDC one-ampere resistive/125 VAC 0.5-ampere resistive.
6. Contacts in control circuits shall be silver and rated for 125 VDC 5-amperes inductive/120 VAC 5 amperes.
7. Indicating lights for 120 VAC shall be transformer type using a LED lamp.
8. Indicating lights for 24 VDC shall be resistive type using a LED lamp.
9. Lights shall be capable of being changed from the front of the panel without special tools.
10. Unit shall be UL/CSA listed.
11. Oil-tight Selector switches in other locations shall be as specified in Section 26 09 16.

Acceptable Manufacturer:

Execution:

Installation:

Application/Calibration:

Senasys Inc., Series CMC. or approved equal.

Mount and connect in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.

Application, calibration, and set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	XXL
Instrument Description:	Pilot Light
Instrument Function:	Operator Indicator (Pilot) Light
Power Supply:	120 VAC, 60 Hertz
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none">1. Each assembly shall have up to four positions that can be configured as segmenters indicating light units.2. Provide indicating lights, legend plated and colored lenses as shown on the Drawings.3. Indicating lights shall be oil-tight heavy-duty units, conforming to NEMA 250 Type 4 or better, as required.4. Indicating lights for 130 VAC shall be transformer type using a LED lamp.5. Indicating lights for 24 VDC shall be resistive type using a LED lamp.6. Lights shall be capable of being changed from the front of the panel without special tools.7. Units shall have UL/CSA listing.
Acceptable Manufacturer:	Senasys, Inc. Series CMC. or approved equal.
Execution:	
Installation:	Mount and connect in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.
Application/Calibration:	Application, calibration, and set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:	UR
Instrument Description:	Paperless recorder
Instrument Function:	Miniature-case panel recorder
Power Supply:	120 VAC (90 - 250 VAC), 50-60 hertz, 50 VA maximum
Signal Input:	Multiple channels, analog and digital, as specified
Signal Output:	N/A
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none">1. General purpose electronic data recording in a 144 mm DIN format size.2. Accepts up to 16 universal analog inputs and stores data on integral removable storage media, as specified.3. Display: 5.5" color active matrix LCD that provides wide viewing angles along with bright easy to read displays. Minimum QVGA (320 x 240 pixels) resolution.4. The operator interface provides easy access to the recorder menus for quick setup and replaying of the data.5. Independent display chart speeds and data storage rates for each pen.6. Compatible with TrendManager Pro R software suite from Honeywell for configuration, calibration, and database management and reporting.7. Internal memory for data storage capable of storing 8 channels of data for 30 days at a sample rate of 1/sec.8. Ethernet port for interface to a remote monitoring device.9. USB port and CompactFlash port for removable memory storage devices of 2 GB minimum.10. Data format: Honeywell R binary encoded format.11. Enclosure: UL listed, NEMA 4: 144 mm H x 144 W x 285 mm D; Panel cutout: 138mm H x 138 mm W12. Environmental: Operating temperature: 15 - 40 °C; humidity: 10% - 90% RH, non-condensing.
Acceptable Manufacturer:	Honeywell Model series: QX. No substitutions allowed.
Execution:	Install in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.
Installation:	Application, calibration, and setpoints shall be per Section 40 06 71.

Instrument Identification:	XI1
Instrument Description:	Bar Graph Indicator
Instrument Function:	Dual Bar Graph process indicator
Power Supply:	24 VDC
Signal Input:	2 channel, analog, 1-5 VDC
Signal Output:	N/A
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none"> 1. Indicators shall be buffered solid-state type and shall provide for one or two variables, as specified in Section 40 06 71. 2. Accuracy: 1.0% of span or better. 3. Each bar graph indication shall be comprised of 101 segments, LED bar. 4. Scale: Engineering units. 5. Enclosure: NEMA 250 Type 4X 6. Bezel dimensions; 2.16" W x 6.04" H 7. Panel cutout dimension: 1.8" W x 5.7" H 8.
Acceptable Manufacturers:	<ol style="list-style-type: none"> 1. Weschler Model BI1251 2. Ametek Dixon Model BB202P 3. Approved Equal.
Execution:	
Installation:	<ol style="list-style-type: none"> 1. Install in panels per Section 40 67 00 and in accordance with manufacturer's instructions and Contract Drawings. 2. Application and calibration/set points shall be per Section 40 06 71.

Instrument Identification:	XI2
Instrument Description:	Digital Indicator
Instrument Function:	Digital Indicator
Power Supply:	24 VDC
Signal Input:	1-5 VDC
Signal Output:	Process Input
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none"> 1. Panel mount digital process meter, scalable in engineering units. 2. Display: 4-digits by 0.5" high minimum. LED or back-lighted LCD with adjustable D.P. 3. Accuracy: 0.1% +/- 1 digit 4. Display range: -1999 to 9999 5. Relative humidity: 0 to 85%, non-condensing 6. Operating temperature: 32° to 122°F 7. Enclosure: NEMA 4X; Bezel: 1/8 DIN (96.5 mm W x 49.5 mm H); Panel cutout: (92 mm W x 45 mm H)
Acceptable Manufacturer:	Red Lion controls model PAX. No substitutions allowed.
Execution:	Install in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.
Installation:	Application, calibration, and setpoints shall be per Section 40 06 71.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Relays and control switches and pilot devices shall be installed in panels per Section 40 67 00 and in compliance to EIA RS-310C.

3.02 TESTING

- A. Testing requirements per Section 40 61 13.

END OF SECTION

SECTION 40 79 39

SIGNAL CONDITIONERS AND CONVERTERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for panel mounted signal conditioning modules.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
EIA RS-310C	Racks, panels, and associated equipment.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Product Data: per Section 40 61 13.
- C. Test Results: per Section 40 61 13.
- D. Operations and Maintenance Information per Section 01 78 23.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise specified or shown, signal conditioning modules shall comply with the following requirements:
1. Analog signal inputs shall be 1 to 5 VDC with minimum input impedance of 20M ohms.
 2. Analog signal outputs shall be 4 to 20 mA DC with minimum of 600 ohms driving capability.
 3. Discrete output contacts shall be SPDT rated 5 amperes at 120 VAC and 24 VDC.
 4. Power supply shall be 120 VAC or 24 VDC as shown, plus or minus 10 percent. Power supply effect shall not exceed 0.005 percent per 1.0 percent change.
 5. The output contacts of electronic trips shall change state as follows:
 - a. When shown as E>SP, the relay coil shall energize and contacts shall change state when input (E) is greater than or equal to set point (SP).
 - b. When shown as E<SP, the relay coil shall energize and contacts shall change state when input (E) is less than or equal to set point (SP).
 6. Modules shall be rated for continuous operation in an ambient temperature of 0 to 80 degrees C. Ambient temperature effect shall not exceed plus or minus 0.01 percent per degree C within that range.
 7. Span and zero adjustments shall be made by front accessible multi-turn potentiometers and/or field programmable switches or jumpers.
 8. Electronic trip modules shall be provided with LED indicators for relay status.
 9. Modules shall withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25 percent calibration effect. Modules shall also be provided with traps on the terminals to shunt conducted radio frequency interference to ground.
 10. Signal and power supply terminals shall be galvanically isolated from the chassis ground.

- B. Unless otherwise specified, all modules specified in this Section shall be the product of a single manufacturer.

2.02 INSTRUMENTATION SPECIFICATION (INSTRUSPEC) SHEETS

- A. General requirements for instruments specified in this Section are listed on INSTRUSPEC. Application requirements are specified in the instrument schedule in Section 40 06 71, and/or on the Drawings.

2.03 INSTRUSPEC SHEETS

- A. The following INSTRUSPEC sheets are included in this Section.

INSTRUSPEC Symbol	Instrument Description	Instrument Function
YAT	Alarm trip, Single or Dual	Function trip
YPC	Potentiometer Converter	Function module
YVC	DC Voltage/Current Isolating Amplifier	Function module

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

Instrument Description:

Instrument Function:

Power Supply:

Signal Input:

Signal Output:

Process Connection:

Product Requirements:

YAT

Alarm trip, Single or Dual, as specified

Function module

120 VAC AC, 60 Hertz or 24 volts DC, as specified

1-5 DC or 4-20 mA DC, as specified

Relay Contact(s), Form C.

N/A

1. Alarm trip shall monitor the input signal and shall switch isolated form C relay output(s). For a "high alarm" the signal decreases below the set point.
2. Input span shall be field programmable via dip switches, jumpers, or pushbutton programming; Pickup set point(s) shall be adjustable from 0 to 100 percent of span.
3. Alarm deadband shall be adjustable from 1 to 5 percent of span or better.
4. Accuracy/repeatability shall be 0.1 percent of span or better.
5. Operating temperature range of 0° to 60° C (32° to 140° F); Temperature stability shall be 0.2 percent of span plus 30 microvolts per degree C or less over operating temperature range.
6. Relays: One or two Form-C relays, as specified. Contact rating: 1 A at 120 VAC, Programmable for: hi or low trip, normal or failsafe operation, latching or non-latching.
7. Mounting: DIN rail
8. Acceptable Manufacturers:
 - a. Absolute Process Instruments (API) – Model series APD 1020, No Substitutions.

Installation:

1. Mount and connect in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.

Application/Calibration:

Application, calibration, and set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

YPC

Instrument Description:

Potentiometer converter

Instrument Function:

Function module

Power Supply:

120 volts AC 60 Hertz, or 24 Volts DC, as specified

Signal Input:

1K - 100K nom. Potentiometer

Signal Output:

4-20 mA DC into 600 Ohms

Process Connection:

N/A

Product Requirements:

1. Potentiometer converter shall provide constant current slidewire excitation and convert slidewire position into process output. Excitation current shall not exceed 1 mA for 1000 ohm slidewires.
2. Span shall be adjustable from 80 to 100 percent of slidewire travel; zero shall be adjustable from 0 to 10 percent of slidewire travel.
3. Accuracy/repeatability: 0.1 percent of span or better; time constant: 100 milliseconds or less.
4. Operating temperature range of 0° to 60° C (32° to 140° F); temperature drift plus or minus 0.02 percent of span plus 30 microvolts per degree C or less over operating temperature range
5. Power supply effect shall not exceed 0.1 percent of span with power supplies provided.
6. Mechanical: DIN rail mounted
7. Acceptable Manufacturers:
 - a. Absolute Process Instruments (API) – Model series APD 4008, No Substitutions.

Installation:

Mount and connect in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.

Application/Calibration:

Application, calibration, and set points shall be per Section 40 06 71.

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

Instrument Identification:

YVC

Instrument Description:

DC Voltage/Current Isolating Amplifier

Instrument Function:

Function module

Power Supply:

120 Volts AC, 60 Hertz or 24 Volts DC, as specified

Signal Input:

1 to 5 VDC or 4 to 20 mA DC, as specified

Signal Output:

4 to 20 mA DC into 500 Ohms

Process Connection:

N/A

Product Requirements:

1. DC isolation converter shall provide an output that is linearly proportional to the input. Span and Zero shall be field selectable and adjustable +10% via multi-turn potentiometer or program function.
2. Isolation: Between Input, Output, Power, and Ground - 1000 VAC, minimum.
3. The unit shall have the following features:
 - a. Filtering and conditioning to reduce susceptibility to transients and noisy operations.
 - b. Linearity: 0.05 percent span or better;
 - c. Accuracy/repeatability: 0.1 percent of span or better.
 - d. Response time: less than 1 second.
 - e. Operating temperature range of 0° to 60° C (32° to 140° F); Temperature drift: less than 0.02 percent of span plus 30 microvolts per degree C or less over operating temperature range.
4. Mechanical: DIN rail
5. Acceptable Manufacturers:
 - a. Absolute Process Instruments (API) – Model series APD 4380, No Substitutions.

Installation:

Mount and connect in panels per Section 40 67 00 and in accordance with manufacturer's instructions to the specified functional requirements.

Application/Calibration:

Application, calibration, and set points shall be per Section 40 06 71.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Signal conditioning modules shall be installed in panels per Section 40 67 00 and in compliance to EIA RS-310C.

3.02 TESTING

- A. Testing requirements per Section 40 61 13.

END OF SECTION

SECTION 40 79 53

MISCELLANEOUS INSTRUMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for miscellaneous instruments used to provide process control and interface between the operator and the process.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
UL 508A	Industrial Control Panels

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts and product data as required in Section 40 61 13.
- C. Intermediate Software Submittal (60%) including draft coding.
- D. Test Data: Full factory test documentation, signed, and dated.
- E. Operations and Maintenance information per Section 01 78 23.

PART 2 PRODUCTS

2.01 STROBE LIGHTS

- A. Flashing Strobe: 360 degree beam.
- B. Flash rate between approximately 65 and 90 times per minute.
- C. UL listed.
- D. Wall mount.
- E. Housing:
 - 1. NEMA 7, explosion proof.
 - a. Class 1, Divisions 1 and 2
 - 2. NEMA 4X, corrosion resistant.
- F. Indicating light color: As indicated on Drawings
- G. Power: 120VAC, 60 Hz
- H. Acceptable manufacturer and Model:

1. NEMA 7:
 - a. Edwards Signaling, Model 116-EXMST(*)-N5
 - b. Hubbell, Model ESX
 - c. Approved Equal.
2. NEMA 4X:
 - a. Edwards Signaling, Model 117(*)-N5
 - b. Hubbell, Model ESX
 - c. Approved Equal.

2.02 WARNING HORN

- A. Output: 97 dBa minimum at 10 feet and adjustable from 90 to 110 dBa
- B. UL listed.
- C. Wall mount.
- D. Housing:
 1. NEMA 7, explosion proof.
 - a. Class 1, Divisions 1 and 2
 2. NEMA 4X, corrosion resistant.
- E. Duty cycle: Continuous operation
- F. Power: 120 VAC, 60 Hz
- G. Manufacturer and Model:
 1. NEMA 7:
 - a. Edwards Signaling, Model 878EX-N5
 - b. Federal Signal Corp., Model 31X
 - c. Approved Equal.
 2. NEMA 4X:
 - a. Edwards Signaling, Model 870P-N5
 - b. Federal Signal Corp., Model 350WB
 - c. Approved Equal.

2.03 INSTRUMENT SPECIFICATION (INSTRUSPEC) SHEETS

- A. General requirements for instruments specified in this Section are listed on INSTRUSPEC sheets.

2.04 INSTRUSPEC SHEETS [NOT USED]

PART 3 EXECUTION

3.01 INSTALLATION

- A. Instruments shall be installed on panels per Section 40 67 00.

3.02 TESTING

- A. Testing requirements per Section 40 61 13.

END OF SECTION

SECTION 40 79 56

MACHINE MONITORING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the general requirements for monitoring equipment to be used on pumps, motors, and other equipment as specified in other Sections. Specific application-dependent requirements are delineated in Section 40 06 71 and the Drawings.
- B. Purpose: The equipment shall monitor each of the mechanical systems for vibration and/or temperature at the bearings and other locations shown in the contract drawings. The equipment shall warn operators of the following:
1. Vibration monitors warn of excessive vibration at the monitor points shown in the Drawings.
 2. Temperature monitors warn of lubrication loss, mechanical wear, and/or electrical trouble at the bearings and motor windings shown in the Drawings.
 3. Seal Leak monitors warn of contamination of lubrication oil by water leaking through the pump shaft seals.
- C. Machine Monitoring Equipment:
1. Provide machine monitoring equipment for the following per the Drawings and these specifications.

Equipment No.	Description	P&ID
704-P03DC011	RAW SEWAGE PUMP 1	WP704-P-60011
704-MTR03DC011	RAW SEWAGE PUMP 1 MOTOR	WP704-P-60011
704-P03DC021	RAW SEWAGE PUMP 2	WP704-P-60012
704-MTR03DC021	RAW SEWAGE PUMP 2 MOTOR	WP704-P-60012
704-P03DC031	RAW SEWAGE PUMP 3	WP704-P-60013
704-MTR03DC031	RAW SEWAGE PUMP 3 MOTOR	WP704-P-60013
704-P03DC041	RAW SEWAGE PUMP 4	WP704-P-60014
704-MTR03DC041	RAW SEWAGE PUMP 4 MOTOR	WP704-P-60014

2. Provide new sensors as indicated in the Drawings and the Instrument Schedule (Section 40 06 71). Locate per the Drawings.
3. Connect new monitoring equipment to motor drives per the Drawings.

1.02 DEFINITIONS

- A. The following terms shall be as defined in ANSI/ISA-51.1:
1. Accuracy.
 2. Repeatability.
 3. Dead Band.
 4. Range.
 5. Span.
 6. Calibrate.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ISA 51.1	Process Instrumentation Terminology

1.04 SUBMITTALS

- A. Provide in accordance with Section 01 33 00:
1. Shop drawings of all equipment, including schematic drawings.
 2. Installation drawings.
 3. Manufacturer's catalog or other data confirming conformance to specified design, material, and equipment requirements.
 4. Interconnection diagram for the system. Show the location of each device and the size and type of cables between devices. Show terminal numbers where each conductor is terminated. Show power and ground connections.
 5. Calibration Procedures.
 6. Complete step-by-step functional test procedure including forms for recording test results per Section 01 75 20.
 7. Test results for tests specified in this Section.
 8. Operating and Maintenance manuals per Section 01 78 23.
 9. Training Schedule and Course Outline per Section 01 79 00.

1.05 QUALITY ASSURANCE

- A. Qualifications of Installer:
1. The system shall be supplied and installed by an experienced firm regularly engaged in the installation of similar machine monitoring systems.
 2. The installer shall be a qualified factory-trained representative of the equipment manufacturer and shall have a minimum of 5 years' experience in design, installation, and testing of machine monitoring systems of similar scope and complexity.
 3. The County may reject any proposed installer who cannot show proof of such qualifications.

PART 2 PRODUCTS

2.01 MACHINE MONITORING EQUIPMENT

- A. Codes and Standards:
1. Devices and equipment provided shall be Factory Mutual approved.
 2. Devices shall be compatible with Emerson Ovation Machinery Health Monitoring modules.
- B. Mounting and Power supplies:
1. Provide rack-mounted or DIN-rail mounted monitoring and alarm modules. The modules shall continuously monitor each input device and display real-time data.
 2. Monitoring equipment for each pump system shall have power supplies independent from monitoring equipment for other pump systems.
- C. Vibration monitoring modules:
1. Single or Dual channel vibration monitoring and alarm modules.
 2. Inputs: Accelerometer, sensitivity as specified.
 3. Range: Velocity, 0.0-1.0 inch/sec RMS, or as specified.
 4. Recorder output of 1-5 V or 4-20 mA per channel.

5. Peak or RMS alarm detection.
 6. One single-ended, buffered raw sensor output per channel on a readily accessible BNC connector.
- D. Temperature monitoring modules:
1. Multi-channel temperature monitoring and alarm modules.
 2. Inputs: 100-Ohm Pt RTD inputs.
 3. Range: 0 - 300deg F, or as specified.
 4. Recorder output of 1-5 V or 4-20 mA per channel.
- E. Alarm modules, General:
1. User programmable via the Monitor Display panel or via a Laptop PC.
 2. Programming shall allow setting:
 - a. One high and one low DANGER setpoint per channel.
 - a. One high and one low WARN setpoint per channel.
 - b. Adjustable time delays for DANGER and WARN alarms.
 - c. Adjustable startup attenuation and hold-off delay time (for vibration inputs).
 - d. Alarm relay "AND/OR" voting logic, and trip-inhibit lockout.
 - e. Alarm relay function as latching, failsafe, normally energized, or normally de-energized
 3. Provide programming software for the alarm modules, as recommended by manufacturer.
- F. Alarm contacts: Unless otherwise specified, alarm contacts shall comply with the following requirements:
1. Contact outputs used for WARN alarms shall be normally open and shall close on alarm.
 2. Contact outputs used to control equipment shall be normally open (closed) and shall close (open) to start or enable the equipment.
 3. Contact outputs shall be suitable for switching logic-level circuits and shall be rated not less than 100 mA at 120 VAC and 75 VDC.
 4. Provide a common WARN alarm contact, a common TRIP alarm contact, and a common FAULT alarm contact per pump system.
- G. Environmental:
1. The machine monitoring equipment shall operate under ambient conditions of 10 to 40 C and 10 to 95 percent relative humidity (non-condensing).
- H. Power: 120 VAC \pm 10% at 10 A maximum.
- I. Acceptable Manufacturers:
1. Vibration and alarms:
 - a. Emerson Ovation Machinery Health Monitor
 - b. Approved Equal.
 2. Seal Leak monitors (conductivity)
 - a. GEMS sensors.
 - b. SymCom model 460.
 - c. Warrick Controls.
 - d. Approved Equal.
 3. The County has a preselected contract for procurement of Temperature Sensors. No alternate Manufacturer will be considered.
 Contract Number: 330267
 ITB Number: 05-017 JAE
 Instruments: Temperature Sensors RTDs and related items
 Manufacturer: Weed Instruments Co.
 Model Series: 305 with 1/2-H260, with 2A or 1A
 Local Representative: CB Engineering Pacific, Inc.
 Phone: (425) 822-1702
 Address: 909 7th Avenue Suite #201
 Kirkland, WA 98033

2.02 MEASURING ELEMENTS

- A. Process Instruments are included in Section 40 70 20.
- B. The following INSTRUSPEC sheets are included in this Section

INSTRUSPEC Symbol	Instrument Description	Instrument Function
SE	Speed Sensor Element	Speed Measurement
TT	Temperature Transmitter	Temperature Measurement
VE	Vibration Sensor Element	Vibration Measurement

- C. Measuring element and transmitter enclosures shall be rated at a minimum, Type 4 per NEMA ICS-6, or as required by location classification.

Identification:

Instrument Function: Speed measurement.
Instrument Description: Speed sensor element.
Power Supply: 24 VDC, as specified on the Drawings; 20 VA maximum.
Signal Input: Pulse frequency from sensor
Signal Output: 1024 hz pulse
Process Connection: N/A
Product Requirements:
Sensor:

- 1) Provide a ferro-magnetic discontinuity sensor with open collector transistor output compatible with the transmitter input circuitry and powered by the transmitter.
- 2) Split gear assembly: 60 teeth
- 3) Acceptable manufacturer:
 - a) Avtron
 - b) Approved Equal.

Installation: 11. Split gears shall be clamped to an exposed section of pump shafting.

Calibration: Application, calibration, and set point requirements per Section 40 06 71.

Instrument Identification:

Instrument Function: Temperature measurement.
Instrument Description: Temperature transmitter
Power Supply: 24 VDC Two-wire transmitter; 8 VA maximum
Signal Input: 3, or 4-wire RTD 100 Ohm Platinum
Signal Output: 4-20 mA
Process Connection: 1/2" NPT
Product Requirements:
Sensor:

1. Provide a sensor in accordance with Section 40 06 71
2. Acceptable manufacturer:
 - a. WEED instruments series 305 w/series H260 thermowell (All places except West Point Treatment Plant),

Instrument Identification:	TT
	no substitutions. b. Rosemount – Emerson Process Management (West Point Treatment Plant only), no substitutions.
Transmitter:	<ol style="list-style-type: none"> 1. Transmitter shall convert the sensor resistance or mV output to a milliampere transmission signal output with an accuracy of ± 0.1 percent of range or better. 2. Accuracy and stability: $\pm 0.1\%$ of range or $0.1\text{ }^{\circ}\text{C}$, whichever is greater, for 2 years with RTD sensor and 1 year with T/C sensor. 3. Isolation: Input/Output/Power 500 VAC minimum 4. Transmitter shall provide output power for sensor or Cold Junction compensation for sensor, as required 5. Display: 3-1/2 digit integral LCD display w/decimal point, minus sign, and $^{\circ}\text{C}/^{\circ}\text{F}$ indicator 6. Provide: HART 7. Approvals: FM Explosion-proof and/or Intrinsically safe, as required 8. Enclosure: Aluminum cast w/polyurethane baked enamel coating, NEMA 4X 9. Environmental: Operating Temperature: $-20\text{ }^{\circ}\text{C}$ to $70\text{ }^{\circ}\text{C}$ Humidity: 5% – 85%, non-condensing 10. Acceptable Manufacturers: a. Rosemount – Emerson Process Management, No substitutions.
Installation:	Install per manufacturer's instructions and recommendations of API RP-551.
Calibration:	Application, calibration and set point requirements per Section 40 06 71.

Instrument Identification:	VE
Instrument Function:	Vibration measurement.
Instrument Description:	Vibration Element
Accelerometer:	<ol style="list-style-type: none"> 1. Electrical Connection: 2- or 3-wire connection 2. Excitation Current: $<10\text{mA}@12\text{-}28\text{VDC}$ 3. Range: $\pm 50\text{ g}$ 4. Sensitivity: 100 mV/g 5. Frequency response: 1 to 12,000 Hz $\pm 3\text{dB}$ 6. Environmental temperature range: -50 to $120\text{ }^{\circ}\text{C}$ 7. Mounting Includes: Mounting base, connector, and 10m cable assembly 8. Locations: Standard accelerometers on flywheel and motor bearings, low profile accelerometers on pump top bearing.
Acceptable manufacturers:	<ol style="list-style-type: none"> 1. Wilcoxon model 793 (std) or model 797 (low profile) 2. Rockwell/ENTEK model 9000A (std) or model 9200A

Instrument Identification:

- VE**
(low profile)
3. IMI/PCB model 601A (std) or model 602D (low profile)
 4. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Signal wiring shall be carried in raceways in compliance with Division 26 and Section 40 61 13, except that runs of signal cables containing only single pairs or triads shall not be run in trays or other open raceways. Circuits shall be run as individually shielded single twisted pairs or triads, as required. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall not be formed by using two pairs. Terminal blocks shall be provided at instrument cable junctions, and circuits shall be identified at such junctions unless otherwise specified. Signal circuits shall be run without splices between instruments, terminal boxes, and panels.
- B. Unless otherwise specified, shields shall be bonded to earth ground at a single point and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

3.02 INSTALLATION

- A. Install equipment as shown on the Drawings and in accordance with the manufacturer's recommendations and NFPA 70, API RP-550, and API 670.
- B. Sensors:
 1. Install speed sensor on shaft element per equipment manufacturer recommendations and instrument manufacturer requirements. Insure all guards are properly installed.
 2. Install vibration sensor mounts at the locations shown in the Drawings with epoxy adhesive per MMM-A-134. Thread accelerometers into sensor mounts with torque as specified by the manufacturer. Dress cables so that they do not transmit any strain to the accelerometer due to vibration or flexing.
 3. Install RTD temperature sensors in bearing housing or equipment casing such that the tip of the probe is in intimate contact with the outer bearing race.
 4. Coordinate with pump/motor manufacturer and County Maintenance personnel for exact location and mounting configuration of accelerometers and RTD sensors.

3.03 CALIBRATION

- A. Calibrate each instrument onsite, except as noted below. Calibration shall be performed by an instrument technician who by virtue of an acceptable training course or documentable experience is qualified to calibrate that instrument. Acceptable training shall include successful completion of the manufacturer's training course or successful completion of applicable training courses in a recognized trade school.
- B. Where field calibration is not feasible, certified laboratory calibration reports may be substituted for field test data subject to prior written approval of the Project Representative. Certified calibration test data shall be traceable to NIST.
- C. Certified laboratory test data may be submitted for the following instruments in lieu of individual onsite tests:

Paragraph	Description
40 79 56.2.02A	RTD
40 79 56-2.02B	Accelerometer

- D. Calibration Equipment:
1. Provide all tools and equipment required to calibrate each instrument. Test instruments used to simulate inputs and read outputs shall be suitable for the purpose and shall have a rated accuracy at least 3 times greater than the specified accuracy of the instrument being calibrated. Each test instrument shall be certified by an established calibration laboratory traceable to NIST standards prior to the commencement of testing and shall be re-certified after completion of testing to verify accuracy throughout the testing period.
- E. Calibration Procedure:
1. Calibrate each channel of each monitor/alarm module at 10 percent, 50 percent, and 90 percent of its specified full scale.
 2. Calibrate by simulating inputs to monitor modules with an AC signal source (for accelerometers), or precision resistance substitution box (for RTD's and Seal Leak detectors). Simulation signals shall be connected at the field end of the circuit so that field wiring is also tested.
 3. Enter all test data on test forms. Deliver a report to the Project Representative containing all instruments listed by instrument number, certifying that each instrument has been calibrated and meets Contract requirements. For each instrument, the report shall include the test form with test data entered, together with a statement of defects noted and corrective actions taken.
- F. Any instrument which fails to meet any Contract requirement or any published manufacturer performance specifications for functional and operational parameters not specified in the Contract shall be repaired or replaced at the discretion of the Project Representative and at no cost to the County.
- G. Test each instrumentation loop and alarm circuit for overall functioning as an integrated system. This test shall verify that all interconnections are properly made and that all elements operate properly.

3.04 TESTING

- A. After installation is complete, the manufacturer's representative shall test the equipment in the presence of the Project Representative.
- B. Inform the Project Representative of the testing schedule at least one week prior to the test.
- C. Functional tests shall conform to the requirements of this specification.
- D. Acceptable test results shall be in accordance with the manufacturer's recommendation and equipment requirements.
- E. Test each instrumentation loop and alarm circuit for overall functioning as an integrated system. This test shall verify that all interconnections are properly made and that all elements operate properly.

3.05 STARTUP AND TRAINING

- A. Provide 80 hours of Startup assistance and forty (40) hours of training for the County's personnel on all aspects of operation and maintenance of the machine monitor system.
- B. Procedures: Section 01 79 00.
- C. Provide a summary of installed temperature and vibration setup parameters in a table format.

END OF SECTION

SECTION 41 22 13.13

BRIDGE CRANE AND HOISTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies electric motor top running double girder bridge cranes.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP Raw Sewage Pump Crane	704-C03CC011
RSP Bridge Crane Motor 1	704-MTR03CC011
RSP Bridge Crane Motor 2	704-MTR03CC021
RSP Bridge Crane Trolley Motor 1	704-MTR03CC031
RSP Bridge Crane Trolley Motor 2	704-MTR03CC041
RSP Bridge Crane Hoist	704-MTR03CC051

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AISC	Steel Construction Manual American Institute of Steel Construction
ASME B30.2	Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.10	Hooks
ASME B30.11	Monorails and Underhung Cranes
ASME B30.17	Cranes and Monorails (With Underhung Trolley or Bridge)
ASME HST 4	Performance Standard for Overhead Electric Wire Rope Hoists
CMAA #70	Specification for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Crane
HMI	Hoist Manufacturer's Institute
OSHA	Occupational Safety and Health Administration
WISHA	Washington Industrial Safety and Health Act,
NFPA 70	National Electric Code (NEC)

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Load bearing connections shall be provided at the runway to limit deflection to less than 1/800 of span. Attachment to the runway shall be as shown on the structural Drawings.
 2. Top-Running Multiple Girder Overhead Traveling Crane: CMAA No. 70 and ASME B30.2 and B30.17.

B. Performance Requirements:

Equipment Name	RSP Building Bridge Crane
Bridge Crane Type	Electric wire rope bridge crane
Capacity, Ton	25
Bridge Crane General Arrangement	Top running bridge with top running hoist trolley, as indicated in the Drawings
Bridge Beam Span (feet)	33 ft – 5 in, field verify the exact length
Bridge Beam Length (feet)	34 ft – 4 ¾ in maximum, measured at the widest part of the crane (5 7/8 in maximum extension beyond CL runway rail each side)
Height of Bridge Crane and Hoist	3 ft – 3 in maximum, measured from the top of runway rail to top of highest point on the hoist assembly
Vertical Lift	47 ft – 4 in
High Hook Elevation (feet)	140 ft – 2 1/4 in (1 ft – 2 in below top of runway rail)
Low Hook Elevation (feet)	95 ft – 0 in
Lifting Speed (fpm)	0-15 (variable)
Trolley Speed (fpm)	0-30 (variable)
Bridge Speed (fpm)	0-80 (variable)
Control Device:	Radio remote control and pendant control
Minimum Hoist Motor (hp)	30 HP, 1800 RPM, TENV
Minimum Trolley Motor (hp)	Two – 1.5 HP, 1800 RPM, Inverter Duty
Minimum Crane Motor (hp)	Two – 2 HP, 1800 rpm, Inverter Duty
Power Supply (v-p-Hz)	480-3-60
Reeving	Double
Main Runway Electric Conductors	Bus Bar Located on South Side
Bridge, Trolley and Hoist Service Class	D / H4 (heavy)
Bridge Drive System	CMAA A4
Trolley Conductor Type	Festoon
Crane Hook Coverage Physical Limits	See Drawings.
- North	6 ft – 11 in south of gridline C
- South	4 ft – 8 in north of gridline E
- East	7 ft – 2 in west of gridline 8
- West	7 ft – 11 in east of gridline 2

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Provide the following submittals:

1. Manufacturer's drawings of the bridge crane.
2. Manufacturer's catalog data for bridge beam, end trucks, trolley, and hoist confirming rated capacity, structural requirements, and compliance with HMI and CMAA standards, equipment speeds, horsepower, and electrical requirements.
3. Complete catalog information, descriptive literature, materials of construction, and specifications on bridge drive system, end trucks, runway stops, footwalks and platforms, wheels, shafting, drive motor, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), pendants, controls, remote control system, and accessories.
4. Make, model, weight and horsepower
5. Manufacturer's experience.
6. Power and control wiring diagrams including terminals and numbers.

7. Factory finish system.
8. Motor data in accordance with Section 40 05 93.
9. Structural calculations and details for bridge crane design. Calculations shall be stamped and signed by a professional engineer licensed in the State of Washington.
10. All applicable operation and maintenance information specified in Section 01 78 23.
11. Manufacturer's certification of installation with form 43 05 01-A in Section 01 33 10.
12. A written report describing the results of the field testing.
13. Factory test results.
14. Field Performance Test Procedures:
 - a. Proposed load test procedures shall be developed by crane supplier and approved by Project Representative.
 - b. Submit test procedures at least 30 days prior to crane testing.
 - c. Testing shall not begin until the test procedures have been approved by the Project Representative.
 - d. Load test report and certification for crane use.

1.05 QUALITY ASSURANCE

- A. The bridge crane shall be designed by a crane builder with a minimum of 10 years of experience building overhead cranes.
- B. All equipment furnished under this Section shall comply in all respects with the requirements of OSHA, WISHA, the standards of the CMAA and HMI.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: Section 26 05 00: Unclassified.

1.08 LABELING AND SIGNAGE

- A. The rated load of the crane shall be marked on each side of the crane and shall be legible from the ground or floor. Directional markings ("north", "south", "east", "west") shall be posted on beam or hoist to match pendant controls.
- B. Floor-operated and remote-operated cranes shall have a safety label or labels affixed to the pendant station, portable operating station, or load block in compliance with ANSI Z535.4.

PART 2 PRODUCTS

2.01 GENERAL

- A. Crane manufacturer to coordinate equipment requirements with steel structures, panels, drive motor, trolley and hoist, hoisting cable or chain, hook, crane mounted conductors, rails, stops, and electrical equipment controls.
- B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Electric Motor Bridge Cranes:
 - a. Acco.
 - b. American Crane.
 - c. Harrington Hoists and Cranes.
 - d. R&M Material Handling.
 - e. Washington Crane and Hoist.
 - f. Approved Equal.
- B. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the Project Representative.

2.03 RUNWAY

- A. Runway beams, brackets, and associated framework furnished under Section 05 12 00, Structural Steel Framing.
- B. Runway rails shall conform to cross-sections and weights per yard as specified in Table 1-21 of the AISC Steel Construction Manual. Furnish rails, crane stops, and conductors by crane manufacturer.

2.04 BRIDGE

- A. Furnish girders from structural shapes proportioned to resist vertical, lateral, and torsional forces.
- B. Construct bridge end trucks in accordance with CMAA #70 except that Section 3.6.1 of CMAA #70 shall be revised to delete the sentence "The wheel base of the end truck shall be 1/7 of the span or greater". For Class D and E cranes, designed for impact loading and repeated duty cycle. Furnish end trucks with rail sweeps and impact-absorbing bumpers.
 - 1. Bumpers shall be provided as follows:
 - a. Maximum force transmitted to the crane stop shall not exceed 1,000 lbs.
 - b. Maximum overall length shall not exceed 3 inches.
- C. Provide bridge travel limit switches, located approximately 10 feet to 15 feet from each end of bridge runway, or as required such that bridge travel speed is reduced to 20 fpm prior to bridge engaging runway end-stops. Bridge drive speed past the limit switch locations shall be limited to 10 fpm.
- D. Wheels: Rolled or forged steel with treads and flanges heat treated, or cast iron wheels with chilled tread. Minimum tread hardness 200 Brinell. Clearances, wheel loads, and tolerances in accordance with CMAA #70. Wheel axles of alloy steel, machined and ground to receive inner bearing races. Use rotating axles and wheels mounted by press fit and keys.
- E. Bridge driving machinery consisting of a cross shaft driven by an electrical motor through a gear speed reducer unit. Cross shaft, high-grade steel, turned, ground, polished, and adequately supported with self-aligning bearings. Shaft diameter to resist torsional strains when bridge is traveling under full load, or when stopped suddenly. Furnish oil-tight speed reducer gear case and support on common base with bridge brake.
- F. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- G. Bearings: Combination radial and thrust type, double row, spherical ball, either prelubricated and sealed or fitted for pressure lubrication. Pressure lubrication fittings for maintenance accessibility.
- H. Brakes: Electrically operated, adjustable, suitable for the service class indicated, with rated torque capacities as specified in CMAA #70.

- I. Platform: Provide full length service platform.

2.05 TROLLEY

- A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Design to control deflection of trolley assembly while transmitting the carrying load to bridge rails.
- B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.
- C. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.
- D. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.
- E. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.
- F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.17. Furnish stops on trolley rails or beams.
- G. Provide trolley travel limit switches, located approximately 6 feet to 8 feet from each end of trolley rails/beams, or as required such that trolley travel speed is reduced to 10 fpm prior to trolley engaging the trolley end-stops. Trolley drive speed past the limit switch locations shall be limited to 10 fpm.

2.06 HOIST

- A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on supplement located at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.
- B. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.
- C. Hook: Designed in accordance with ASME B30.10. Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.
- D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

2.07 ELECTRICAL

- A. Furnish electrical equipment including motors, motor starters, control systems, wire, and conduit. Bridge conductors may be removed for shipment. Crane wiring by crane supplier.
- B. Electrical: in accordance with NFPA 70, NEC Article 610.
- C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120-volt ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.

- D. Bridge and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.
- E. Enclosed Bus Bar Conductors: Hard copper enclosed in insulation. Collector sliding long-wearing copper graphite shoe type, with adjustable spring tension arms for contact between bus bar and controls.
- F. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.
- G. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.08 CONTROLS

- A. Furnish electric cranes with momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.
- B. Controls: Fully magnetic, plain reversing type, housed in NEMA 250, Type 4X Stainless Steel enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified crane service class.
- C. Bridge and Trolley Drives: Variable Frequency Drive (VFD) controls, 460/230-volt ac series device, installed in between drive motor and motor breaker with torque and acceleration rate adjustable, suitable for crane service, and work in conjunction with crane controls.
- D. Pushbutton Control Stations: Heavy-duty, oil-tight, suspended from trolley or bridge with control transformers to supply 120-volt ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 6-foot intervals. Furnish control station buttons for control of bridge, trolley, and hoist, ON/OFF main line contactor power switch which removes all power from crane and controls.
- E. Remote Control System: Frequency modulated, radio-controlled system, belt mounted operator and capable of operating all crane functions.
- F. Control motions indicate direction of resultant crane motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway crane situations.
- G. Crane motions shall stop automatically when crane can no longer receive remote signals and designed to stop when control signal for any motion becomes ineffective.
- H. Remote Control Crane Motions: Hook raise and lower, trolley movement, bridge movement, and crane power up and power. Furnish an EMERGENCY OFF pushbutton station which will disconnect main line power via a remote switch, and manual reset function to activate all motions after an EMERGENCY OFF event.
- I. Isolation and Lock Out Tag Out: Crane system to be fed from one isolatable power source, to provide simple LOTO procedure for maintenance activities.

2.09 FACTORY FINISHING

- A. Prepare and prime coat in accordance with Section 09 90 00 and 09 06 90.

- B. Prepare and finish coat as specified in Section 09 90 00 and 09 06 90.

2.10 FEATURES AND COMPONENTS

- A. The bridge crane capacity and dimensions shall meet or exceed the requirements of this specification and as shown on the structural and mechanical Drawings.
- B. Electric motor bridge cranes shall be designed in accordance with ASME B30.2 and all requirements of the CMMA and HMI.
- C. For each bridge crane and hoist, provide one transmitter and one receiver.

2.11 QUALITY CONTROL

- A. Factory inspections: inspect equipment and control panels for required construction, electrical connection and intended function.
- B. Factory Tests and Adjustment: No-load run test. Factory test report shall include test data sheets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the complete bridge crane, trolley, and hoist as specified and shown on the Drawings and in accordance with the manufacturer's recommendations.

3.02 FIELD TESTING

- A. Manufacturer's representative shall test bridge crane, trolley, and hoist to verify smooth operation and quiet operation over the system's full range of movement with a verified load provided by the Contractor. Load test shall comply with OSHA, ASME B30.17, and ASME B30.16.
- B. Test complete assemblies for proper alignment, connection, and quiet operation.
- C. Field Performance Component Test Procedures:
 - 1. Proposed load test procedures shall be developed by the crane supplier and submitted to the Project Representative.
 - 2. Submit test procedures 30 days in advance of specific crane testing.
 - 3. Testing shall not begin until the test procedures have been approved by the Project Representative.
- D. System Test:
 - 1. Conduct performance test on each crane.
 - 2. Load tests conducted by crane supplier in compliance with OSHA, ASME B30.17, and ASME B30.16.
- E. Provide completed Manufacturer's Certificate of Proper Installation.

3.03 TRAINING

- A. Procedures: Section 01 79 00.
- B. Provide a minimum of 4 hours per training.

END OF SECTION

SECTION 42 11 40

BOILER STACK

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies boiler vent stack.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
NFPA 211	Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Items to be Submitted for This Section:
1. Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of Section 43 05 01. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
 2. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
 3. Seismic design and engineering calculations for anchorage and bracing system for equipment shall be in accordance with Section 01 73 00.

1.04 QUALITY ASSURANCE

- A. Unit Responsibility: The unit responsible boiler manufacturer specified in Section 23 52 39.16 is required to confirm equipment specified in the Section is compatible with each boiler.

1.05 WARRANTY

- A. For the work of this Section, provide all warranties as described in Section 01 78 36 and provide all normal commercial warranties available as described in the General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
1. Metalbestos.
 2. Metal-Fab.
 3. Van Packer.
 4. Schebler.
 5. Approved equal.
 6. The boiler stack manufacturer's standard models or products may require modifications to conform to specified requirements.

2.02 MATERIALS

- A. Boiler stack materials include:

Component	Material
Inner Pipe	20-gauge Type 316 stainless steel
Outer pipe	24-gauge Type 316 stainless steel
Insulation	2-inches of ceramic fiber insulation between inner pipe and outer pipe

- B. The stack shall be UL 103 listed and conform to NFPA Standard No. 211.
- C. The boiler stack shall be all fuel type for burning fuel oil from a forced draft burner. The stack shall include tees, elbows, adjustable length fittings, ventilated roof thimble, flange adapter, stack and clamp flange, method of removing condensate, and shielded concentric rain cap.
- D. The boiler stack shall have ports for an oxygen sensor and a testing port.
- E. The boiler stack shall have drain connections at the low point of the outer pipe and inner pipe.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Attach to the boiler. Support independently of the boiler. Seal joints according to manufacturer's recommendations. Existing supports into the building have been kept through notes on the demolition Drawings for reuse with the replacement stacks. Any new anchor points needed must be shown on shop drawings for Project Representative approval.
- B. Pipe drainage locations for replacement boiler stacks for Boilers 1 and 3 shall terminate in the same location as the boiler stack being removed. Pipe drainage location for combined Boiler 2 and 4 stack shall follow same path as the boiler stack being removed, however the minimum height to opening shall be raised to 24 inches.

3.02 TESTING

- A. In addition to any testing herein, perform all testing for this product or system consistent with the requirements of Section 01 75 20, the applicable codes, and the manufacturers' current quality assurance program.

END OF SECTION

SECTION 43 05 01

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies general requirements which are applicable to all mechanical equipment and the electrical equipment driving the mechanical equipment.
- B. Additional specific requirements are listed in other Sections of the Contract Specifications and Drawings.
- C. Equipment under this Division includes providing and testing the equipment described in the sections listed in Divisions 11, 22, 23, 26, 40, 41, 42 43, 44.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roll Bearings
ASME B1.1	Unified Inch Screw Threads
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
ASME B18.2.1	Square and Hex Bolts and Screws
ASME B18.2.2	Square and Hex Nuts
IBC	International Building Code
IFC	International Fire Code
IMC	International Mechanical Code
ISO 1940	Mechanical Vibration- Balance Quality Requirements of Rigid Rotors
NFPA 70	National Electrical Code
UL 508	Industrial Control Equipment
UPC	Uniform Plumbing Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Submittals: made as specified for each equipment item or group of related equipment items. Identify the equipment by the number listed in the Specification section, by manufacturer and by type designation.
- C. Unit Responsibility Engineer qualifications.

1.04 QUALITY ASSURANCE

- A. Arrangement: The arrangement of equipment shown on the Drawings is based upon information available at the time of design and is not intended to show exact dimensions for a specific

manufacturer. The Drawings are, in part, diagrammatic and some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements. Structural supports, foundations, connected piping and valves, electrical and instrument equipment connections shown may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings: submitted prior to beginning the work.

B. Unit Responsibility:

1. Equipment systems (operating units) made up of two or more components that require the Contractor to assume Unit Responsibility are identified in their respective Specification Sections. Coordinate, assemble, install, and test the system as an operating unit.
2. Coordinate equipment selection with the manufacturer(s) or supplier(s) of each component to ensure its compatibility with other system components. Ensure listed system components fit together and will function properly as an operating unit to achieve the performance requirements specified.
3. Where the system specification requires a Unit Responsibility Certification Form, such certificates shall conform to the content, form and style of Form 43 05 01-C included in Section 01 33 10, signed and certified by the Contractor that the components are compatible as specified.
4. Submittals for components of a listed system will not be processed until a Unit Responsibility Certification Form for that system has been received and has been found to be satisfactory. Owner approval of individual component submittals will not relieve the Contractor of its system Unit Responsibility.
5. Provide Unit Responsibility Certification Forms for the following equipment systems:

DESIGNATED UNIT RESPONSIBILITY	SECTION	REQUIRED COMPATIBLE COMPONENTS
Variable Speed Solids Handling End Suction Centrifugal Pumps	43 23 04	26 29 23 – Variable Frequency Drives 40 05 94 – Electric Motors – Large Low Voltage
Steel Fire Tube Boilers	23 52 39.16	42 11 40 – Boiler Stack

Note: Not all systems are identified in the table. Only selected large items are identified in the table. Refer to other Specification Sections for other requirements for Unit Responsibility.

C. Balance:

1. Unless specified otherwise, all rotating elements in motors, pumps, blowers and centrifugal compressors: fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements: balanced to G 2.5 as specified in ISO 1940, Parts 1 and 2.
2. Where specified, balancing reports, demonstrating compliance with this requirement, submitted as product data.

D. Qualifications:

1. Unit Responsibility Engineer:
 - a. Demonstrate that the Unit Responsibility Engineer has experience coordinating equipment selection with manufacturer(s) or supplier(s) of two or more components to ensure its compatibility with the other system components that required the Contractor to assume Unit Responsibility.

1.05 UNIT RESPONSIBILITY ENGINEER RESPONSIBILITIES

A. General:

1. Coordination of Unit Responsibility process.

2. Preparation and coordination of Unit Responsibility documentation specified in this Section and individual Specification Sections of equipment included in a Unit Responsibility System. This documentation includes:
 - a. Unit Responsibility Certification Forms.
 - b. Letters of certification signed by the Unit Responsibility Engineer.
 - c. Letters of certification signed by officers of equipment manufacturers included in a Unit Responsibility system.
 - d. Other specified Unit Responsibility documentation.
3. Provide technical support to equipment manufacturers included in a Unit Responsibility system.
4. Coordinate preparation of submittals from equipment manufacturers included in a Unit Responsibility system.
5. Coordinate with equipment manufacturers included in a Unit Responsibility system as necessary to address any submittal comments and questions and in the preparation of equipment resubmittals.

1.06 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.07 SEISMIC REQUIREMENTS

- A. Anchor and brace equipment: Section 01 73 00.

1.08 ELECTRICAL REQUIREMENTS

- A. Starters: Except for starters specifically included in Division 26, furnish all starters for motors in this Division.
- B. Disconnects: Except for factory-supplied disconnects mounted on mechanical equipment or in combination with starters, motor disconnects: in accordance with Division 26.
- C. Power and control wiring: except for factory wiring on mechanical equipment, power and control wiring under this Section: in accordance with Division 26.
- D. Provide controls, controllers, transformers, and switches required by the work of this Section.
- E. Factory-wired assemblies and panels: prewired to numbered terminal strips for connection to field wiring.
- F. Provide disconnect switch for each control circuit connection to prewired assemblies and control panels.
- G. Provide approved wiring diagrams for work furnished under this Section.
- H. Provide weatherproof devices and installations for outdoor applications or as specified in Division 26.
- I. Install wiring as specified in Division 26.
- J. Equipment devices and wiring shall comply with NEC.
- K. See Section 26 05 00 for listing and labeling requirements

PART 2 PRODUCTS

2.01 FLANGES AND PIPE THREADS

- A. Unless otherwise noted, all flanges on equipment and appurtenances: flat faced and shall conform in dimensions and drilling to ASME B16.1, Class 125.
- B. Flange assembly bolts: heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ASME B18.2.1 and B18.2.2. Threads: Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ASME B1.1.
- C. All pipe threads shall conform in dimension and limits of size to ASME B1.20.1, Class 2 NPT, Taper Pipe Thread.

2.02 BEARINGS

- A. Unless otherwise specified, equipment bearings: oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing: rated in accordance with the latest revisions of ABMA 9 and ABMA 11. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 100,000 hours. The rating life: determined using the maximum equipment operating speed.
- B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when fittings are greater than 5 feet above the floor and/or difficult to reach by maintenance personnel. Grease supply fittings: standard hydraulic alemite type.
- C. Oil lubricated bearings: equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system: of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and: equipped with a filler pipe and an external level indicator gage. Provide extension pipes, plugs, and valves for oil drain to allow drainage of oil into a container.

2.03 V-BELT ASSEMBLIES

- A. V-belt assemblies:
 - 1. Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings,
 - 2. Wood's Super V-belts with matching Sure-Grip sheaves and Wood's Sure-Grip bushings,
 - 3. Approved Equal.
- B. Where stationary control variable pitch sheaves are specified, they: dry lubricated, and shall have locking collars to clamp all movable parts securely in place to eliminate relative motion between sheave parts. The sheaves: adjustable only when the unit is stopped and the sheaves are unloaded.
- C. Sheaves and bushings: statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5,500 feet per minute: dynamically balanced. Sheaves: separately mounted on their bushings by means of 3 pull-up grab or cap tightening screws. Bushings: key seated to the drive shaft.
- D. Belts: selected for not less than 150 percent of rated driver horsepower and, where two sheaves sized are specified, capable of operating with either set of sheaves. Belts: of the anti-static type where explosion-proof equipment is specified. Multiple belts: in matched sets.

2.04 SHAFT SEALS

- A. General: Seals for water and wastewater pump shafts: mechanical seals or packing. Unless otherwise specified, mechanical seals shall be the split type. Unless specified otherwise, mechanical seals and packing shall conform to the requirements set forth in this paragraph.
- B. Mechanical Seals:
1. Unless otherwise specified, provide split mechanical seals for rotating shafts.
 2. Self-aligning, and self-centering, single seals.
 3. Nondestructive (nonfretting) type.
 4. Factory installed.
 5. Seal: external, single seal, split-type for removal without disassembly of the pump.
 6. Balanced seals: provided when operating pressure, shaft size, and operating speed dictate this requirement.
 7. Factory provided seals: installed solid but be built to split. All replacement seal components: split in half including the elastomer, gland, rotary and stationary seal faces and rotary holder. The non-shaft elastomer shall incorporate a ball and socket to ease installation.
 8. The seal shall provide positive sealing under system surge pressure (1.5 times operating head) and momentary vacuum up to 25 inches of mercury.
 9. Stationary seal face: multiple springs to maintain the sealing function. Spring system: isolated from the pumpage to eliminate corrosion and clogging.
 10. Seal: install over a stainless steel shaft sleeve.
 11. Shaft sleeve: alloyed per the pump section specification without heat treatment so set screws can properly anchor.
 12. Seal gland: a universal adjustable gland drilled with two standard NPT flushing connections.
 13. Seal chambers: provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. Bushing: split design and shall control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.
 14. Materials of construction components:
 - a. Gland and rotary holder: 316 Stainless Steel
 - b. Springs: Elgiloy, Hastelloy C, or duplex stainless steel for resistance to chlorides.
 - c. Rotary Seal Face: Tungsten Carbide or Silicon Carbide
 - d. Stationary Seal Face: Solid Silicon Carbide
 - e. Elastomer: Viton
 15. Unless otherwise specified, mechanical seals:
 - a. Chesterton 442 with SpiralTrac™.
 - b. John Crane 3740 seals with Type 24SL bushing.
 - c. Flowserve Corp. Durametallic type PSS Split Seal with active throat bushing
 - d. Approved Equal.
- C. Cartridge Seals:
1. Where specified, provide cartridge seals for rotating shafts.
 2. Meet all the requirements of the mechanical seals, except for split features.
- D. Packing
1. Where specified, provide shaft packing for rotating shafts with stuffing boxes.
 2. Stuffing boxes: tapped to permit introduction of seal liquid and shall hold a minimum of 5 rows of packing or minimum 3 rows of packing with specified throat bushing.
 3. Packing: Unless otherwise specified, die-molded packing rings of material suitable for the intended service and as recommended by the manufacturer (non-asbestos).
 4. Lantern rings:
 - a. 2-piece construction and provided with tapped holes to facilitate removal.
 - b. Non metallic construction.
 - c. Not required if SpiralTrac™ Version P throat bushing system provided.
 5. Unless otherwise specified, provide throat bushing system:
 - a. SpiralTrac™ Version P by EnviroSeal Engineering Products Ltd. .

- b. Approved Equal.

2.05 COUPLINGS

- A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2-HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member: attached to flanges by means of clamping rings and cap screws, and the flanges: attached to the stub shaft by means of taperlock bushings which shall give the equivalent of a shrunk-on fit. There: no metal-to-metal contact between the driver and the driven unit. Each coupling: sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.
- B. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or approved equal, couplings will be acceptable, provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. Install in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

- A. Exposed moving parts: provided with guards which meet the requirements of WISHA. Guards: fabricated of flattened expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards: designed to be readily removable to facilitate maintenance of moving parts. Guards: provided with reinforced holes. Provisions: made to extend lube fittings through guards.
- B. Unless otherwise specified, guard materials:
 - 1. Class 1, Div 1 or 2 areas: Aluminum, 5005-H34, 3/4-.125
 - 2. Corrosive atmosphere areas: Stainless steel, Type 304, 3/4-13
 - 3. All other areas: To match the material of the equipment.

2.07 CAUTION SIGNS

- A. Equipment with guarded moving parts which operate automatically or by remote control: identified by signs reading "CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs: constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post or wall mounting, in accordance with Section 10 14 00. Letters: white on a red background. The sign size and pattern: as shown on the Drawings. Signs: installed near guarded moving parts.

2.08 GAGE TAPS, TEST PLUGS, DRAINS, AND GAGES

- A. Unless otherwise specified, 1/2-inch threaded pressure taps with full port ball valve isolation cocks: provided on the suction and discharge sides of all pumps, blowers and compressors.
- B. Permanent pressure devices (gages, sensors, switches, etc.): provided only where shown or specified, and installed in accordance with the standard details shown on the Drawings.
- C. Gage taps, test plugs, and gages: as specified in Division 40.
- D. Air release taps on pump discharge and suction lines: 1-inch minimum; larger where shown on the Drawings.

2.09 NAMEPLATES

- A. Nameplates: provided on each item of equipment and shall contain the specified equipment name and equipment number. Equipment nameplates: laser etched on 1/16-inch thick Type 316 stainless steel with 3/16-inch letters. The normal size of nameplates: 3/4-inch high by 2-inch long
- B. Equipment titles: spelled out on the nameplates. If abbreviations are required because of space limitations, abbreviations: submitted to the Project Representative and approved prior to manufacture.
- C. Nameplates: fastened to the equipment in an accessible and easily visible location with No. 4 or larger oval head self-tapping stainless steel screws or drive pins. The use of adhesives shall not be permitted.

2.10 LUBRICANTS

- A. Provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants: of the type recommended by the equipment manufacturer. Limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types, consistent with the County's current supplier. Not less than 90 days before the date shown in construction schedule for starting, testing and adjusting equipment, provide the Project Representative with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHORAGE

- A. Anchorage: designed for lateral forces for both pullout and shear in accordance with the provisions of Section 01 73 00. Unless otherwise stated in the specifications, cast-in concrete anchors and post-installed concrete anchors materials shall be Type 316 stainless steel and conform to the provisions of Section 03 15 19 and Section 05 05 19.

2.12 ELECTRICAL DEVICES

- A. All motors, starters, controls, instruments, and other electrical components and devices furnished with mechanical systems: listed and labeled for the purpose for which it is used by Underwriters Laboratories (UL) or equivalent nationally recognized testing laboratory acceptable to the Washington State Department of Labor and Industry and to the local administrative authority. Where one of these listings is required but not available, Contractor shall obtain written permission for a variance from the authorities having Jurisdiction. In addition, electrical components and devices shall comply with Division 26 of these Specifications.

2.13 CONTROL PANELS

- A. All control panels, factory, shop or field assembled, labeled as a unit in accordance with UL 508. The UL 508 label: affixed to the inside of the door or cover, adjacent to the data pocket.

2.14 MOTORS AND CONTROLLERS

- A. Provide under Divisions 11, 22, 23, 26, 40, 41, 42 43, 44, and 46 all motors for all equipment specified herein and all controllers other than those specifically indicated as being furnished under other sections; all equipment and wiring shall conform to applicable sections of Division 26.
- B. Power wiring for all motors and associated controllers other than wiring for automatic controls will be furnished under Division 26. Unless otherwise noted, power supply will be 480 volts, 3-phase, 60 hertz for motors. Control voltages: 120 volts or lower, single phase, 60 hertz, or direct current, 30 volts or

lower. Disconnect switches for roof exhaust fans or other equipment installed remote from its controller: furnished as an integral part of the equipment.

- C. The horsepower ratings of electrical motors shown on the Drawings and Specifications are based on engineering design calculations and the selection of specific manufacturer's catalog items of mechanical equipment. If the actual equipment to be furnished requires a different motor horsepower, any resulting changes in motor branch circuits and associated circuiting shall be included in the original contract bid.
- D. Alignment of all motors to equipment: in accordance with the requirements of Section 43 05 61.
- E. All equipment: designed and built for industrial service and be capable of delivering rated horsepower under the following applicable conditions:
 - 1. 110 degrees F maximum ambient temperature.
 - 2. Voltage variations to +/-10 percent of nameplate rating.
 - 3. Frequency variations to +/-5 percent of nameplate rating.
 - 4. Combined voltage and frequency variations to +/-10 percent total, as long as frequency does not exceed +/-5 percent.
- F. Unless otherwise specified, motors: TEFC.

2.15 SPARE UNITS

- A. Section 01 78 40.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Locate and install sleeves, inserts, and supports as required at proper stage of construction.
- B. Basis for equipment and material installation is the published recommendations of manufacturer. Submit recommendations for review.
- C. Protection of equipment: 01 67 00.

3.02 TESTING

- A. Equipment: provided and tested within the tolerances recommended by the equipment manufacturer where indicated in the individual mechanical specification sections. Certain sections may also require that equipment additionally be installed and tested under the direction of installers who have been factory trained by the equipment manufacturer. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work. Forms 43 05 01-A and 01 79 00-C specified in Section 01 33 10, completed and submitted.
- B. System-wide, station-wide, and plant-wide process testing: in accordance with Section 01 75 20.

END OF SECTION

SECTION 43 05 50

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies vibration and critical speed limitations for rotating equipment. Individual equipment Specifications Sections may specify more stringent requirements which shall then govern over this specification.
- B. This specification outlines the basic standards for acceptance of equipment. Any equipment demonstrating levels above these limits shall be repaired, modified or replaced at the Contractor's expense as determined by the Project Representative.
- C. This specification covers requirements for calculating expected vibration resonances.
- D. This specification covers requirements for on-site field testing of vibration of the installed equipment and reporting the test results. Submittals for field-testing are only required when specified in the individual equipment Specifications.

1.02 DEFINITIONS

- A. The following definitions shall apply:
 - 1. Peak to Peak Displacement: Root Mean Square (RMS) average of the peak to peak displacement multiplied by the square root of 2 for sinusoidal signals.
 - 2. Peak Velocity: RMS average of the peak velocity multiplied by the square root of 2 for sinusoidal signals.
 - 3. Peak Acceleration: RMS average of the peak acceleration multiplied by the square root of 2 for sinusoidal signals.
 - 4. High Frequency Enveloping: A process to extract very short duration time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectra of acceleration versus frequency. Typical manufacturers' notation is "Spike Energy" by IRD Mechanalysis or "PeakVue" by CSI.
 - 5. Low Speed Equipment: Equipment or components rotating at less than 600 rpm.
 - 6. Convert velocity to displacement:

$$D = 19,100 * V / F$$

D is the peak-to-peak displacement in mils.

V is the peak velocity in inches per second.

F is the frequency in cycles per minute.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
AGMA 6000-B96	American Gear Manufacturers Association Specification for Measurement of Linear Vibration of Gear Units
ANSI/HI 9.6.4	American National Standard for Rotodynamic Pumps for Vibration Measurements and Allowable Values

AMCA Std. 204	Air Movement and Control Association Standard for Balance Quality and Vibration Levels for Fans
HI	Hydraulic Institute
ISO 1940/1	International Organization for Standardization Standard for Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state —Part 1: Specification and verification of balance tolerances

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00
- B. The following information shall be provided when specified in the individual equipment Specification Sections:
 - 1. Test plan as outlined in Section 01 75 20.
 - 2. Test data report sheets for each piece of equipment showing mounting location of test instruments.
 - 3. Manufacturer's certified calculations and data showing location of critical speeds in relation to the operating speeds.
 - 4. Any deviation from the vibration or critical speed standards shall be noted on the submittal cover sheet and approved prior to release for manufacture.
 - 5. Test equipment calibration certificates.
- C. Qualifications:
 - 1. Vibration analysis personnel.

1.05 QUALITY ASSURANCE

- A. Instrumentation: Provide necessary test instrumentation which has been calibrated within one year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington DC, or approved source.
- B. Testing Qualifications: Tests shall be performed by an experienced vibration analysis expert who shall interpret the results against this Specification and provide recommended acceptance or modification requirements to the Project Representative.
 - 1. Field vibration testing Subcontractor shall have an established program for monitoring and testing equipment calibration with accuracy traceable in an unbroken chain in accordance with National Institute of Standards and Technology requirements.
 - 2. Field vibration testing personnel shall possess not less than the following qualifications:
 - a. Three years field experience covering all phases of field vibration testing and data collection.
 - b. Current Vibration Category II certification from the Vibration Institute or Professional Engineer license (need not be registered in Washington).
 - 3. Data analysis personnel shall have not less than 5 years combined field testing and data analysis experience.

1.06 VIBRATION ACCEPTANCE CRITERIA

- A. Vibration Limits - Pumps: Unless otherwise specified, pumping equipment shall meet the requirements of ANSI/HI 9.6.4.
 - 1. RSP overall vibration shall not exceed 0.25 in/s RMS when operating within the POR and 0.33 in/s RMS when operating outside POR, but within the AOR.
 - 2. In addition to allowable velocity vibration criteria specified, meet the allowable displacement vibration criteria selected and adjusted per ANSI/HI 9.6.4.
- B. Vibration Limits - Fans: Unless otherwise specified, fans shall meet the vibration limits of AMCA Std. 204, fan application category BV-3.

RPM	AMCA 204, BV-3		
	Max Mil, peak to peak	Peak Velocity (in/sec)	
		Filter In	Filter Out
500 or Below	4.8	0.15**	0.25**
501-700	4.0	0.15**	0.25**
701-900	3.0	0.15**	0.25**
901-1200	2.4*	0.15	0.25
1201-1500	1.7*	0.15	0.25
1501-1800	1.4*	0.15	0.25
1801-3000	1.0*	0.15	0.25

*The peak to peak displacement values for RPM >900 are for reference only.

**The peak velocity levels for RPM < 900 are for reference only

- C. Other Equipment Vibration Velocity Limits: Unless otherwise specified, other equipment shall not exceed the following RMS velocities (inches/second).

Equipment	Unfiltered Overall Limit	
Motors	0.18	
Steady Bearings	0.25	
Centrifugal Blowers	0.15	
Gear Reducers	< AGMA 6000-B96 limits	
Other Equipment, Radial	0.16	
Other Equipment, Axial	0.10	

1.07 CRITICAL SPEED REQUIREMENTS

- A. Electric Motors:
1. Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency (7200 CPM, 120 Hz) that is more than 40% of the peak at rotational frequency.
 2. Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the rotational frequency around the line frequency peak (i.e., 7200 CPM +/- 1800 CPM for a 4-pole motor).
- B. Unless otherwise specified, rotating mechanical equipment shall satisfy the following:
1. First system natural frequency of the constant, variable, and 2-speed driven equipment is to be at least 20% above the maximum operating speed.
- C. Critical speeds for equipment with flexible shaft-rotor systems shall be at least 20% above maximum operating speed.
- D. Refer to Section 43 23 04 for Finite Element Analysis requirements for solids-handling centrifugal pumps.

PART 2 PRODUCTS

2.01 TEST VIBRATION INSTRUMENT REQUIREMENTS

- A. Analyzers:
1. Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, Fast Fourier Transform (FFT) software, phase measurement capability, time wave form data storage capability, high frequency enveloping capabilities, FFT frequency ranges from 21 to 1,500,000

cycles per minute, adjustable FFT resolution from 400 to 6400 lines, storage for up to 100 3200 line frequency spectra, RS232C or Ethernet data output port, circuitry for integration of acceleration signal to velocity or double integration to displacement.

2. Acceptable Manufacturers:
 - a. Computational Systems Inc., (CSI) Division of Emerson Electric, Model 2140, Machinery Health/Analyzer with applicable analysis software.
 - b. Approved Equal.

B. Analyzer Settings:

1. Units: English, inches/second, mils and g's.
2. Fast Fourier Transform Lines: Most equipment 1600 lines minimum. Motors require enough lines to distinguish motor current frequencies from rotational frequencies. Use 3200 lines for motors with a nominal speed of 3600 rpm, 3200 lines minimum for High Frequency Enveloping and 1600 lines minimum for low speed equipment.
3. Sample Averages: 4 minimum
4. Maximum Frequency (Fmax):
 - a. 40 times rotational frequency for rolling element bearings.
 - b. 10 times rotational frequency for sleeve bearings.
5. Amplitude Range: Auto Select. Full scale shall not be more than twice the acceptance criteria or the highest peak, whichever is lower.
6. Fast Fourier Transform Windowing: Hanning Window.
7. High Pass Filter: Minus 3 dB at 120 cycles per minute for high-speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

C. Accelerometers:

1. Low Speed Equipment:
 - a. Low frequency, shear mode accelerometer, 500 millivolts per g sensitivity, 10 g range, +/- 5% frequency response from 0.5 hertz to 850 hertz, magnetic mount.
 - b. Acceptable Manufacturers:
 - 1) Wilcoxon Research, model 797L
 - 2) PCB, Model 393C
 - 3) Approved Equal.
2. High Speed Equipment:
 - a. General purpose accelerometer, 100 millivolts per g sensitivity, 50g range, +/- 2 dB. Frequency response range from 2 hertz to 12,000 hertz when stud mounted or magnetic mount.
 - b. Acceptable Manufacturers:
 - 1) Wilcoxon Research, Model 793
 - 2) Approved Equal.

PART 3 EXECUTION

3.01 FIELD VIBRATION TESTING

A. General:

1. Equipment testing for vibration and natural frequencies shall be conducted with equipment, installed, grouted and operational.
2. Test instrumentation shall be portable, temporarily mounted or permanently installed components if suitably calibrated for the test measuring and recording instruments.

B. Test Requirements:

1. Measure vibration spectra for RMS velocity, peak to peak displacement versus frequency and measure vibration phase in three perpendicular planes at each normally accessible bearing housing on the driven equipment, gear or clutch assembly and the driver. One plane of measurement shall be parallel to the axis of rotation of the component. Measure rotational speeds using a photometric or other tachometer with input directly to the vibration data collector.
2. Fixed speed equipment shall be operated at the design operating condition during the test recording. Variable speed equipment shall be tested to establish performance over the entire speed

- range. Variable speed testing shall include a minimum of 8 equally spaced test speeds and shall not exceed 50 rpm increments.
3. Field test for natural frequency: Excite the installed equipment and support system in three perpendicular planes. Use the same locations as used for vibration tests above. Determine the natural resonant frequency of the driver, clutch or gear, driven equipment and supports.

END OF SECTION

SECTION 43 05 51

VIBRATION ISOLATION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies vibration isolation system requirements for mechanical equipment. Additional vibration isolation system requirements are provided in individual mechanical equipment specification Sections.
- B. This Section requires supervision by the vibration isolation manufacturer's qualified representative as is necessary to assure and certify correct installation and adjustment of the vibration isolators and seismic restraints.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASHRAE CH 48	Handbook, HVAC Applications, Sound and Vibration Control
IBC	International Building Code

1.03 DESIGN REQUIREMENTS

- A. All vibration isolation systems, including the isolators, seismic restraints, and flexible connectors between the isolated equipment and associated piping, ducting, and/or electrical work, shall be designed, signed, stamped, and dated by a Professional Engineer registered in the state of Washington and qualified in vibration isolation systems. This provision shall not be construed as relieving the Contractor of its overall responsibility for the work.
- B. Flexible connectors shall be provided by the manufacturer of the mechanical equipment item in accordance with the recommendations of the vibration isolation system engineer.

1.04 SEISMIC RESTRAINTS

- A. General:
 - 1. Restraint devices shall resist the forces specified and be designed in accordance with Section 01 73 00.
 - 2. Design lateral forces shall be distributed in proportion to the mass distribution of the equipment.
- B. Floor Mounted Equipment:
 - 1. Provide equipment and appurtenances resiliently floor mounted on spring or pad type vibration isolators, except for curb mounted equipment, with seismic snubbers.
 - 2. Four all-directional restraint/snubbers.
 - 3. Capacity of snubbers, at 3/8-inch deflection, shall be 3 to 4 times the load at the adjacent equipment mount.
 - 4. Restraint assembly shall consist of welded steel interlocking assemblies welded or bolted securely to the equipment or the equipment bases and the supporting structure.
 - 5. Line restraint assembly surfaces, which engage under seismic motion with a resilient elastomer 3/4 inches thick.

6. Restraints shall be field adjustable and be positioned for 1/4-inch clearance both vertically and horizontally or clearance as required preventing interference during normal operation, stopping, or starting.
 7. Restraint assembly shall have a minimum rating of 1.0 g based on independent test data.
- C. Curb Mounted Equipment:
1. Slack stainless steel cables designed to provide 1.0 g restraint in the four primary horizontal directions based on independent test data.
- D. Suspended Equipment:
1. Restraint assembly for suspended equipment, piping, or ductwork shall consist of plow steel cable attached to steel thimbles with neoprene sleeve all specifically designed for cable service and securely fastened to the equipment, or the equipment base and the building structure.
 2. Size cables for a force of 1.0 g with a minimum safety factor of 2.0 based upon independent test data.
 3. Install cables to prevent excessive seismic motion and arranged so as not to engage during normal operation, starting, or stopping.

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Manufacturer and manufacturer's type designation.
 2. Manufacturer's catalog data.
 3. Seismic system design calculations.
 4. Seismic restraint test reports.
 5. Installation reports.
 6. Static and dynamic deflections, weights, isolator locations, and flexible connector designs.
 7. Spring deflections and diameters, compressed spring heights, and solid spring heights.
 8. Scale drawing of Type D mounting hanger showing the 30-degree arc capability.
 9. Curb mounted base seal and wind resistance details.
 10. Seismic restraint load deflection curves up to 1/2-inch deflection along the three principal orthogonal axes.

1.06 QUALITY ASSURANCE

- A. Qualifications:
1. The vibration isolation manufacturer's qualified representative shall provide supervision as is necessary to assure correct installation and adjustment of the vibration isolators and seismic restraints.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer:
1. Mason Industries, Inc.
 2. Korfund Dynamics Corporation.
 3. Consolidated Kinetics Corporation.
 4. Approved Equal.

2.02 BASES

- A. See Section 43 05 62.

2.03 VIBRATION ISOLATION MOUNTINGS

- A. Type A:
 - 1. Double deflection neoprene mountings having a minimum static deflection of 0.35 inches.
 - 2. All metal surfaces shall be neoprene covered to avoid corrosion and shall have friction pads both top and bottom so that they need not be bolted to the floor.
 - 3. Bolt holes and anchor bolts where required to resist lateral migration.
 - 4. Resilient washers and bushings to prevent contact between the bolts and the equipment support bases.
 - 5. On equipment such as small vent sets, use steel rails above the mountings to compensate for the overhang.
- B. Type B:
 - 1. Freestanding spring type isolators laterally stable without any housing and complete with 1/4-inch neoprene acoustical friction pads between the base and the support.
 - 2. Leveling bolts shall be rigidly bolted to the equipment.
 - 3. Hot-dip galvanized steel.
 - 4. Springs:
 - a. Diameters shall be no less than 0.8 times the compressed height of the spring at rated load.
 - b. Minimum additional travel to solid: equal to 50 percent of the rated deflection.
- C. Type C:
 - 1. Type B mountings with a housing having vertical limit stops to prevent spring extension when weight is removed.
 - 2. Provide for equipment with operating weight different from the installed weight, such as chillers, boilers, etc., and equipment exposed to the wind, such as cooling towers.
 - 3. Housing shall serve as blocking during erection and shall be located between the supporting steel and roof or the grillage and dunnage as shown on the Drawings.
 - 4. Installed and operating heights shall be the same. A minimum clearance of 1/2 inch shall be maintained around restraining bolts and between the housing and the spring to prevent interference with the spring action.
 - 5. Limit stops shall be out of contact during normal operations.
 - 6. Hot-dip galvanized steel.
- D. Type D:
 - 1. Steel hangers which contain a steel spring and a 0.3-inch deflection neoprene element in series.
 - 2. Neoprene element shall be molded with a rod isolation bushing which passes through the hanger box.
 - 3. Spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing through a 30-degree arc before contacting the hole.
 - 4. Springs: minimum additional travel to solid equal to 50 percent of the rated deflection.
- E. Type E:
 - 1. Double deflection, cork and rubber sandwich pads consisting of a high-density cork layer permanently bonded to top and bottom layers of corrugated oil-resistant synthetic rubber.
 - 2. The corrugated design shall allow deflection to increase with load and shall form a nonskid surface to resist lateral migration of the equipment.
 - 3. Bolt holes and anchor bolts where required to resist migration.
 - 4. Resilient washers and bushings to prevent contact between the bolts and the equipment support bases.

PART 3 EXECUTION

3.01 GENERAL

- A. Securely anchor or fasten seismic restraints to the equipment and supporting structure in accordance with approved submittal.

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- B. Adjust operating clearances so that restraints do not interfere with normal operation of the equipment.

3.02 MOUNTING REQUIREMENTS:

- A. Unless the equipment incorporates unit construction using an integral rigid frame or is specified otherwise, mount each item of mechanical equipment along with its drive unit on rigid steel or steel and concrete base.
- B. Cast iron bases: not permitted when equipment is furnished with a vibration isolation system.
- C. Vibration:
 - 1. Where specified, mount the equipment, including the base, on or suspended from vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the supporting structure.
 - 2. Vibration isolation available internally in the equipment shall not be considered equivalent and shall not be provided when vibration isolation as specified herein is required.
 - 3. Normally provided internal vibration isolators shall be replaced with rigid supports in such cases.
 - 4. Vibration isolators shall be selected in accordance with unit weight distribution to produce reasonably uniform deflections at each support.
- D. Unless otherwise indicated, bases, isolators, and deflections shall be as specified in ASHRAE CH 48.

3.03 TESTING

- A. Seismic restraint tests shall be conducted in an independent laboratory or under the supervision of a Professional Engineer registered in the state of Washington.
- B. Bolt the snubber assemblies to the test machine as the snubber is normally installed.
- C. Test reports shall certify that neither the elastomeric nor the snubber body sustained any obvious deformation after release of load.

3.04 FIELD CERTIFICATION

- A. Upon completion of the installation and after the system is placed into operation, the manufacturer's representative shall make a final inspection and submit its installation report in writing certifying the correctness of installation and compliance with approved submittal. The inspection shall include removal of the flange bolts to insure proper alignment of the piping without bolts. Correct any relative movement or separation of the flange faces without using bolts to distort the make-up.

END OF SECTION

SECTION 43 05 60

EQUIPMENT SUPPORT, GROUTING AND INSTALLATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. This Section specifies minimum requirements for equipment supports, including concrete housekeeping pads, equipment bases, supports, anchorage, and accessories for equipment meeting any of the following criteria:
 - 1. Weights greater than 200 pounds.
 - 2. Less than 25 horsepower.
 - 3. Equipped with a vibration isolation system.
 - 4. As applicable when this Section is referenced.
- B. Refer to requirements of Section 01 73 00 for Seismic Anchorage.
- C. If conflict exists between specification sections and recommendations of individual equipment manufacturers, the more restrictive shall prevail.
- D. Vibration isolation systems are specified in Section 43 05 51.

1.02 DEFINITIONS

- A. Base or Baseplate: Rigid Fabricated welded steel elements cast iron, or plate steel baseplate providing a common mounting element on which the soleplate or feet, or mounting surfaces of equipment are mounted by means of bolted connections.
- B. Soleplate: A machined plate providing a common mounting element on which the feet or mounting surfaces of equipment are mounted by means of bolted connections.
- C. Mounting Blocks: Multiple smaller baseplates on which individual feet or equipment supports are mounted when the mounting surfaces of equipment or a driver are not fastened to a common baseplate or soleplate.
- D. Housekeeping Pads: Structural Concrete pad to raise the equipment or equipment foundation above grade level of the supporting floor.
- E. Equipment Pedestal: Concrete foundation for supporting and elevating equipment baseplate or mounts above the supporting structural floor slab or local grade. Pedestals to have minimum weight of ten times the weight of the pump or equipment it supports.
- F. Mounting Pads: Thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers are bolted and/or doweled to the baseplate or soleplate.
- G. Leveling Blocks: Temporary steel blocks placed under baseplates, soleplates, or a mounting block at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or mounting blocks prior to grouting.
- H. Shims: Thin stainless steel plates of a uniform thickness installed on top of Leveling Blocks for fine adjustment of level. Shims may also be used between equipment or drivers and baseplates, soleplates, or mounting blocks for equipment alignment purposes.
- I. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges

are used between equipment pads and baseplates, soleplates, or mounting blocks for the purpose of leveling baseplates, soleplates, or mounting blocks.

- J. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or mounting blocks for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or mounting blocks.
- K. Reinforcement Dowels: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
- L. Machine Alignment Dowels: Tapered diameter rods inserted in tapered diameter holes for the purpose of aligning machinery. The practice of drilling tapered diameter holes through machinery and baseplates so that Machine Alignment Dowels may be inserted to facilitate alignment of machinery is known as Doweling.
- M. Leveling Position: A location on the top of a concrete equipment pad or pedestal where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and mounting blocks prior to grouting.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
HI 14.3	Rotodynamic Pumps for Design and Application
HI 14.4	Rotodynamic Pumps for Installation, Operation, and Maintenance
API 610	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Shop drawings for all equipment bases showing anchorage and reinforcement details:
 - a. No less than 4 weeks in advance of equipment installation.
 - 2. Stamped drawings and calculations bearing the stamp of a Professional Engineer registered in the state of Washington are required for:
 - a. Equipment with a vibration isolation system.
 - b. Equipment equal to or greater than 25 horsepower require stamped drawings and calculations (See Section 43 05 63).
 - 3. Seismic anchorage design:
 - a. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.
 - 4. Manufacturer's information on epoxy grout or cementitious grout as applicable.
 - 5. Machine and equipment base installation schedule with manufacturers' anchor bolt torque requirements.
 - 6. Results of grout strength tests.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide all supports, anchorage, and mounting of all equipment, unless otherwise specified, in accordance with the manufacturer's recommendations, the IBC, and industry standards requirements.
- B. Each piece of equipment shall be anchored to resist the greater of the maximum lateral and vertical forces required by the local governing code or by the manufacturer of the equipment, whichever is greater. This force shall be considered acting at the center of gravity of the piece under consideration. No equipment shall be anchored to vertical structural elements without written approval of the Project Representative.
- C. All equipment shall be mounted on concrete housekeeping pads. Unless otherwise specified, equipment and drivers shall be rigidly mounted on a common cast iron or fabricated steel baseplate or soleplate grouted into place on the housekeeping pads. Under no circumstances shall equipment supports be connected directly to concrete slabs or floors.
- D. Installation practices shall follow the guidance presented in Chapters 4 and 5 of API Recommended Practice 686, unless superseded by more restrictive requirements of these specifications or manufacturer requirements.

2.02 CONCRETE HOUSEKEEPING PADS

- A. Concrete housekeeping pads for equipment and floor penetrations shall be at least 2 inches larger in plan on all sides than the steel or cast base and not less than 6 inches above the finished floor elevation, and shall be shaped to drain liquids away from the base.
- B. Housekeeping pad details shall follow the requirements set forth in Figure A-4 of API 686 unless superseded by more restrictive requirements of these specifications or the requirements of the equipment manufacturer.
- C. All conduits, piping connections, drains, etc. serving the equipment, shall be enclosed by the concrete housekeeping pad. Unless otherwise specified, no conduits, piping connections, drains, etc., will be accepted which rise directly from the floor.

2.03 EQUIPMENT BASES

- A. General:
 - 1. Unless otherwise specified, rigidly mount equipment and driver on a common cast iron or fabricated steel baseplate.
 - 2. Unless otherwise indicated, hot-dip galvanize steel equipment bases after fabrication.
 - 3. For belt driven equipment shown as in-line and piggyback, the base shall be rectangular and the motor shall always be behind and above the driven equipment and never over the driven equipment unless approved by the Project Representative or indicates as such in the equipment specification. Motor mounting hardware for any belt driven configuration shall allow for belt tension adjustment.
 - 4. All bases shall have edges bearing on the grout surface rounded to a radius of not less than 2-inches to avoid producing stress risers on the grouted foundation.
 - 5. Grout pouring holes (minimum 4 inches in diameter) shall be provided in all bases and all bases shall have grout release holes.
 - 6. Except where vibration isolation systems are specified, all bases shall be grouted as specified in this Section.
 - 7. Internal stiffeners shall be provided and shall be designed to allow free flow of grout from one section of the base to another.
 - 8. The minimum acceptable opening in cross-bracing and stiffeners shall be 2-inches high by 6-inches in length. All welds shall be continuous and free from skips, blow holes, laps and pockets.

9. Equipment bases for horizontal pumps shall conform to the requirements of this Section, ANSI/HI 1.3, API 610, and shall provide common support for the pump and motor. In the event of conflict, the requirements of this Section shall govern.
10. Eight positioning jackscrews shall be provided for all drivers for all horizontal pump baseplates. All bases for horizontal pumps shall be equipped with jackscrews for positioning and leveling the base prior to grouting.
11. Mounting holes for anchor bolts in the bases, mounting blocks, or sole plates shall be drilled and not burned out and they shall not be open slots.
12. Mounting pads for equipment shall be machined after all welding and stress relieving and shall be coplanar to 0.002 in. in all directions.
13. Mounting pads shall extend not less than 1-inch on all sides beyond the position for the equipment.
14. Direct mounting on the housekeeping pads will not be permitted.

B. Curb Mounted Bases:

1. Curb mounted equipment where vibration isolation is required, principally roof top heating, ventilating and air conditioning equipment, shall be mounted on vibration isolation bases that fit over the curb and under the isolated equipment.
2. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1-inch minimum deflection with 50 percent additional travel to solid.
3. Spring diameters shall be no less than 0.8 times the spring height at rated load.
4. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of ¼-inch so as not to interfere with spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible neoprene connection duct joining the outside perimeter of the aluminum members. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.

C. Type I Bases:

1. Type I bases shall be structural steel bases with thickened steel pads for doweling.
2. The bases shall be rectangular in shape for equipment other than centrifugal refrigeration machines and pump bases, which may be "T" or "L" shaped to accommodate the equipment drive and accessories.
3. Pump bases for split case pumps shall include supports for suction and discharge base ells, if required by the specified configuration.
4. Perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
5. Terminations requiring connections to the base shall be nuts welded to the bottom side of the base and plugged with cork, plastic plugs or grease, or acorn nuts.
6. Grout holes shall be provided for the bases of all equipment where vibration isolation is not specified.
7. Sole plates, mounting blocks and baseplates weighing more than 1000 pounds shall be leveled with jackscrews incorporated into the fabrication. Jackscrews shall be located in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.

D. Type II Bases:

1. Type II bases shall be steel members used to cradle machines having legs or bases that do not require a complete supplementary base.
2. All members shall be sufficiently rigid to prevent strains in the equipment. Height saving brackets shall be employed in all mounting locations to provide a clearance of 1-inch below the base.

E. Type III Bases:

1. Type III bases shall be rectangular foundations consisting of concrete filled structural steel beam or channel forms.
2. Bases for split case pumps shall be of sufficient size to provide support for suction and discharge base ells. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer or required for mass or rigidity.

3. In general, base depth shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches.
 4. Forms shall include, as a minimum, concrete reinforcement consisting of ½-inch bars or angles welded in place on 6-inch centers each way in a layer 1½ inches above the bottom or additional steel as required by structural conditions.
 5. Forms shall be provided with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations.
 6. Height saving brackets shall be employed in all mounting locations to maintain a 1-inch clearance below the base.
- F. Type IV Bases:
1. Type IV bases shall be cast iron.
 2. Terminations requiring connections to the base shall be nuts welded to the bottom side of the base and plugged with cork, plastic plugs or grease, or acorn nuts. In no case shall the fastener terminate only into the metal base.
- G. Soleplates:
1. Where soleplates are provided, the underside shall be scribed with the words "THIS SIDE DOWN" using welding rod material prior to milling the equipment mating surface flat to a tolerance of not less than 0.002 in./ft in all directions.
- H. Mounting Blocks:
1. Where equipment is fabricated or cast with individual support pads or feet and provision of a common base, as in bottom suction pump, the equipment may be supported on individual piers in lieu of a common housekeeping pad. In such instances, the equipment may be supported at the pads or feet on individual sole plates or mounting blocks, which shall be leveled and grouted into place as specified in this Section.

2.04 GROUT FOR EQUIPMENT BASES

- A. Unless otherwise indicated, grout for equipment bases shall be non-shrinking epoxy grout as specified in Section 03 60 00.
- B. Cementitious grout may be used for equipment rated 5 horsepower or less and weighing less than 1,000 pounds, unless noted otherwise. Cementitious grout is specified in Section 03 60 00.
- C. Procedures for leveling and clamping equipment shall be as specified in this Section.

2.05 EPOXY PRIMER

- A. The epoxy primer shall be a lead free, chrome free, rust inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer shall be a product of the epoxy grout manufacturer.

2.06 ANCHOR BOLTS

- A. Anchor bolts shall be Type 316 stainless steel, set in PVC sleeves, per Section 03 15 19 for cast-in-place and Section 05 05 19 for post-installed. Sleeves shall allow a free length projection of not less than fifteen bolt diameters above the concrete required to develop the strength of the bolt. Projection above the nut on the baseplate or soleplate shall be no more than 3/4-inch.
- B. A non-seize or non-galling compound shall be used on all threads.
- C. The equipment manufacturer shall recommend the size of the anchor bolts for the equipment. The minimum size bolt shall be as follows:
 1. ¾-inch for equipment rated 20 to 25 hp.

- D. Manufacturer shall provide the recommended tightening torque for the nuts.

2.07 ANTI-SEIZE/ANTI-GALLING COMPOUND

- A. Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in an aluminum complex baseplate grease conforming to MIL-PRF-907E.
- B. Acceptable products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or approved equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Pumps shall be installed in accordance with this Section and ANSI/HI 14.1. Grouting of equipment bases shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless the Project Representative accepts an alternate installation procedure in writing, baseplates shall be grouted with the equipment removed.
- B. Equipment that is not mounted on vibration isolators shall be anchored directly to the supporting floor system. In addition to the anchorage, all such equipment shall be internally designed so that all static and moving parts are anchored to the supporting framework to resist all imposed forces. All forces shall be transmitted to the base in order to be anchored as required.
- C. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections.
- D. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, the Contractor shall delete any flexible coupling (including equipment connection fittings) shown on the Drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:
 - 1. The equipment pad shall be prepared as shown on the details for rigid equipment mounts.
 - 2. The baseplate, soleplate, or mounting blocks supporting the equipment shall be installed, leveled, and grouted in place as specified in this Section.
 - 3. The equipment shall be installed, aligned and doweled in place as specified.
 - 4. The piping shall be installed and aligned to the equipment connections and the field piping connections without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted up and pressure tested.
 - 5. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.
 - 6. The final sections of piping shall be aligned with the equipment and field connections without the use of jacks, chain falls or other devices to force it into alignment.
 - 7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the Project Representative.
- E. Conduit and piping for future equipment shall be capped flush with the floor or concrete pad in such a manner to allow future connection.
- F. Coordinate location of electrical conduit and piping penetrations within the concrete pad and equipment base. All penetrations shall stub-up on the same side of the equipment as required for connection to the equipment. Equipment drains shall be located as required for drainage from equipment.

3.02 INSTALLATION

- A. Anchor Bolts:

1. Prior to concrete placement, anchor bolts shall be accurately set according to the manufacturer's shop drawings and firmly secured to prevent shifting during concrete placement. The bolts shall be embedded in the structural concrete to develop the full strength of the bolt. Concrete in housekeeping pads cannot be used for this purpose.
 2. All anchor bolts shall be dimensionally checked against the shop drawings for proper length, diameter, thread length, thread projection, etc., by a representative of the equipment manufacturer prior to placing concrete.
 3. Prior to placing concrete for the housekeeping pad, plastic sleeves shall be placed around each bolt to provide for minor adjustment of bolt position prior to grouting.
 - a. Bolt threads and projections in the sleeves shall be per Section 43 05 60.
 - b. Bolt projections above the structural slab shall be protected in the sleeve by heavily greasing or waxing the threads and shank with paste wax and wrapping with plastic sheeting.
 - c. The protective wrapping shall be firmly secured with tie wires.
 - d. The protective wrapping shall be removed prior to placing the grout.
- B. Concrete Housekeeping Pad Preparation:
1. After the concrete is fully cured, the top of the equipment pad shall be roughened by chipping the surface.
 - a. Chipping shall remove all laitance and defective or weak concrete and result in a rough surface profile with a 0.25 inch minimum amplitude.
 - b. Chipping shall expose broken aggregate without dislodging unbroken aggregate from the cement matrix and shall not cause fractures below the concrete surface.
 - c. A light duty, hand held pneumatic chipper with a chisel type tool shall be used for chipping the equipment pad concrete surface. Abrasive blast, bush-hammer, jack hammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted is not acceptable.
 - d. The chipped surface of the concrete shall be such that the final baseplate, soleplate, or mounting block elevation results in the grout manufacturer's recommended grout thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate or underside of mounting block.
 - e. All edges shall be chamfered 2 inch to 4 inch at a 45-degree angle
 - f. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.
 2. The grout contact surface on the housekeeping pad shall be coated with one coat of catalyzed epoxy resin of not more than 5 mils thickness.
- C. Equipment Bases, Soleplates, and Mounting Blocks:
1. All surfaces of equipment bases and soleplates to be in contact with epoxy grout shall be cleaned to SSPC SP-6 and shall be primed with cementitious non-shrink primer within 8 hours of cleaning.
 2. Primer coatings shall conform to the supplier's recommendations for thickness and solvents.
- D. Leveling and Shimming:
1. All machinery shall be mounted and leveled by millwrights.
 2. All equipment bases and equipment shall be leveled against steel surfaces. Use of other materials for leveling purposes is prohibited.
 3. Unless otherwise specified, baseplates, mounting blocks and soleplates weighing less than 1000 pounds shall be leveled on stainless steel blocks 4 inches square and 1½ inches thick with a hole drilled in the center for the anchor bolt, placed under the base at every anchor bolt. Jackscrews acting on flat steel plates shall be used for heavier components.
 4. Leveling shall be by use of leveling blocks machined flat on all horizontal surfaces and measuring not less than 4 inches wide horizontally and shims that shall extend not less than three inches beyond the base of the equipment. Leveling blocks shall be coated with a light oil just prior to beginning the leveling and grouting work.
 5. Using precut stainless steel shims coated with a light oil between the base and the steel blocks at the anchor bolts, level the equipment baseplates, soleplates or mounting blocks against the anchor bolt nuts to a maximum tolerance of 0.005 in/ft or as otherwise required by the equipment manufacturer, if more stringent. Mounting surfaces for equipment shall be coplanar within 0.002 in.

in any direction. The shims shall be placed so the tabs on the shims are easily accessible. A minimum of four shims per anchor bolt shall be used. The total shim thickness at each anchor bolt shall be at least 0.015 inch.

6. Leveling shall be against anchor bolts prior to final grouting. Leveling equipment shall be precision surveying equipment. Machinists' spirit levels will not be permitted for leveling purposes for any base plate or equipment foundation with a plan dimension greater than 4 feet.
7. Leveling nuts may be used for mounting equipment less than 500 pounds. Level the equipment against the anchor bolt nuts to a maximum tolerance of 0.005 in/ft or as otherwise required by the equipment manufacturer, if more stringent. Wedges will not be allowed.

E. Grouting:

1. Forms:

- a. Built of minimum of 3/4-inch thick waterproof plywood
- b. Securely braced (minimum brace size shall be 2-inch by 4-inch).
- c. Coat all areas that will come in contact with the grout with three coats of paste wax to prevent the grout from bonding to the forms.
- d. Forms shall be waxed before assembly to prevent accidental application of wax to surfaces where the grout is to bond.
- e. Before any forms are installed, all concrete surfaces that will contact epoxy grout shall be free from any foreign material, such as oil, sand, water, grease, etc.
- f. Forms shall be liquid-tight. Any open spaces or cracks in forms, or at the joint between forms and the foundation, shall be sealed off, using sealant.
- g. All outside vertical and horizontal edges of the grout shall have 45-degree chamfers.
- h. Blockouts shall be provided at all shimming and leveling nut positions to allow removal of shimming equipment after the grout has cured.
- i. Jackscrews shall be coated with a light oil or other acceptable bond-breaking compound.

2. Top of Grout:

- a. The 45-degree chamfer strip shall be located at the top of the grout.
- b. The top of the grout on baseplates with exposed I-beam or C-channel supports shall be at the top of the lower support flange.
- c. The top of the grout on baseplate plates with solid sides and soleplates, shall be 1.0-inch above the bottom of the baseplate plate or the underside of the soleplate. The grout's final elevation shall not be so high as to bond the anchor bolt nut and washer.

3. Epoxy grout:

- a. The epoxy resin and hardener shall be mixed in accordance with the grout manufacturer's recommendations.
- b. Aggregate shall be slowly added to the mixer one bag at a time.
- c. The grout should be mixed only long enough to wet out all the aggregate.
- d. Grout shall be placed at the center of one end of the baseplate or soleplate and worked toward the ends in such a manner as to force the air out from beneath the baseplate or soleplate and out the vent holes, to eliminate voids.
- e. The grout shall be placed in a manner that avoids air entrapment using a head box to pour grout into the grout holes.
- f. When the head box is moved to the next grout hole, a 6-inch high standpipe shall be placed over the grout hole and filled with grout.
- g. The Contractor shall exercise care to never allow the grout to fall below the baseplate level once the grout has made contact with the baseplate.
- h. Grout placement shall be continuous until the all portions of the space beneath the baseplate or soleplate have been filled. Subsequent batches of grout shall be prepared so as to be ready when the preceding batch has been placed. Under no circumstances shall the grouting operation be halted because of lack of grout mix.
- i. After the entire baseplate is full, 6-inch high standpipes shall be maintained over each grout hole, to continue purging of air.
- j. When the grout has started to take an initial set (determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.

4. Grout Sampling:

- a. A grout sample shall be taken for each piece of equipment to be grouted.
 - b. The sample shall be placed in a cylinder of sufficient size to yield three 2" x 2" x 2" test samples.
 - c. The samples shall be tagged with the equipment number and ambient temperature at the time of placement.
 - d. The samples shall be tested in accordance with the manufacturer's recommendations.
 - 1) Once the epoxy grout cylinder has been completely filled, it shall be placed next to the foundation of the equipment being grouted and allowed to cure for 48 hours.
 - 2) After 48 hours, the test cylinder shall be tested in accordance with the grout manufacturer's recommendations by an independent testing laboratory.
 - 3) The results shall be reported directly to the Project Representative.
 - 5. Forms shall be removed only after the grout has cured sufficiently and upon specific permission from the Project Representative.
- F. Completion:
- 1. Form Removal:
 - a. Upon acceptance by the Project Representative and the equipment manufacturer's representative, and after the grout has reached sufficient strength, the shims shall be removed, or leveling nuts or jack screws backed off to allow the grout to fully support the equipment base, leveling block or soleplate.
 - b. Removal procedures shall protect the grout from damage.
 - 2. Torque Requirements:
 - a. The anchor bolts shall be torqued, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer.
 - b. Anchor bolts shall be torqued in increments of not more than 25 percent of final value in an alternating pattern to avoid stress concentration on the grout surface.
 - 3. Pockets for access to shims, mounting blocks, or leveling nuts shall be filled with grout mix and pointed after the anchor bolts have been torqued to final values.

3.03 FINAL INSPECTION

- A. The Project Representative will conduct a final inspection with the Contractor for conformance to requirements of the contract documents.

END OF SECTION

SECTION 43 05 61

MACHINE ALIGNMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for alignment of mechanical and HVAC equipment weighing 400 pounds or more.
- B. Equipment with drivers 5 horsepower and less are specifically exempted from the requirements of this Section.
- C. This Section also includes requirements for alignment software and equipment to be provided to the County on commissioning.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
-	Shaft Alignment Handbook, second edition, John Piotrowski, Marcel Decker Inc.

1.03 ALIGNMENT REQUIREMENTS

- A. General:
 - 1. All equipment shall be aligned using laser alignment equipment to the tolerances specified by the subject equipment manufacturer or the criteria specified in this Section, whichever is more stringent.
 - 2. Alignment Criteria: unless otherwise indicated by more stringent manufacturers' requirements, all mechanical equipment shall be aligned to the following criteria:

Maximum Tolerable Misalignment			
Speed	Couplings		Spacer Shaft
rpm, maximum	Offset (mils)	Angularity (mils/inch)	offset (mils/inch of shaft length)
600 and less	5.0	1.0	1.8
900	4.0	0.7	1.2
1200	2.5	0.5	0.9
1800	2.0	0.3	0.6
3600	1.0	0.2	0.3
7200	0.5	0.1	0.15

- a. Soft foot shall be not more than 2.0 mils for any speed.
- b. Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements.
- c. All units shall be installed and leveled as specified.

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.

- B. All alignment records, in both hard copy and electronically.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Alignment equipment used to perform the work required shall:
 - 1. Employ laser alignment techniques to achieve the required tolerances.
 - 2. Be computer based and compatible with 2010 or newer MS Excel based spreadsheets and databases.
 - 3. Employ a hand-held field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance.
 - 4. Have a computer powered by rechargeable NiCad batteries and capable of storing up to 1000 machine measurement sets, complete with labels, graphics and comments.
- B. The link between field measurement instruments and the computer shall be through infrared.
- C. External interface between the field computer and other processors shall be by RS-232C serial cable ports.
- D. Laser emitter:
 - 1. Class 2 type, FDA 21 CFR 1000 and 1040 compliant.
 - 2. Powered by lithium ion batteries.
 - 3. Operate on a 670 nm wavelength and have a beam divergence of less than 0.3 microradians at a power of not more than 1 microwatt.
- E. Laser receiver: 5 axis capability with a resolution of 0.04 mil offset and 10 micro radians angularity.

PART 3 EXECUTION

3.01 GENERAL

- A. Shim for level and alignment between motor base plate and the mounting base per Section 43 05 60, 43 05 62, and 43 05 63.
- B. Grout after leveling and aligning. Machines supported on integral feet or support pads shall be leveled, grouted and aligned in the following order: driven machine; intermediate bearings or machines; and driver.
- C. Align all machines prior to any connections to piping, electrical and instrumentation systems. Upon completion of all field connections, recheck alignment to demonstrate no change. If change has occurred, eliminate any external forces affecting machine alignment and repeat the alignment process.
- D. Recheck all machine alignment parameters after the equipment has been brought to operating temperature by operation at specified conditions. Where required by other Sections, factory authorized installation technicians representing the equipment manufacturer shall witness final alignment work.
- E. Independently check all alignment work using the shaft and coupling spool method described in the Shaft Alignment Handbook. After completion of all alignment work and acceptance in writing by factory installation technician, all machines shall be dowelled in place using tapered stainless steel dowels.
- F. Perform alignment work with millwrights skilled in this type of work under the supervision of a technician trained in the use of the laser alignment by the manufacturer of the alignment equipment. All final results of the alignment work shall be subject to inspection and verification by the Project Representative.

- G. Submit all alignment records, in both hard copy and electronically. Hard copy to be signed and dated by the technician performing the alignment work.

END OF SECTION

SECTION 43 05 62

GENERAL EQUIPMENT MOUNTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies equipment mounting for all equipment, except pumps and reciprocating equipment over 25 horsepower. It specifies equipment bases, supports, anchorage, and accessories.
- B. Vibration isolation systems are specified in Section 43 05 51.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
IBC	International Building Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Shop drawings for all equipment bases and anchorage details.
 - 2. No less than 4 weeks in advance of equipment installation, submit anchorage and bracing drawings and calculations bearing the stamp of a Professional Engineer registered in the state of Washington. Drawings and calculations shall include and clearly show the criteria used to determine seismic coefficients and forces applied to the equipment, including seismic zone, soil profile type, and importance factors.

1.04 MOUNTING REQUIREMENTS

- A. Unless otherwise indicated, provide all supports, anchorage, and mounting of all equipment in accordance with the manufacturer's recommendations, the IBC, and industry standards requirements.
- B. Provide all elements required to resist the calculated forces described herein or required by the equipment manufacturer.
- C. Design anchorage for all equipment bases, supports, and foundations in accordance with IBC and Section 01 73 00.
- D. All anchorage of equipment shall be made of poured-in-place concrete elements; it is imperative that anchorage be coordinated with the concrete work so that anchorage may be installed at time of pouring. If calculations and anchorage details are not approved prior to pouring of concrete, Contractor shall become responsible for any strengthening of concrete elements.
- E. For belt driven equipment shown as in-line and piggyback, the base shall be rectangular and the motor shall always be behind and above the driven equipment and never over the driven equipment unless approved by the Project Representative or indicates as such in the equipment specification. Motor mounting hardware for any belt driven configuration shall allow for belt tension adjustment.

- F. For equipment 15 horsepower and larger, anchor bolt calculations showing adequacy of bolt sizing and anchor embedment shall be performed, stamped, dated, and signed by a Professional Structural Engineer currently licensed in the state of Washington.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise specified, rigidly mount equipment and driver on a common cast iron or fabricated steel baseplate.
- B. All equipment located on floor slabs shall be mounted on concrete pads.
- C. Unless otherwise indicated, hot-dip galvanized the bases after fabrication, except cast iron bases.

2.02 CONCRETE PADS

- A. Provide concrete pads, for equipment and associated floor penetrations that are at least 2 inches larger than the steel or cast base and not less than 6 inches above the finished floor elevation.
- B. Shape to drain away from the base.
- C. Enclose all conduits, piping connections, or drains. Unless otherwise indicated, no fixtures that rise directly from the floor, including conduits, piping connections, or drains, will be accepted.

2.03 EQUIPMENT BASES

- A. Curb Mounted Bases:
 - 1. Curb mounted equipment where vibration isolation is required, principally roof top heating, ventilating and air conditioning equipment, shall be mounted on vibration isolation bases that fit over the curb and under the isolated equipment.
 - 2. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1-inch minimum deflection with 50 percent additional travel to solid.
 - 3. Spring diameters shall be no less than 0.8 times the spring height at rated load.
 - 4. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4 inch so as not to interfere with spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible neoprene connection duct joining the outside perimeter of the aluminum members. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.
- B. Type I Bases:
 - 1. Type I bases shall be structural steel bases with thickened pads for doweling.
 - 2. The bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases, which may be "T" or "L" shaped to accommodate the equipment drive and accessories.
 - 3. Pump bases for split case pumps shall include supports for suction and discharge base ells.
 - 4. All perimeter members shall be beams with a minimum depth equal to 1/10 of the longest dimension of the base. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 inch.
- C. Type II Bases:
 - 1. Type II bases shall be steel members used to cradle machines having legs or bases that do not require a complete supplementary base.

2. All members shall be sufficiently rigid to prevent strains in the equipment. Height saving brackets shall be employed in all mounting locations to provide a clearance of 1-inch below the base.
- D. Type III Bases:
1. Type III bases shall be rectangular foundations consisting of concrete filled structural steel beam or channel forms.
 2. Bases for split case pumps shall be of sufficient size to provide support for suction and discharge base ells. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer or required for mass or rigidity.
 3. In general, base depth shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches.
 4. Forms shall include, as a minimum, concrete reinforcement consisting of ½-inch bars or angles welded in place on 6-inch centers each way in a layer 1½ inches above the bottom or additional steel as required by structural conditions.
 5. Forms shall be provided with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations.
 6. Height saving brackets shall be employed in all mounting locations to maintain a 1-inch clearance below the base.
- E. Type IV Bases:
1. Type IV bases shall be cast iron.
 2. Cast iron bases located within a building, vault, tunnels, or galleries do not require galvanizing but shall be sealed in accordance with the requirements for bleeding surfaces specified in Section 09 90 00 prior to grouting.
 3. All fasteners requiring connections to the base shall be terminated by nuts welded to the bottom side of the base and plugged with cork, plastic plugs or grease, or acorn nuts. In no case shall the fastener terminate only into the metal base.
 4. Bases for pumps shall be provided with perimeter drip rims plumbed to the equipment drain.

PART 3 EXECUTION

3.01 GENERAL

- A. Anchor each piece of equipment to resist the minimum lateral force required by code, the IBC or by the manufacturer of the equipment, whichever is greater. Consider this force acting at the center of gravity of the piece under consideration.
- B. Anchor no equipment to vertical structural elements.
- C. Equipment which is not vibration isolated shall be anchored directly to the supporting floor system. In addition to the anchorage, all such equipment shall be internally designed so that all static and moving parts are anchored to the supporting framework to resist the imposed seismic forces. All forces shall be transmitted to the base in order to be anchored as required. Vibration isolated equipment shall be specially designed to meet these same requirements.
- D. Piping and Conduit:
 1. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections.
 2. Cap flush conduit and piping for future equipment with the floor or concrete pad in such a manner to allow future connection.
 3. Coordinate location of electrical conduit and piping penetrations within the concrete pad and equipment base.
 4. Stub up all penetrations on the same side of the equipment as required for connection to the equipment.
 5. Locate equipment drains as required for drainage from equipment.

3.02 INSTALLATION

- A. Unless otherwise indicated, place steel blocks 4 inches square and 1½-inches thick with a hole drilled in the center for the stud under the base at every mounting stud.
- B. Leveling:
 - 1. Level equipment by using precut stainless steel shims between the base and the steel blocks at the mounting studs.
 - 2. Place the shims so the tabs on the shims are easily accessible.
 - 3. Use a minimum of 4 shims per stud.
 - 4. The total shim thickness at each stud shall be at least 0.015 inches.
 - 5. Leveling nuts may be used for mounting equipment less than 10 horsepower.
 - 6. Wedges: not allowed.
- C. Mounting:
 - 1. Unless otherwise indicated, mounting bases for equipment 20 horsepower and larger shall be a minimum of 1-inch thick.
 - 2. Drill and do not burn out mounting holes in the bases. The holes shall not be open slots.
 - 3. Use mounting studs that are 316 stainless steel. Use a non-seize or non-galling compound on the threads
 - 4. Use mounting studs that are the "L" shaped type and go through any concrete pad into the floor.
- D. Manufacturer specifications for mounting:
 - 1. The equipment manufacturer shall recommend the size of the mounting studs for the motor and equipment and shall also furnish the recommended tightening torque for the nuts.
 - 2. Regardless, the minimum size stud shall be:
 - a. ¾-inch for 20 to 100 horsepower.
 - b. 1-inch for over 100 to 300 horsepower.
 - c. 1¼-inch for 300 to 500 horsepower.
 - d. Over 500 horsepower shall be as recommended by the manufacturer of the equipment.
- E. Grout:
 - 1. Grout and grouting equipment per Section 03 60 00.
 - 2. No less than 7/8-inch thick and no more than 1-5/8 inches thick.
 - 3. In accordance with Section 43 05 60.

END OF SECTION

SECTION 43 05 63

LARGE PUMP AND RECIPROCATING EQUIPMENT MOUNTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies minimum requirements for pad-mounting large pump and reciprocating equipment (25 hp and up, except equipment with vibration isolation systems). Completed equipment supports shall consist of equipment pads, equipment anchors, and rigid equipment mounts (baseplates and soleplates, or mounting blocks) set in grout.
- B. Unless alternate requirements for equipment mounts are specified in the applicable equipment specification, the requirements of this Section shall be applied. If conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.
- C. Mounting for pumps under 25 hp or equipment with vibration isolation systems: Section 43 05 60

1.02 DEFINITIONS

- A. Per Section 43 05 60

1.03 REFERENCE STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
HI 14.4	Rotodynamic Pumps – for Installation, Operation, and Maintenance
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
IBC	International Building Code (including local amendments)

1.04 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Seismic Anchorage Design:
 - 1. Seismic anchorage design shall be in accordance with Specification Section 01 73 00. If a conflict exists between specification Sections and recommendations of individual equipment manufacturers, the more restrictive shall prevail.
 - 2. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$
- C. Provide the following submittals:
 - 1. Schedule of rigid equipment mount installations.
 - 2. Name, employer and certificates or other information documenting compliance with the journeyman qualifications requirements for millwrights who will install rigid equipment mounts.
 - 3. Manufacturer's information on epoxy grout.
 - 4. Certificates or other documentation issued by the non-shrink grout manufacturer that demonstrates that the grout manufacturer's technical representative has been factory trained on installation of grout for equipment mounts.

5. Shop drawings for all equipment pads, equipment anchors, and baseplate, soleplate or mounting block details. Shop drawings shall be identified by the specification number and equipment number of the supported equipment, to allow filing the shop drawing with the equipment submittal.
6. Stamped and signed equipment anchor calculations by a registered structural or civil engineer licensed in the state of Washington.

1.05 QUALITY CONTROL BY CONTRACTOR

- A. To demonstrate conformance with the specified requirements for rigid equipment mounts, the Contractor shall provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. The testing laboratory shall sample and test equipment mount related materials as indicated in this Section. Costs of testing laboratory services shall be borne by the Contractor.
- B. The Contractor shall provide the services of a grout manufacturer's technical representative that has been factory trained by the grout manufacturer. The grout manufacturer's technical representative shall perform training and quality control of grout installation for rigid equipment mounts as indicated in this Section.

PART 2 PRODUCTS

2.01 CONCRETE HOUSEKEEPING PADS AND PEDESTALS

- A. Equipment baseplates or soleplates shall be mounted to the concrete pad or pedestal as shown on the Drawings. Concrete equipment pads and pedestals to be as follows:
 1. Achieve the proper elevation for mounting of the equipment as shown in the Drawings.
 2. Unless otherwise shown, the minimum pad height is six inches above the floor and sufficient length and width to provide a minimum of two inches on all sides of the baseplate.
 3. Metal pedestals are not allowed for equipment mounted per this Section.
- B. Shop drawings shall depict the following:
 1. Size and location of equipment pads and reinforcement.
 2. Equipment drains.
 3. Equipment anchor, size, location, and projection.
 4. Expansion joint locations.
 5. Elevation of top of grout and grout thickness.
 6. Elevation of top of baseplate; soleplate; or mounting block.
 7. Size and location of electrical conduits.
 8. Any other equipment mounting features embedded in equipment pads.

2.02 BASEPLATES, SOLEPLATES, AND MOUNTING BLOCKS

- A. General:
 1. Baseplates shall be of the type and size shown on the Drawings (see Section 43 05 60 for more detail on each type):
 - a. Type I: Structural steel bases with thickened steel pads for doweling.
 - b. Type II/III Baseplates are not applicable to this Section. They are applicable for equipment provided with vibration isolation systems.
 - c. Type IV Baseplates: Cast iron with thickened mounting pads for doweling and bolting equipment to the baseplate.
 2. Grouting provisions:
 - a. Grout pouring holes and grout release/vent holes shall be provided in all baseplates and soleplates.
 - b. Mounting blocks may be grouted without grout pouring holes provided that no dimension of the mounting block (width or length) exceeds 18 inches.
 3. Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and mounting blocks.

- a. Mounting holes for equipment anchors shall not be burned out and they shall not be open slots.
 - b. All mounting studs shall be Type 316 stainless steel. An anti-seize or anti-galling compound shall be applied to all mounting stud threads prior to installing nuts on mounting studs.
 - c. Terminations requiring connections to baseplates, soleplates, or mounting blocks shall be acorn nuts welded to the underside of the baseplate or nuts welded to the underside of the baseplate and plugged with cork, plastic plugs or grease. In no case shall the fastener terminate only into the metal baseplate.
 - d. Where baseplates, soleplates, or mounting blocks are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
 - 4. Baseplates, soleplates, and mounting blocks shall be fabricated as follows:
 - a. Annealed to relieve stresses associated with welding after fabrication is complete.
 - b. Final machining shall be performed after annealing.
 - 5. Mounting pads for equipment shall be fabricated as follows:
 - a. Machined after all welding and stress relieving.
 - b. Coplanar within 0.002 inch per foot in all directions.
 - c. Pads shall extend not less than 0.5 inch beyond the perimeter of the foot or mounting surface of the mounted equipment, in all directions.
 - 6. Equipment baseplates shall provide common support for the equipment and driver (and flywheel, if one is specified):
 - a. Baseplates shall be furnished with eight transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates.
 - b. Two of the eight transverse alignment/positioning jackscrews shall be installed in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver.
 - c. Eight additional jackscrews are to be provided for transverse alignment of the flywheel.
- B. Soleplates:
- 1. Shall be a minimum of 1-inch thick.
 - 2. Where soleplates are provided, the underside shall be scribed with the words "THIS SIDE DOWN" using welding rod material prior to milling the mounting pad for each equipment foot or mounting surface.
 - 3. Mounting surfaces and mounting pads on soleplates shall be milled flat to a tolerance of not less than 0.002 inch per foot in all directions.
 - 4. Soleplates shall be machined for an indexed fit to the mounted equipment or driver.
- C. Mounting Blocks:
- 1. Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of a common baseplate or soleplate and equipment pad:
 - a. In such instances, the equipment shall be supported at the feet or mounting surfaces on individual mounting blocks.
 - b. The mounting blocks shall be leveled and grouted into place on the individual piers or equipment pads as specified in this Section.
 - c. All mounting blocks shall be tapped with jackscrew threads for the purpose of leveling mounting blocks (three tap locations, minimum). Provide jackscrews.

2.03 GROUT FOR EQUIPMENT PADS

- A. Epoxy Grout:
- 1. Grout for setting bearing surfaces of baseplate plates, soleplates, and mounting blocks on equipment pads shall be epoxy grout as specified in Section 03 60 00.

2.04 PRIMERS

- A. Epoxy:

1. The epoxy primer shall be as specified in Section 43 05 60.

2.05 ANCHOR BOLTS

- A. Per Section 43 05 60.
- B. Equipment anchor calculations shall demonstrate that equipment anchor size, embedment, and edge distance comply with the IBC and are sufficient to resist the maximum lateral and vertical forces (pull-out and shear) encountered during operation of the equipment.
 1. Maximum lateral and vertical forces shall include, but are not limited to, the combined forces resulting from seismic loads specified in the International Building Code, loads resulting from pipe connections and pipe anchorage, and vibration plus other loads resulting from operation of the equipment.
 2. Equipment anchor size (diameter) shall be as required to resist the maximum lateral and vertical forces specified in this paragraph.
 3. Equipment anchor calculations shall be sealed by a registered structural or civil engineer licensed in the State of Washington.
- C. The minimum size bolt shall be as follows:
 1. 3/4-inch for equipment rated 25 to 100 horsepower.
 2. 1-inch for equipment rated over 100 to 300 horsepower.
 3. 1¼-inch for 300 to 500 horsepower.
 4. Anchor bolts for equipment rated over 500 horsepower shall be as recommended by the manufacturer of the equipment and as approved by the Project Representative.
- D. Manufacturer shall provide the recommended tightening torque for the nuts.
- E. A non-seize or non-galling compound shall be used on all threads. See Section 43 05 60.

PART 3 EXECUTION

3.01 GENERAL

- A. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless the Project Representative accepts an alternate installation procedure in writing, baseplates, soleplates, and mounting blocks shall be leveled and grouted with the equipment removed.
- B. Mounting blocks for dry-pit bottom-suction pumps may be leveled and grouted in position with the equipment on the mounting blocks. Pumps shall be installed in accordance with this section and HI 14.4.
- C. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections.

3.02 INSTALLATION

- A. Anchor Bolts:
 1. Per Section 43 05 60.
- B. Concrete Housekeeping Pad Preparation:
 1. Per Section 43 05 60.
 2. Leveling surfaces of the concrete that have been finished smooth and level for baseplate, soleplate, or mounting block leveling at equipment anchors shall be protected from damage during chipping.

C. Priming of Baseplates, Soleplates, and Mounting Blocks:

1. Per Section 43 05 60.

D. Leveling:

1. All machinery shall be mounted and leveled by journeyman millwrights. Precision surveying equipment shall be used for leveling. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or mounting block with a plan dimension greater than 4 feet:
 - a. Baseplates and mounting blocks shall be leveled to a maximum tolerance of 0.002 inch per foot or as otherwise required by the equipment manufacturer, if more stringent.
 - b. Soleplates shall be leveled to 0.0005 inch per foot or as otherwise required by the equipment manufacturer, if more stringent.
 - c. An anti-seize or anti-galling compound shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or mounting block leveling.
2. All baseplates, soleplates, and mounting blocks shall be leveled against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited:
 - a. Unless otherwise specified, baseplates, mounting blocks, and soleplates shall be leveled as indicated in the leveling details.
 - b. Leveling equipment and tools shall be stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates.
 - c. The use of leveling nuts for leveling mounting blocks is not permitted.
 - d. Leveling nuts may be used for leveling baseplates and soleplates weighing less than 200 pounds.
3. Procedures after baseplates, soleplates, or mounting blocks have been leveled on the leveling equipment:
 - a. Contractor shall clamp the baseplates, soleplates, or mounting blocks in position by installing the equipment anchor nuts and washers.
 - b. Clamping torque shall be less than the final clamping torque specified by the manufacturer, but sufficient to hold the baseplate, soleplate, or mounting block in position.
 - c. The Contractor shall verify that the correct level and position of the baseplate, soleplate, or mounting block has been maintained after clamping on the leveling equipment.
4. Leveling blocks:
 - a. Stainless steel, four inches square and 1½ inches thick with an open-ended slot terminating in the center for the equipment anchor.
 - b. Machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor.
 - c. Coated with a light oil just prior to beginning the leveling and grouting work.
5. Shims:
 - a. Pre-cut stainless steel, slotted for removal after grouting.
 - b. Extend not less than three inches beyond the baseplate, soleplate or mounting block. Shims shall be placed so the tabs on the shims are easily accessible.
 - c. Coated with a light oil just prior to beginning the leveling and grouting work.

E. Grouting:

1. See Section 43 05 60.

F. Completion:

1. Form Removal:
 - a. Upon acceptance by the Project Representative and the equipment manufacturer's representative and after the grout has reached sufficient strength, grout forms and block outs at leveling positions shall be removed.
 - b. Leveling blocks and shims or wedges and support plates shall be removed.
 - c. Leveling nuts and jack screws shall be backed off to allow the grout to fully support the baseplate, mounting block, or soleplate.
 - d. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.
2. Torque Requirements:

- a. The equipment anchor nuts shall be tightened, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer.
 - b. Equipment anchor nuts shall be tightened in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface.
3. After the equipment anchor nuts have been tightened to final values, block outs (pockets) for access to leveling nuts, leveling blocks and shims, or wedges, shall be filled with the grout material and pointed.
4. Jackscrews shall be removed and holes in the baseplate, soleplate, or mounting blocks filled with a flexible sealant (silicone rubber) or a short cap screw.
5. Check for baseplate, soleplate, or mounting block movement (soft foot):
 - a. Individually loosening and re-tightening each equipment anchor.
 - b. Vertical movement at each equipment anchor shall be measured and recorded during loosening and retightening and shall not exceed 20 micrometers (0.001 inch).
 - c. Vertical movement shall be measured using a magnetic-baseplated dial indicator on the baseplate, soleplate, or mounting block referenced to the cementitious non-shrink grout surface of the equipment pad or other approved method.
 - d. Soft foot conditions shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks.

3.03 FINAL INSPECTION

- A. The Project Representative will conduct a final inspection with the Contractor for conformance to requirements of the Contract Documents.

END OF SECTION

SECTION 43 23 04

VARIABLE SPEED SOLIDS HANDLING END SUCTION WASTEWATER PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies centrifugal sewage pumps with the following attributes; variable speed, solids handling, overhung impeller, vertical, end suction, direct drive with an intermediate shaft.
- B. The general requirements applicable to all mechanical equipment, as specified in Section 43 05 01, are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP - Raw Sewage Pump 1	704-P03DC011
RSP - Raw Sewage Pump 2	704-P03DC021
RSP - Raw Sewage Pump 3	704-P03DC031
RSP - Raw Sewage Pump 4	704-P03DC041
Spare Unit Back Pull-Out Assembly	704-P03AU011

- D. Spare Units shall be provided in accordance with Section 01 78 44.

1.02 DEFINITIONS

- A. Total head, net positive suction head (NPSH), acceptance grade, and pump efficiency are used in this Section as defined by Hydraulic Institute (HI) 14.6.
- B. Allowable Operating Region (AOR) and Preferred Operating Region (POR) are used in this Section as defined by HI 9.6.3.

1.03 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
AGMA 9000	Flexible Couplings – Potential Unbalance Classification
ANSI/HI 1.3	Rotodynamic (Centrifugal) Pumps for Design and Application
ANSI/HI 9.6.3	Rotodynamic Pumps – Guideline for Operating Regions
ANSI/HI 9.6.4	Rotodynamic Pumps for Vibration Measurements and Allowable Values
ANSI/HI 9.6.8	Rotodynamic Pumps Guideline for Dynamics of Pumping Machinery
ANSI/HI 14.1-14.2	Rotodynamic Pumps for Nomenclature and Definitions
ANSI/HI 14.3	Rotodynamic (Centrifugal) Pumps for Design and Application
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

Reference	Title
ASTM A48	Gray Iron Castings
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A395	Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A743	Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant for General Application
ISO 1940/1	International Organization for Standardization Standard for Mechanical Vibration
OSHA	Occupational Health and Safety Administration

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

- Specifically designed to pump wastewater and to operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.
- The fluid to be pumped is anticipated to have the following properties:
 - Temperature range between 45 degrees F and 70 degrees F.
 - Contains sand and grit from the upstream combined sewer system.
 - Contains up to 350 mg/L of total suspended solids consisting of organic and inorganic material with small quantities of petroleum products, animal fats and greases.
- The pump and the driver shall be designed to operate at variable speed without damaging cavitation or damaging vibration over the entire specified range of flow and head conditions.
- Installed pumping units shall meet the vibration and critical speed limitations specified in Section 43 05 50.
- The pump shall be capable of passing a sphere of the specified diameter from inlet to discharge.
- All components shall be designed to safely withstand forces resulting from flow reversals up to 125 percent of maximum speed within the pump during shutdowns.

1.05 DESIGN REQUIREMENTS

A. Pump Design Parameters:

- Sphere diameter passage: 4.5 inch minimum.
- Suction size: 54 inch.
- Discharge size: 54 inch.

B. Performance Requirements:

- The pumps shall perform in accordance with the following:

Condition	Capacity (gpm)	Total Head (ft)	Minimum Efficiency (%)	NPSH3 (ft)
A	102,000	22.0	>70	<27
B	>107,000	<18	>60	<30
C	24,000	18	>60	<25
D	>62,000	19	>85	<17

- Condition A: The rated, continuous-duty operating condition. Condition A shall be between 120% and 140% of the flow at the pump best efficiency point. Performance at the rated condition shall be guaranteed in accordance with Acceptance Grade 1U set forth in HI 14.6.
- Condition B: The runout condition. Pump shall be able to operate at Condition B infrequently for moderate durations; Condition B shall be within the AOR.
- Condition C: Continuous duty, minimum-speed condition. Condition C shall be within the AOR.
- Condition D: Typical operating condition at reduced speed. Condition D shall be between 90% and 110% of the flow at the pump best efficiency point.
- The pump head capacity curve shall slope in one continuous curve with no points of reverse slope inflection within the AOR capable of causing hunting at any pump operational speed.
- Motor power shall not exceed 900 HP for any specified operating condition.

- C. System Operation: Section 40 65 01
 - 1. Pump speed will be adjusted to maintain a stable wet well level to match the influent flow.
 - 2. Pump will be able to deliver a minimum flow of 35 mgd, which will require operation outside the POR for the lowest flow conditions.
 - 3. Typical pump operation will be within the pump's POR.
 - 4. Operation outside the POR to the right will only be required in an unusual scenario with one pump out of service with a high flow event occurring (+300 mgd entering the WPTP).

1.06 SUBMITTALS

- A. Procedure: Section 01 33 00.
- B. Provide the submittals from this Section with the submittals for Section 40 05 94 and Section 26 29 23 to allow evaluation as a unit responsibility system.
- C. Provide the following submittals:
 - 1. Unit responsibility documentation assembled and coordinated by the Unit Responsibility Engineer per Section 43 05 01:
 - a. Unit Responsibility Certification Form: Assignment attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this Section and Section 43 05 01. No other submittal material will be reviewed until the Unit Responsibility Certification Form has been received and found to be in conformance with these requirements.
 - b. Letter signed the Unit Responsibility Engineer certifying the following:
 - 1) Receipt and review of specifications, drawings, and other documents from the motor and VFD equipment manufacturers.
 - 2) All questions have been resolved with the motor and VFD equipment manufacturers.
 - 3) Final pump equipment selection has taken into consideration any equipment selected by motor and VFD equipment manufacturers.
 - c. Letters of certification signed by officers of the pump manufacturer, the VFD manufacturer, and the motor manufacturer that all have reviewed the specific application and that the selected equipment units are compatible and will satisfy operating requirements under all conditions of operation without adverse impacts on the designated unit responsibility system components.
 - 2. Manufacturer's predicted performance curves for head, capacity, horsepower, efficiency and NPSHR over the entire operating range of the pump, from shutoff to maximum (i.e. runout) capacity. Indicate separately the head, capacity, horsepower, and pump efficiency at the guarantee point.
 - 3. Manufacturer's specification data including materials of construction and descriptive literature.
 - 4. Factory tests procedures including
 - a. Diagram of test setup showing instruments, instrument locations, pump location, piping system.
 - b. Test fluid.
 - c. Sample test log sheet.
 - d. Sample calculations.
 - 5. Shop drawings including dimensions and cross sectional views of equipment showing details of fabrication.
 - 6. Drawings showing general dimensions, size of pumps, size of motors, drive components, discharge spool and piping connections, access ladder, railing and platforms, installation details, wiring diagrams, and weights of all major components.
 - 7. Combined moment of inertia for each pumping unit, of all pumping unit rotating components including, but not limited to pump, couplings, shaft(s), and motor.
 - 8. Motor data as specified in Section 40 05 94.
 - 9. Vibration data as specified in Section 43 05 50.
 - 10. Motor base and pump support calculations made and signed by a professional engineer.
 - 11. Critical speed and mass elastic system analyses for torsional, rotordynamic, and structural finite element analysis.
 - 12. Calculations of radial thrust and bearing life analysis.
 - 13. Shaft deflection calculation.
 - 14. Balancing reports.

15. Factory performance test report including reduced scale calculations, test setup description and diagram, description and calibration certification for instruments, test data, certified performance test curve for full-scale equipment including head, capacity, efficiency, horsepower, and calculated NPSH as a function of flow. NPSH data shall be calculated based on measured NPSH3 at pump runout value.
16. O&M manual: 01 78 23.
17. Manufacturer's Installation Certification Form 43 05 01-A.
18. Manufacturer's Instruction Certification Form 01 79 00-C.
19. Bill of Materials, including Form 01 78 45-A.
20. Spare Units, including Form 01 78 44-A.
21. Training Attendance Form 01 79 00-A.
22. Training Procedure Documentation Form 01 79 00-B.
23. Seismic anchorage design:
 - a. Seismic anchorage design shall be in accordance with the requirements of Section 01 73 00.
 - b. Unless noted otherwise, all equipment covered by this Section shall be assigned a Seismic Importance Factor, $I_p = 1.0$.
24. Structural design drawings and calculations of the access platforms, ladders, and railings.
25. Documentation verifying the pump fronthead (suction inlet) has been coordinated with the Formed Suction Inlet to allow direct connection of the Formed Suction Inlet to pump fronthead.
26. Discharge Pipe Connection Work Plan.
27. Details of provisions made by Contractor for County representatives to witness factory performance testing.

1.07 QUALITY ASSURANCE

- A. Unit Responsibility:
 1. Provide unit responsibility as specified in Section 43 05 01 for the variable speed solids handling end suction pump system with the required compatible components listed in Section 43 05 01.
 2. The variable speed solids handling end suction pump component of the unit responsibility system includes the equipment specified in this Section including the pump suction fitting, sole plate, pump base, motor support base, pump shaft and shaft sleeves, wear rings, shaft packing, shaft lantern rings, shaft throat bushing system, bearings, intermediate drive shaft and couplings, pump access ladders, grating and railings and other components integral to the pump design.
 3. Additionally, the Contractor shall assure the coordinated design of the pumping units with the manufacturers of the variable frequency drives and motors, such that all equipment is compatible and capable of achieving the performance requirements specified herein.
- B. Vibration and critical speeds:
 1. A computational analysis of equipment shall be completed by or at the direction of the pump manufacturer in accordance with the methodologies outlined in ANSI/HI 9.6.8 for Level 3 vibration analysis:
 - a. Pump rotordynamic and structural analysis shall demonstrate that the system will have no critical or resonant frequencies less than 125 percent of the pump speed required to meet the specified operating conditions.
 - b. The torsional analysis shall demonstrate that no critical speed produces a torsional stress exceeding 3,500 psi.
 2. Section 43 05 50.

1.08 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.

1.09 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.
- B. Electrical classification: As shown on Drawings.

- C. The pumps will be installed in a ventilated pumping station at approximately sea level.

1.10 WARRANTY

- A. The pump manufacturer shall guarantee in writing the units supplied to the County against defects in material and workmanship for a period of at least 1 year established per the Contract General Terms and Conditions and Section 01 78 36.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
1. Solids-Handling Pumps:
 - a. Flygt A-C Series WSY.
 - b. Flowserve (Worthington) Series MC.
 - c. Approved Equal.
 2. Intermediate Drive Shaft System:
 - a. Johnson Power Limited.
 - b. Approved Equal.
- B. All pumps specified in this Section shall be supplied by a single manufacturer.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. The Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Casing, backhead, and fronthead	Cast iron, ASTM A48, Class 30 with 2-3% nickel added or Ductile Iron, ASTM A395 Grade 60-40-18
Wear rings	Impeller ring: 410 stainless steel, ASTM A743 CA15, BHN 300-350; Casing ring: 420 stainless steel, ASTM A743 CA40, BHN410-484
Shaft sleeve	316L stainless steel, ASTM A743, grade CF3M
Impeller	Cast iron, ASTM A48, Class 30
Pump Shaft	Steel, ASTM A322, Grade 4140.
Intermediate Drive Shaft	Steel, ASTM A322, Grade 4140.
Bearing frame	Cast iron, ASTM A48, Class 30.
Shaft Seal Packing	Section 43 23 04 2.03 I.
Discharge spool	Section 40 05 01 Piping System 12
Access ladders, platform and railings	Galvanized steel per Section 05 50 00

2.03 EQUIPMENT FEATURES AND COMPONENTS

- A. Casing (Volute):
1. Flange per Section 43 05 01 on the casing discharge.
 2. The location of the pedestals for the casing support feet shall be located in a manner which shall permit proper orientation of the discharge nozzle as necessary to align with the discharge spool.
 3. Handhole with cover, 20 inch or larger on side of the pump discharge nozzle. The inner contours of the handhole cover shall match the contours of the waterway. The discharge nozzle shall be drilled and tapped for a 1/2 inch gage connection.

4. At least four lifting eyes.
 5. Integrally cast supports for access ladder, railing and platforms.
 6. Maximum dimensions to allow removal by bridge crane through overhead 13 foot by 13 foot clear opening.
 7. Maximum dimensions to maintain a minimum of 36 inches between adjacent pumps.
- B. Pump Fronthead (Suction Inlet):
1. Fronthead shall be a grooved coupling connection in accordance with Section 40 05 40 and 43 05 01.
 2. Fronthead shall be coordinated with and mount directly to the Formed Suction Inlet (FSI).
 3. Fronthead head dimensions shall be adjusted, as necessary, to vertically align the centerline of the pump discharge with the existing discharge piping centerline.
 4. Handhole with cover, 12- inch or larger in the fronthead. The inner contours of the handhole cover shall match the contours of the waterway.
 5. Provide four 1/2-inch diameter FNTF taps and screwed plugs for future air injection system piping, equally spaced around the circumference of the mid-section of the fronthead.
- C. Discharge Spool:
1. Configured with:
 - a. Flange at pump end to match pump casing flange in accordance with Section 40 05 40.
 - b. Grooved end coupling at end near wall to allow connection to existing discharge piping through wall of Pump Room.
 2. Designed to provide smooth transition from pump discharge to existing discharge piping.
 3. Discharge Piping Work Plan:
 - a. Include Discharge Piping Work Plan as part of Overall Operational Work Plan and Specific Operational Work Plans specified in Section 01 88 00.
 - b. Comply with the procedures and requirements of Section 01 88 00.
 - c. Provide details in the work plan for the following elements at minimum:
 - 1) Shop drawings for:
 - a) Discharge spool.
 - b) Connection to existing discharge piping in accordance with Section 40 05 24.
 - 2) Dimensions of existing discharge piping at wall and details of modifications to the existing discharge piping at wall as required to connect to discharge spool.
- D. Backhead and Bearing Frame:
1. Self-centering.
 2. Back pullout design to allow removal of the rotating assembly from the volute without disturbing the suction or discharge piping.
 3. Openings to permit adjustment of the seal.
 4. Stuffing box:
 - a. Integrally cast with the backhead and designed to accommodate either packing or mechanical seal without re-machining.
 - b. Sized for minimum of three rings of graphite-impregnated synthetic packing and specified shaft seal throat bushing system.
 - c. Drilled and tapped for seal flushing with a 1/2-inch NPT tap.
 - d. Packing glands shall be two-piece split interlocking, made of 316 stainless steel, held in place by 316 stainless steel studs and nuts.
 5. Backhead drain trough with minimum 1-inch diameter drain pipe connection to collect stuffing box leakage and route to drain.
- E. Impeller:
1. Enclosed single suction solids-handling impeller.
 2. Clearance to pass a minimum sphere size as specified.
 3. Dynamically balanced to ISO 1940 Grade G2.5.
 4. Keyed to the shaft.
 5. Impeller nut shall be set screwed to the shaft with 304 SS set screws.

- F. Pump Shaft:
1. Sized and proportioned suitably for use in variable speed pumping applications.
 2. Ample strength and stiffness to operate without distortion or damaging vibration throughout the range of service specified.
 3. Turned, ground, and polished
 4. The section of shaft fitting between radial and thrust bearings shall be suitably thickened to withstand bending loads at all speeds of operation and at all conditions of flow and head.
 5. Shaft deflection calculations:
 - a. Each shaft section of constant diameter shall be modeled as a beam with a fixed end at its nearest point to the bearing, and a free end nearest to the impeller centerline.
 - b. Superposition shall be used to accumulate deflections of shaft sections. Superposition shall use end displacement and orientation of subsequent shaft sections (i.e. the impeller end of a shaft section is parallel to tangent to the bearing end of the next shaft section).
 - c. Radial forces: HI 1.3. Forces shall be directed perpendicular to the shaft at the impeller centerline
 6. Sufficient cross sectional area to limit deflection at the stuffing box to less than 0.002 inches at any of the specified operating conditions.
 7. Fatigue: Conduct finite element analysis for the rotating assembly and provide calculations demonstrating no shaft stresses above 40 percent of the material tensile strength at any point along its length, including fillets radii and keyways, particularly the first radius just behind the impeller and the shaft sleeve shoulder. Provide a safety factor of 2:1 to account for areas of maximum combined stress.
- G. Shaft Sleeve:
1. Replaceable.
 2. Held to the shaft to prevent rotation.
 3. Sealed to prevent leakage between the shaft and the sleeve.
 4. Minimum shaft sleeve thickness shall be 3/8 inch.
- H. Wear Rings: For the impeller and the casing and attached by screwed fasteners.
- I. Shaft Seal:
1. Packing per Section 43 05 01:
 - a. Minimum three rings of graphite-impregnated synthetic packing with throat bushing.
 2. Throat bushing:
 - a. Split configuration.
 - b. Materials of construction: PTFE.
 - c. Acceptable manufacturer:
 - 1) SpiralTrac™ Version P by EnviroSeal Engineering Products Ltd.
 - 2) Approved Equal.
 3. Packing gland:
 - a. Two-piece split interlocking.
 - b. 316 stainless steel, held in place by 316 stainless steel studs and nuts.
- J. Bearings: Section 43 05 01 with the following superseding requirements:
1. The radial and thrust bearings shall be designed for the worst combination of loading developed for Operating Conditions A, B, or C for a bearing life (L-10) of 100,000 hours in accordance with ABMA 9 or 11.
 2. Radial loads shall be calculated in accordance with the provisions set forth in this Section.
 3. The bearing housing shall include a suitable mounting boss for a vibration sensor.
 4. The vibration sensing instrument shall be located as described by HI 9.6.4 and in accordance with Section 40 79 56.
 5. The bearing housing shall be fitted with 100 ohm platinum temperature detector (RTD) installed in a manner that is suitable for sensing bearing temperature and provides ready access for maintenance purposes- in accordance with Section 40 79 56.

K. Pump Base:

1. Provide steel base plate and feet cast on the casing rib structure, with sole plates. Provide machined mating surface between feet and sole plates. Mount sole plates on a concrete pedestals designed to permit access to the suction inlet and cleanout.
2. Designed to support the assembled weight of the pump and intermediate drive shaft system.
3. Anchor bolting shall be designed to withstand the unbalanced force developed by the pump at 200 percent of shutoff head at the maximum specified speed and in accordance with Section 43 05 01.
4. Pump mounting detail shall be in accordance with 43 05 63 and designed to coordinate with that shown on the Contract Structural Drawings, and with provided details regarding the concrete supports. Contractor is responsible for redesign of the concreted pump base, if necessary for the submitted pump.

L. Intermediate Drive Shaft System:

1. General:
 - a. Provide the intermediate shaft system as a single shaft with couplings and associated hardware.
 - b. Provide a steel drive shaft.
 - c. All components including coupling shall be dynamic balanced at the factory.
 - d. Dynamically balance the drive shafts to AGMA 9000 Class 9 balance criteria. Balancing procedures and certifications shall be furnished upon request.
2. Coupling:
 - a. The coupling on the drive shaft shall be a disc pack to connect the drive shaft to the motor and the pump.
 - b. Disc Pack:
 - 1) The disc pack selection shall consist of two stainless steel disc packs to connect the center tubular spacer assembly to the motor and pump.
 - 2) Insert a thrust button between the pump flange and disc pack spacer assembly to support the shaft weight.
3. Stub Flanges:
 - a. The stub flange connecting the intermediate drive shaft to disc pack shall be a compression fit metal flange or a bonded and riveted steel stub flange.
 - b. The stub flange shall provide a torsional strength that is higher than the strength of the intermediate drive shaft.
 - c. For metal stub flanges, a layer of E-glass reinforced fibers shall be placed between the end fittings stub and the tube inner surface to provide a galvanic corrosion protection.
 - d. The stub flanges shall have a precision-machined bolt pattern to mate with the flex element or the disk pack.
4. Safety Guards:
 - a. Galvanized for corrosion resistance.
 - b. Manufacture in rugged semi-circular sections, with steel bars to support rigidity and facilitate installation and removal.
 - c. Safety guards to extend three feet above the pump bearing frame.
5. Intermediate Drive Shaft System Performance:
 - a. The system shall be capable of withstanding the applied torque produced by the motor with a safety margin of no less than 2 over the expected motor peak torque covering the entire range of operating speed specified.
 - b. The drive shaft system shall accommodate angular misalignment of ½ degree per flex element or disc pack connection as a minimum, and provide a theoretical infinite fatigue life at rated torque, speed, and misalignment.
 - c. Design and construct to avoid harmonic vibrations throughout the operating speed range of the driven equipment. Conduct lateral and torsional critical analyses to demonstrate compliance with this requirement.
 - d. The drive shaft critical and torsional natural frequencies shall not be less than 120% of the pump and motor operating speed and shall not be within 80% to 120% of the pump vane-pass frequency.

M. Pump Access Ladder, Platform and Railing:

1. Platform, access ladder and railings: meets WISHA standards, WAC 296-24 and all subsections.

2. Access ladder: ship stairs meeting WISHA, WAC 296-24-740, and WAC 296-24-74025.
 - a. Locate access ladder and platform supports to avoid obstructing egress from the Pump Room.
 - b. Locate access ladder and platform supports to avoid obstructing portions of the pump or piping that require access for cleaning and maintenance.
3. Handrail, stair rail and guardrail: meets WISHA standards, WAC 296-24-74015, WAC 296-24-750.
4. Located on top of the volute casing to serve each pump and provide access completely around the shaft.
5. Supports for platform and railing shall be from integrally cast supports in the pump casing per this Section.
6. The access platform and any associated equipment, nonstructural elements, components, and elements permanently attached to any portion of these, shall be anchored and braced to resist seismic forces in accordance with Section 01 73 00.
7. Platform, railing and access ladder shall be designed to allow removal of back pullout assembly without removing platform frame, railing, or access ladder. It is acceptable to remove the platform grating during back pullout assembly removal.
8. Platform width, minimum: 24 inches.

2.04 MOTOR

A. Section 40 05 94.

B. Motor support:

1. Each motor shall be supported on the steel plate and framing as shown in the Contract Drawings. Framing layout shall be modified as needed to accommodate the actual locations of the attachment bolts. Anchorage of the motor to the plate and frame shall be designed by the Contractor and shall include the Dead, Operating, unbalanced forces and seismic loads required in Section 01 73 00 using a Seismic Importance Factor, $I_p = 1.0$.
2. Criteria established in this Section and Section 43 05 60 shall be used to calculate the dynamic response and resulting loads imposed by the rotating equipment on the supporting plate and framing. The motor/frame/support plate assembly shall be analyzed for the resulting Dead, Operating, Seismic and unbalanced forces resulting from rotation of the motor to determine the Factor of Safety against a resonant response to these loads. The finite element analysis model shall include the concrete beams and floor slabs between Gridlines D and E and Gridlines 2 and 8 with all motors and their supports included in the analysis model. The slabs and beams may be assumed to be fixed at the noted Gridlines. The modulus of elasticity of the concrete shall be assumed to be 80% of 4,000 psi concrete to allow for the effect of cracked section properties. The magnitude of the unbalanced forces shall be calculated in accordance with ISO 1940/1 Balance Quality Requirements of Rigid Rotors. Calculations and supporting data shall be provided. Vibration limits specified in Section 43 05 50 shall apply.

2.05 VARIABLE FREQUENCY DRIVE

A. Section 26 29 23.

2.06 ACCESSORIES

A. Special tools if required for equipment maintenance and repair.

2.07 SPARE UNITS

A. Section 01 78 44.

B. Provide the following components as a spare unit for each size and type of pump:

1. One back pull-out assembly as defined by ANSI / HI 14.1-14.2 .
2. Two portable reusable structural frames/cradles:
 - a. Adequate to support and safely store a complete pump back pull-out assembly vertically.
 - b. Allow for free rotation of pump impeller while stored in frame/cradle.

- c. Steel fabrication in accordance with Section 05 50 00.
- d. Floor supported and transportable by forklift with pump back pull-out assembly in place.
- e. One frame/cradle shall be used to store spare pump back pull-out assembly while second frame/cradle shall be used to support a back pull-out assembly during maintenance and disassembly of an in-place pump.

2.08 FINISHES

- A. Section 09 90 00.

2.09 SOURCE QUALITY CONTROL

A. Factory Tests:

- 1. Factory tests shall be conducted in accordance with ANSI/HI 14.6-2022 unless otherwise indicated herein.
- 2. Witnessing provisions:
 - a. County may elect to witness factory performance testing.
 - b. Provide the Project Representative with not less than 60 days advance written notice of the date and place of each factory performance test.
 - c. Payment and administration for County witnessing testing: Section 01 29 00.
 - d. Number of days per test and number of pumps tested per visit to be determined by the Manufacturer and Contractor. Provide for additional visits if additional testing is required due to a failure of the pumps to meet specified conditions.

B. Factory Hydrostatic Test:

- 1. Hydrostatic testing shall be conducted on each RSP.
- 2. Each RSP shall be tested to a pressure equal to or greater than 150% of the pump shutoff head and the pressure shall be maintained for 15 minutes with no visible signs of leakage.
- 3. A test report shall be provided.

C. Factory Performance Test:

- 1. Tests shall verify the full range of operating conditions.
- 2. Performance tests may be conducted using a reduced-scale geometrically similar model pump at a scale not smaller than one-third the full scale pump dimensions.
- 3. If a reduced-scale performance test is conducted, it shall be completed consistent with the guidance provided in Appendix K of ANSI/HI 14.6-2022.
- 4. Performance of pumps identical or geometrically similar to those tested may be certified to be in compliance with the factory test by an authorized representative of the pump manufacturer.
- 5. Pump hydraulic efficiency shall be determined based on the measured hydraulic efficiency during the factory test. No credit shall be taken for projection of improved efficiency in a full-scale pump based on efficiency values measured for the reduced scale equipment.
- 6. The pump performance test shall be completed using the same total dynamic head as the prototype pump.
- 7. Pump performance test shall be in accordance with Grade 1U as defined in ANSI/HI 14.6-2022.
- 8. At least ten (10) data points shall be measured to predict the pump's operating characteristics on the design head pump curve. Data collected at each point shall include speed, capacity, head, efficiency, and power.
- 9. NPSH Testing:
 - a. The NPSH3 value shall be determined for the operating point furthest to the right on the pump curve. This value should be determined using the Type II test method outlined in ANSI/HI 14.6-2022.
 - b. An NPSH3 curve shall be calculated and plotted on the certified pump curve for the entire AOR based on the NPSH3 data measured at the runout condition.

- D. Guaranteed performance: If equipment fails to meet the performance requirements specified herein, the County may, at the County's option and at no additional cost, require the equipment to be modified

or replaced with equipment that does meet the specified requirements. All changes necessary to meet the specified performance requirements shall be made at no cost to the County.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify all field conditions prior to installation.

3.02 INSTALLATION

- A. Install equipment in the locations shown and in accordance with the provisions of Section 43 05 60.
- B. Alignment: Section 43 05 61.
- C. Each pumping unit shall be aligned, connected, and installed in accordance with the Drawings and the manufacturer's recommendations.
- D. The offset, or misalignment, between motor output and pump input shafts shall not exceed manufacturer's recommendations or that limitation imposed by existing floor openings.
- E. Certified on Form 43 05 01-A per Section 01 33 10.

3.03 FIELD QUALITY CONTROL

- A. Field testing:
 - 1. Comply with requirements of Section 01 75 20.
 - 2. Vibration testing: Section 43 05 50.
 - 3. Perform field testing after installation of each pump to:
 - a. Demonstrate compliance with the specified performance requirements.
 - b. Verify factory performance test results.
 - c. Demonstrate that pump operates in accordance with the specified control strategy.
 - 4. Provide all materials and equipment necessary for testing of the pumps.
- B. Existing conditions and system configuration considerations:
 - 1. For informational purposes and for assessment by the Contractor in the development of Contractor field testing methods:
 - a. The County has measured existing RSP performance in the past using the following testing methods that uses the existing WPTP facility configuration and components of the WPTP beyond the limits of the Project:
 - 1) Developed Test Plan in coordination with WPTP operators to identify pump operating conditions to be tested, including the range of flows.
 - 2) WPTP operators evaluated the Test Plan and confirmed that sufficient volume could be stored in conveyance tunnels prior to testing.
 - 3) Met with WPTP operators prior to testing and discussed Testing Plan.
 - 4) Established communication protocol with WPTP operators and synced clocks with WPTP SCADA clocks.
 - 5) Began testing by operating single RSP to be tested in manual mode (other RSPs must be off).
 - 6) Operated RSP at full speed for sufficient amount of time after fixing the level of the effluent weir such that the level in the primary clarifier was stabilized.
 - 7) Provided tachometer for measurement of pump shaft rotating speed.
 - 8) Collected the following data simultaneously:
 - a) Time of data collection
 - b) Wet well level
 - c) Differential pressure between pump suction and discharge flanges

- d) Pump rotating speed
- e) Pump power
- f) Flow
- 9) Repeated each test at least 5 minutes apart to confirm consistent results.
- 10) Tested at 5 evenly spaced operating speeds from minimum to design full speed.
- 11) Plotted data on variable speed pump curve and established a system curve with data points.

3.04 MANUFACTURER SERVICES

- A. Provide a factory-trained representative at the site for the specified quantity and duration of the following activities. Durations do not include travel time to or from the project site.
 - 1. One Installation Inspection:
 - a. Assist, supervise, and inspect the Contractor's activities during installation.
 - b. Provide a minimum of 8 hours of installation inspection during installation of each pump.
 - c. Complete Form 43 05 01-A, Section 01 33 10.
 - 2. Test Phase Assistance:
 - a. Assist, supervise, and inspect the Contractor's activities during testing.
 - b. Provide a minimum of 12 hours.
 - 3. Training:
 - a. Procedures: Section 01 79 00.
 - b. Provide a minimum of 4 hours per training.
- B. Provide complete vibration diagnostic equipment and trained personnel to test shafting and systems components at start-up.

END OF SECTION

SECTION 43 23 06

RECESSED IMPELLER PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies recessed impeller pumps with motors and appurtenances for pumping raw sewage for sampling.
- B. The general requirements applicable to all mechanical equipment, as summarized in Section 43 05 01 are applicable to the equipment specified in this Section.

- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
RSP Sampler Feed Pump 1	704-P24AX011
RSP Sampler Feed Pump 2	704-P24AX021

- D. Provide 1 set of special tools to accommodate servicing of all pumps.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
Hydraulic Institute Standards	
ASTM A48	Specification for Gray Iron Castings
ASTM A108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A276	Specification for Stainless Steel Bars and Shapes
ASTM A532	Specification for Abrasion-Resistant Cast Irons

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Information required under Sections 43 05 01, 43 05 50, 43 05 51, and 40 65 03.
 - 2. Performance curves developed for the specific application. Performance curves shall show speed, capacity, pressure, and power for specified conditions.
 - 3. Drawings showing general dimensions and confirming the size of pumps, motors and drives, piping connections; and construction details of equipment, wiring diagrams, and weight of equipment.
 - 4. Mill certification confirming hardness of casing, suction piece, impeller, wear plate and shaft sleeve.
 - 5. Operation and maintenance information specified in Section 01 78 23.
 - 6. Bill of Materials, including Form 01 78 45-A.
 - 7. Spare Units, including Form 01 78 44-A.

1.04 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions: Section 01 17 00.

- B. Electrical classification: Section 26 05 00 and as shown on Environment Conditions and Materials Application (EC&MA) Table on Drawings. .

1.05 DESIGN REQUIREMENTS

- A. Pump performance and design parameters:
1. Design condition: 50 gpm, 27 feet TDH, 1320 rpm.
 2. Shutoff condition: 0 gpm, 28 feet TDH, 1320 rpm.
 3. Pump configuration: Horizontal.
 4. Maximum pump speed: 1750 rpm.
 5. Nameplate driver horsepower: 5 hp.
 6. Drive type: Variable speed.
 7. Drive configuration: Direct drive with flexible spacer type coupling.
 8. Minimum solids passage: 2 inches.
 9. Net positive suction head required (NPSHR): 8 feet at 50 gpm.
 10. Minimum suction diameter: 2 inches.
 11. Minimum discharge diameter: 2 inches.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Acceptable Manufacturers:
1. Wemco.
 2. Goulds.
 3. Hayward Gordon.
 4. Approved Equal.

2.02 MATERIALS

- A. Materials specified are acceptable for the application. Contractor may propose alternative materials, subject to review and approval or rejection by the County.
- B. Materials of construction:

Component	Material
Casing, suction piece, impeller, and wear plate	Cast iron, ASTM A48, Class 35
Frame	Cast iron, ASTM A48, Class 35
Shaft	Steel, ASTM A108, Grade 1141 or 4140
Shaft sleeve	Stainless steel, ASTM A276, Type 410, Brinell hardness of 350 min
Stuffing box	Cast iron, ASTM A48, Class 30

2.03 EQUIPMENT FEATURES

- A. General:
1. Single-piece design casing.
 2. Casing flanges: As specified in Section 43 05 01.
 3. Integral suction and discharge nozzles.
 4. Completely open from suction to discharge requiring no impeller face plates.
 5. Allow removal of impeller without disturbing piping.
- B. Stuffing box cover: Permits back pull-out without disturbing piping connections.

- C. Frame:
 - 1. Provide an opening in the frame to permit adjustment and removal of the seal.
 - 2. Drill and tap the stuffing box for seal flushing.
- D. Impeller:
 - 1. Mount completely out of flow path between inlet and outlet so that solids do not flow through impeller.
 - 2. Key to shaft and secure with impeller bolt locked against reverse rotation.
 - 3. Recessed type with semi-open design.
 - 4. Cut-type such that blade ends are surrounded by an integral rim.
 - 5. Statically and dynamically balance per HI standards.
- E. Shaft and sleeve: Fit each shaft or impeller hub that extends into the stuffing box with a replaceable sleeve.
- F. Shaft packing: As specified in Section 43 05 01.
- G. Bearings: Oil or grease-lubricated with an AFBMA L-10 100,000-hour life rating while operating at any point on the head-capacity curve.
- H. Motors:
 - 1. Shall meet the requirements specified in Section 40 05 93.
 - 2. Maximum motor horsepower and motor type: As specified
 - 3. For use with pumps having variable speed operation: Suitable for use with variable frequency drive units specified under Section 26 29 23.
 - 4. Compatibility: Provide letters of motor and variable speed driver unit compatibility shall be provided as specified in Section 26 29 23.
- I. Drive units:
 - 1. Direct drives with flexible coupling in accordance with Section 43 05 01.
 - 2. Mounting: Mount pumps and complete drive unit on a common 1-piece base provided in accordance with Section 43 05 62.
 - 3. Variable speed drives:
 - a. Pumps that require variable speed drives (VSDs) are noted in this Section..
 - b. Of adjustable frequency type as specified in Section 26 29 23.
- J. Base:
 - 1. Mount pump and motor unit on a common, 1-piece base provided with grout holes.
 - 2. Mount equipment in accordance with Section 43 05 62.

2.04 SOURCE QUALITY CONTROL

- A. Factory Testing
 - 1. Factory test 1 pump in each set of pumps with identical operating conditions for performance and hydrostatic pressure as specified in the Hydraulic Institute Standards..
 - 2. Performance of pumps identical to those tested may be certified to be in compliance with the factory test by an authorized representative of the pump manufacturer.
 - 3. Balance, critical speed, and vibration: Pumps shall meet the dynamic performance requirements specified in Section 43 05 50.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Align, connect and install each pump in strict accordance with the manufacturer's instructions.

3.02 FIELD TESTING

- A. Field testing shall be in accordance with Section 01 75 20.

END OF SECTION

SECTION 43 23 32

VERTICAL IN-LINE CIRCULATING PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies vertical in-line booster pumps and motors for heated water circulation to 225 degrees F.
- B. The general requirements applicable to all mechanical equipment, as summarized in Section 43 05 01 are applicable to the equipment specified in this Section.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Boiler 1 Main Circulator Pump	705-P19FC011
Boiler 2 Main Circulator Pump	705-P19FC021
Boiler 3 Main Circulator Pump	705-P19FC031
Boiler 4 Main Circulator Pump	705-P19FC061

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
HI	Hydraulic Institute Standards
NFPA 70	National Electrical Code
IBC	International Building Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Motor data as specified in Section 40 05 93.
- C. Certified copies of test logs and performance curves that satisfy operating requirements specified.
- D. Catalog data showing construction and materials.
- E. Operations and maintenance information in accordance with Section 01 78 23.

1.04 SYSTEM REQUIREMENTS

- A. See schedule on Contract Drawings.

1.05 OPERATING REQUIREMENTS

- A. Pumps shall be identified by the equipment number and designed for continuous duty under the following operating conditions:

1. Continuous duty at flow and head scheduled, system pressure not greater than 60 PSI.
2. Ambient indoor room temperature range 40 F to 95 F.
3. Boiler water, treated, no glycol, water temperature nominal 190 F maximum 225 F.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Bell & Gossett, E-80 series pumps.
- B. Armstrong.
- C. Approved equal, modified as necessary to provide the specified features and to meet specified operating requirements.

2.02 MATERIALS

- A. Cast iron - bronze fitted in accordance with Hydraulic Institute Standards.

2.03 EQUIPMENT FEATURES

- A. Description: Split coupled pump, vertical in-line mounting.
 1. Suction and discharge flanges.
 2. Base ring, ANSI flange to support pump.
 3. Inlet and outlet 1/4 inch gauge taps
 4. NEMA 12 enclosure.
 5. Power disconnect switch included standard.
 6. Impeller Stainless steel or Bronze fitted.
- B. Seals: Manufacturer's standard mechanical seal is acceptable.
- C. Motors: TEFC high efficiency as specified in Section 40 05 93.

PART 3 EXECUTION

3.01 TESTING

- A. Test pump systems in accordance with Section 23 05 93.

END OF SECTION

SECTION 44 05 11

NOISE REQUIREMENTS AND CONTROL LIMITS AND MEASUREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies allowable equipment noise levels and ambient measurement of those levels.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revisions of the embedded standard referenced herein. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
ASA S1.4	Sound Level Meters
AHRI 575	Method of Measuring Machine Sound within an Equipment Space
ASTM E1780	Standard Guide for Measuring Outdoor Sound Received from a Nearby Fixed Source
WAC 173-58	Sound Level Measurement Procedures

1.03 ALLOWABLE NOISE LEVELS

- A. Unless otherwise indicated, the maximum permissible noise levels for a complete piece of mechanical equipment located within or outside a structure shall not exceed 85 dBA at 3 feet. A complete piece of equipment includes the driver and driven equipment plus any intermediate couplings, gears, and auxiliaries.
- B. More detailed acoustical requirements for specific equipment may be found in the individual equipment specifications. If so, those requirements are in addition to the requirements in this Section. If those requirements conflict with the requirements in this Section, the more restrictive requirements take precedence.
- C. Noise levels at West Point Treatment Plant are conditioned under a project level permit approved by Seattle City Council on January 14, 1991. Under Condition #6, Noise Control, noise levels generated by operation of the plant shall comply with the City's noise ordinance and shall not exceed 55 dBA at the publicly accessible areas outside the plant footprint. Public accessibility is defined as the security wall at the perimeter berm and the Hidden Valley Trail and North Bluff Trail on the hillside. Condition #6d further states that "specific fixed identifiable" mechanical sounds shall not exceed 52 dBA at the ordinary high water level at adjacent beaches. All mechanical equipment installed as part of this project shall comply with these requirements.

1.04 NOISE LEVEL MEASUREMENTS

- A. Unless otherwise indicated, maximum permissible noise (sound pressure) levels are in decibels as read on a standard sound level meter.
- B. Make all measurements in relation to a reference pressure of 0.0002 microbar.
- C. Sound level meter shall be set on the "A" scale and to slow response.
- D. Make measurements of emitted noise levels on a sound level meter meeting at least the Type II requirements as set forth in the latest revision of ASA S1.4.

- E. Unless otherwise indicated, in the individual equipment section, make the points of measurement of sound level at the specified distance from any major surface along the entire perimeter and at mid-height of the piece of equipment or at the specified distance from an outer major surface encompassing the sound source including inlets or outlets and in accordance with the referenced standards in this Section.

1.05 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Certified noise test results for each piece of equipment or system.
 - 2. Noise survey results.

1.06 QUALITY ASSURANCE

- A. Certifications:
 - 1. Licensed and registered professional engineer in the state of Washington experienced in acoustical measurement (for field measurements).
 - 2. Noise Test:
 - a. Manufacturer shall certify the maximum noise levels emanating from the equipment, its operating conditions, the environment in which tested, a list of the acoustical instruments used, and the points at which the measurements were made.
 - b. The description shall be sufficiently detailed to permit the test to be repeated, and it shall include a sketch of the item being measured which shows the points of measurement and the point of maximum encountered noise level on the measurement line.
 - c. Submit three copies of certified test results to the Project Representative prior to shipment.

PART 2 PRODUCTS

2.01 FACTORY TESTS

- A. Certified Tests:
 - 1. Where indicated in the individual equipment specification section, provide for each piece of equipment prior to shipment to the job site, a certified factory noise test report on the actual equipment to be provided or an unconditional guarantee that the equipment, when operating under design conditions, will not produce noise exceeding the permissible levels specified.
 - 2. Noise levels in excess of that specified shall be cause for rejection of the equipment.
 - 3. Standard noise data is not acceptable.
- B. Conditions:
 - 1. Perform noise measurements at the factory.
 - 2. Unless otherwise indicated, perform the measurements in a reverberant or semi-reverberant condition, with equipment sitting on a hard reflective surface. Alternatively, permitted conditions are those that duplicate the circumstances under which the equipment will operate at this project.
 - 3. Make tests at 1/2, 3/4, and full load where applicable.
- C. Meeting the specification for any equipment is dependent upon satisfactory noise level performance after installation.

PART 3 EXECUTION

3.01 FIELD TESTS

- A. Field measure each piece of mechanical equipment in a project-wide noise survey.

- B. Employ a licensed and registered professional engineer in the state of Washington experienced in acoustical measurement to perform a field noise survey to measure the noise level of each piece of equipment or assembly that has specified noise generation or attenuation characteristics.
- C. Perform detailed measurements and tests at the noisiest operating point in the specified operating range to confirm compliance with specification requirements.
- D. Equipment:
 - 1. Make all measurements with only the equipment item or assembly in question operating, or adjusted for the contribution from background noise.
 - 2. Noise generated by the subject equipment item or assembly shall exceed the background noise level by at least 5 dB in the frequency range of interest during testing.
- E. Sound power levels:
 - 1. Where sound power levels are specified it shall be acceptable to measure sound power directly, such as by the acoustical intensity technique or substitution technique, or measure sound pressure levels and adjust the measurements for distance and local reverberant conditions.
 - 2. Document adjustments applied to sound pressure levels to derive sound.
- F. Results:
 - 1. Organize the test results in the same format as the specification requirements.
 - 2. The report shall identify the subject equipment item and compare the specification requirements, the manufacturer's certified submittal data, the levels acquired from the field test program, and any adjustments to the data.
- G. Field noise:
 - 1. In the event that the noise tests show levels in excess of the allowable limits, replace equipment or take appropriate field noise reduction measures to reduce the noise levels at the measurement location(s) to the allowable limits.
 - 2. All field noise reduction measures shall be approved by the Project Representative prior to execution.
 - 3. Employ any of the following methods:
 - a. Sound reduction enclosures.
 - b. Acoustical equipment mountings.
 - c. Acoustical wall or ceiling panels.
 - d. Acoustical insulation on the equipment.
 - 4. Clean acoustical materials by hosing down with water.
 - 5. Do not allow rated capacities, operation, and normal maintenance procedures of the equipment to be affected by the noise reduction measures.

END OF SECTION