

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 11 of 11

Technical Specifications
Grit Classifier Replacement Project
Division 02 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



**West Point Treatment Plant
Grit Classifier Replacement
Project**

Contract Number: KC001060

Volume 11: Grit Washer/Classifier
Technical Specifications

100% BID SET

January 2024

Prepared for:
King County Department of Natural
Resources and Parks Wastewater
Treatment Division

Prepared by:
Stantec Consulting Services, Inc.

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GRIT CLASSIFIER REPLACEMENT PROJECT
LICENSEE RESPONSIBLE FOR TECHNICAL SPECIFICATIONS

Technical Specifications prepared by or under the direction of the following registered persons:

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Divisions 02, 09, 10, 23, 40, 41, 43, and 46



01/11/2024

SIGNED AND SEALED ELECTRONICALLY 01/11/2024

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Divisions 03, 05, and 06



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Division 33 and 40



01/11/2024

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Divisions 26 and 28



01/11/2024

SECTION 02 21 00

SITE SURVEYS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies survey work requirements.

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
RCW 58.09	Surveys - Recording

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Qualifications of the surveyor.
 2. Survey field notes and all survey calculations.
 3. Record drawings stamped by a State of Washington licensed surveyor for the tunneled portions of the pipeline and per Section 01 78 39.
 4. Licensed surveys as required by the Project Representative.
 5. Daily record survey for sections.
 6. Record of survey recorded per RCW 58.09.

1.04 SURVEY BY KING COUNTY

- A. Control point(s) for vertical and horizontal control are indicated on the Drawings. Base all work on the Contract control points as listed on the Drawings.

1.05 SURVEY BY CONTRACTOR

- A. Using the Contract control point(s), develop and make such additional surveys as needed for construction, such as control lines, slope stakes, settlement markers, batter boards, stakes for pipe locations, and other working points, lines and elevations. Re-establish any benchmarks and survey control points destroyed.
- B. Complete the layout for the work and be responsible for all measurements that may be required for the execution of the work to the location and limits prescribed on the Drawings. Perform survey work under the supervision of a land surveyor licensed in the State of Washington.
- C. Check and restore monuments and their casings at completion of work per RCW 58.09.
- D. Maintain and preserve all stakes and other marks established until authorized by the Project Representative to remove them.
- E. The Project Representative may require that work be suspended at any time when location and limit marks established by the Contractor are not reasonably adequate to permit inspection of the work.

- F. Comply with the survey requirements for all monitoring as specified in other Sections.
- G. Provide new replacement monuments and boxes when removed or damaged during construction.
- H. Re-establish all permanent survey control monuments prior to final inspection per RCW 58.09.
- I. Provide correct line and grade of the pipelines to be installed.
- J. Maintain control for line and grade within the sections of the pipeline and furnish record survey for review on a daily basis.
- K. Provide preconstruction survey in the creek bottoms, above the alignment, within 15 feet of either side of the areas, and for the roadway effected by the work if not specified otherwise.
- L. Provide all requirements of the Record Documents per Section 01 78 39.

1.06 SURVEYOR QUALIFICATIONS

- A. Surveyor shall be a Professional Land Surveyor who is licensed in the State of Washington.
- B. The Project Representative reserves the right to disallow the person(s) selected by the Contractor for surveying. If in the Project Representative's opinion, the person is not qualified to do the work, select another surveyor and submit qualifications until a qualified person is approved.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Perform surveys based on control points as shown on the Drawings. Use surveys to establish base lines, line and grade hubs, stake elevations, and other reference and construction points.
- B. Replaced monuments shall be set by a licensed land surveyor, registered in the State of Washington.
- C. Offset reference stakes:
 - 1. Set at a minimum 50 feet intervals on tangents and 25 feet intervals on curves.
 - 2. Set additional points as required by the Project Representative.

3.02 FIELD NOTES

- A. Keep in standard bound survey field notebooks using a clear, orderly manner consistent with standard surveying practice. Include titles, numbering, and indexing.
- B. Keep a copy of all field notes including references to monuments and property corners. Submit if required by the Project Representative.
- C. Keep a copy of grade sheets completed prior to all permanent restoration paving.

END OF SECTION

SECTION 02 26 00

HAZARDOUS MATERIAL ASSESSMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section provides information pursuant to 29 CFR 1926.1101, WAC 296-62-077, WAC 296-65, WAC 296-155-176 and to all other applicable requirements concerning working on, working around and reporting on asbestos and lead containing materials.
- B. The information in this Section is based on the results of a good faith review of the Contract Work requirements and a site inspection of the proposed work areas to determine the presence of asbestos or lead containing materials. This review and inspection were performed by King County's AHERA Certified Building Inspector in strict accordance with 29 CFR 1926.1101, WAC 296-62-077, WAC 296-65, WAC 296-155-176, and with the accepted principles and protocol mandated by AHERA.
- C. The reports are of investigations of piping, painted surfaces, building and structural materials. The reports do apply to lead or asbestos which may be found in soils, vegetation or other environments.
- D. Notify all employees and subcontractors who are on site or perform work subject to this Section of the contents 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
AHERA	(Federal) Asbestos Hazard Emergency Response Act
29 CFR 1926.1101	Safety and Health Regulations for Construction: Asbestos
WAC 296-62-077	Occupational Health Standards: Asbestos, Tremolite, Anthrophyllite and Actinolite
WAC 296-65	WISHA Asbestos Standards
WAC 296-155-176	Safety Standards for Construction Work - Lead

1.03 ASBESTOS INSPECTION

- A. The County's Inspection has determined to the best of its ability that the proposed construction areas under this Contract and the materials therein, do not contain asbestos.

1.04 LEAD INSPECTION

- A. The County's Inspection has determined to the best of its ability that the proposed construction areas, under this Contract and the materials therein, do not contain lead.

1.05 CONTRACTOR'S RESPONSIBILITIES

- A. Should suspect material not identified in this Section be encountered, immediately suspend all work that could disturb said material and notify the Project Representative who will implement the proper action. Do not proceed with work that could disturb the material until authorized by the Project Representative, in writing, to do so.

- B. Take the necessary precautions for compliance with Local, State and Federal regulations.
- C. When regulated substances are present, submit an abatement and disposal plan for review and approval by the Project Representative.
- D. Comply with Section 01 35 29.
- E. Fully inform workers of the presence of hazardous materials.

1.06 COUNTY'S RESPONSIBILITIES

- A. Upon notification by the Contractor of the existence of suspect material not identified in this Section, the Project Representative will have said material inspected and analyzed for the presence of asbestos or lead, as required.
- B. If the results of the inspection and analysis confirm the presence of asbestos in the suspect material, the County will take the necessary actions for compliance with 29 CFR 1926.1101 and WAC 296-62-077. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work suspended can proceed.
- C. If the results of the inspection and analysis confirm the presence of lead in the suspect material, the County will take the necessary actions for compliance with WAC 296-155-176. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work under this Contract can proceed.
- D. If the results of the inspection and analysis confirm the presence of other dangerous, hazardous or regulated substances in the suspect material, the County will take the necessary actions for compliance with State and Federal regulations. After compliance is obtained, the Project Representative will notify the Contractor in writing so that work under this Contract can proceed.
- E. If the results of the inspection and analysis confirm that the suspect material is free of asbestos, lead, or other regulated substances, the Project Representative will notify the Contractor in writing so that work suspended can proceed.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 HEALTH AND SAFETY

- A. Comply with Section 01 35 29.

END OF SECTION

SECTION 02 41 00
DEMOLITION AND SALVAGE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies demolition, equipment salvage, cutting, and patching.
- B. For documentation requirement, refer to Section 01 74 19, Construction and Demolition Material Management; and Section 01 78 40, Assets Attribute Collection.

1.02 SUBMITTALS

- A. Procedure: 01 33 00.
- B. Provide the following submittals:
 - 1. Schedule of work planned, schedule to avoid interference with facility operations.
 - 2. Shop drawings for items to be repaired or replaced.

1.03 SALVAGE DISPOSITION, STORAGE AND HANDLING

- A. Salvage Equipment:
 - 1. Refer to Section 01 78 40 for the identification and documentation procedures for equipment identified for salvage. As designated in Section 01 78 40, equipment to be removed from the project shall be:
 - a. Delivered to the County's possession or
 - b. Removed by the Contractor for Contractor's possession and recycling.
 - c. Final disposition of the asset will be documented on form 01 78 40-A.
- B. Materials disposal:
 - 1. Unless otherwise identified, all materials removed from the project become the property of the Contractor and shall be recycled per Section 01 74 19.
- C. Delivery of Salvage Items to the County
 - 1. Remove items designated for removal and salvage or reuse as a unit.
 - 2. Clean, condition, tag, and protect from damage.
 - 3. Deliver to King County facility, 1400 Discovery Park Blvd, Seattle, WA , between the hours of 8:00 and 16:00, Mondays through Friday, except for County holidays.
- D. Recycled by Contractor:
 - 1. Removal and recycling of equipment and materials shall not occur until the Project Representative has been notified of this work.
 - 2. Refer to Specification 01 74 19 for coordination and documentation of recycled equipment and materials.
 - 3. Upon completion of review, promptly remove from site.
 - 4. Do not store or sell Contractor salvaged items or materials on site.

1.04 SALVAGED EQUIPMENT

- A. Salvage all Rosemount transmitters (PIT, TIT, FIT, etc), FCI insertion flow meters, Fisher control valves, and Yokogawa single loop controllers. There are no additional assets that are scheduled to be salvaged on this Project.

- B. During the first milestone demolition stage (removing two classifiers with common drain manifold), delay disposal of one cyclone, gearbox and motor from a single grit classifier unit and maintain for use as spare parts during construction. Temporarily store these three items in the Boiler Room and protect from damage. Contractor shall dispose the cyclone, gearbox and motor after all new classifiers are installed (after second milestone completion). Equipment without asset numbers or components of equipment with asset numbers are identified on the Drawings and listed below:

EQUIPMENT DESCRIPTION	LOCATION
Grit Classifier Gearbox	Grit Classifier Room
Grit Classifier Cyclone	Grit Classifier Room
Grit Classifier Motor	Grit Classifier Room

- C. Equipment with asset numbers: See Section 01 78 40-A for the list of equipment to be removed from the project and disposition of that equipment. Any changes or additions to this list shall be relayed to the Project Representative before removal. Final disposition column will be completed /verified by Contractor and form submitted to the Project Representative prior to Commissioning.

1.05 JOB CONDITIONS

- A. Protection:
1. Remove salvaged equipment in a manner that protects adjacent equipment and piping.
 2. If chipping of concrete is required, perform work in a manner that contains and exhausts concrete dust to a bag filter or other means of complete containment and capture.
 3. Repair or replace property that is damaged.
 4. Typical enclosure required for dust control shall be as shown on Drawings.
- B. Proper Approval:
1. Obtain approval of authorities having jurisdiction for work which affects existing exit ways, exit stairs, means of egress, or access to or exit from such areas.
 2. Review with and obtain approval of authorities for temporary construction which affects such areas.
 3. Special attention is directed to approvals by fire authorities.
- C. Special Requirements:
1. Clean as required and cut in pieces pressure vessels and closed containers which may have contained hazardous or contaminated materials. Disposal of equipment shall not occur until the Project Representative has approved.

1.06 VERIFICATION OF ASSET REMOVAL

- A. Document disposal or salvage of assets removed from the project by completing the Final Disposition column for removed assets in Form 01 78 40- A. The finalized form shall be submitted to the Project Representative prior to final acceptance.
- B. Document salvage of assets per Section 01 78 40.

1.07 VERIFICATION OF DEMOLITION MATERIALS

- A. Document salvage, reuse, disposal, and recycling of demolition materials per Section 01 74 19.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Notify the Project Representative prior to beginning salvage work so that the proper salvage items are identified and the condition of the salvage item and adjacent equipment, piping and structures can be documented. Refer to prepopulated form 01 78 40-A provided by Project Representative for assets to be removed. Notify the Project Representative if there are any changes to, additions to, or discrepancies in the list.

3.02 OPERATION PROCEDURES

- A. Start and complete work in order of precedence as established by approved schedule. The sequence of work may be adjusted with prior approval by the Project Representative, as long as the work does not infringe upon or violate the schedule.
- B. Execute work to protect County employees, County Representatives and the public from injury. Provide protection to persons and property. Conduct work to ensure minimum interference with roads, walks, entrances, exits, and other adjacent occupied facilities as approved by the Project Representative.
- C. Where temporary partitions are required in public areas, construct partitions of clean, painted, minimum 1/2-inch thick, plywood. In interior areas, adequately braced 1/4-inch pre-finished paneling may be used. Provide the following:
 - 1. Passageways where necessary to ensure safe passage of persons in or near areas of work.
 - 2. Substantial barricades and safety lights as required.
 - 3. Temporary dust proof partitions as necessary to prevent infiltration of dust into occupied areas or the atmosphere.
 - 4. Temporary weather protection as necessary to prevent damage to existing facilities and discomfort to persons in occupied areas.

3.03 CUTTING AND REMOVAL

- A. Neatly cut and remove materials and prepare openings to receive new work.
- B. Remove masonry or concrete in small sections.
- C. Provide shoring, bracing, and other supports to prevent movement, settlement, or collapse of remaining or adjacent wall areas, structure, or facilities. Arrange shoring, bracing, and supports to prevent overloading of structure.
- D. Take precautions necessary to prevent damage to existing remaining work or to adjacent facilities. Execute work using methods that will prevent interference with use of remaining and adjacent facilities by the County, utilities, or the public.
- E. Properly disconnect salvaged items to retain their full salvage value, remove from their foundations when applicable, and carefully store at location(s) specified.

3.04 MATCHING AND PATCHING

- A. Where items are removed from existing walls, ceilings, floors, or partitions to remain, repair wall, ceiling, floor, or partition disturbed by removal.
- B. Where walls, ceilings, floors, or partitions are removed, repair abutting walls, ceilings, or floors disturbed by removal.

- C. Where existing construction is cut or otherwise disturbed to permit installation of new work, match and patch existing disturbed construction.
- D. Use methods and materials identical in appearance and equal in quality to areas or surfaces being repaired.
- E. Remove areas, surfaces, or items which cannot be satisfactorily matched, patched and replaced as approved by the Project Representative.

3.05 CLEANUP

- A. Remove debris, rubbish and materials resulting from cutting, demolition or patching operations.
- B. Transport materials and legally recycle or dispose of offsite.

END OF SECTION

SECTION 03 30 01

CAST-IN-PLACE CONCRETE (SMALL JOBS)

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies cast-in-place reinforced concrete, including embedded material and formwork.
- B. The Contractor shall provide cast-in-place concrete, joints in concrete, reinforcement steel and appurtenant work, formwork, bracing, shoring, supports, and shall design and construct falsework, complete and in place, in accordance with the Contract Documents.

1.02 QUALITY CONTROL

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following document. 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
IBC	International Building Code
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 347	Guide to Formwork for Concrete
ASTM A185	Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete

- B. Testing
 1. Perform materials testing to demonstrate conformance with the specifications.
 2. Perform Quality Control per Section 01 15 00.
- C. Be responsible for controlling the quality of the materials and work.

- D. Obtain services of an independent testing laboratory to perform required tests to document compliance with the Contract requirements.
- E. Perform work of this section in accordance with the Referenced Standards.
- F. Be responsible for results of the cured concrete specified and placed per the requirements of this Section, and perform required repair and remediation to meet the Contract Documents.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Concrete-Mix Designs:
 - 1. Prior to beginning the Work, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete. The mix designs shall be checked by an independent testing laboratory acceptable to the Engineer. Costs related to such checking shall be the Contractor's responsibility.
 - 2. Trial batch test results or historic test data demonstrating compliance with ACI 301 for the required 28-day compressive strength(s).
- C. Reinforcing Steel Shop Drawings including bend diagrams, placing lists and detailed drawings.
- D. Concrete Placement Drawings.
- E. Delivery Tickets: Where ready-mix concrete is used, the CONTRACTOR shall furnish certified delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring, and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amounts of water in the aggregate, added at the batching plant, and the amount of water allowed to be added at the Site for the specific design mix. In addition, each certificate shall state the mix number, total yield in cubic yards, and the time of day to the nearest minute, corresponding to the time when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.
- F. Waterstops.
- G. Submit manufacturer's data on specified products showing compliance with requirements.
- H. Submit manufacturers' data on contractor selected products showing quality and suitability for the application. Contractor selected products are to be standards typically used in the industry for similar applications.
- I. On a project-wide basis, provide the following:
 - 1. Total cement used, in pounds
 - 2. Total cement substitutes used, in pounds

PART 2 PRODUCTS

2.01 REINFORCEMENT

- A. Comply with the following as minimums:
 - 1. Bars - ASTM A615, grade 60, unless otherwise shown, using deformed bars for Number 3 and larger.
 - 2. Welded Wire Fabric - ASTM A1064.
 - 3. Bending - ACI 318.

- B. Fabricate reinforcement to the required shapes and dimensions, within fabrication tolerances stated in the Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice.
- C. Do not use reinforcement having any of the following defects:
 - 1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances.
 - 2. Bends or kinks not indicated on the Drawings or required for this work.
 - 3. Bars with cross-section reduced due to excessive rust or other causes.

2.02 CONCRETE

- A. Minimum Requirements:
 - 1. Portland Cement: ASTM C150, Type II, low-alkali, or ASTM C595, Type IL Portland-Limestone Cement (Blended Hydraulic Cement).
 - 2. Aggregate, General:
 - a. ASTM C33 uniformly graded and clean.
 - b. Do not use aggregate known to cause excessive shrinkage.
 - 3. Aggregate, Coarse: crushed rock or washed gravel with maximum size between 3/4-inch and 1-inch.
 - 4. Aggregate, Fine: natural washed sand of hard and durable particles varying from fine to particles passing a 3/8-inch screen, of which at least 12 percent shall pass a 50-mesh screen.
 - 5. Water: clean and potable.
- B. Structural Concrete: unless otherwise specified, provide concrete meeting the following criteria for all applications.
 - 1. Minimum specified compressive strength at 28-days: 4000 psi.
 - 2. Minimum cementitious material content: 560 pounds per cubic yard
 - 3. Maximum water to cement ratio: 0.45
 - 4. Air-entraining admixture conforming to ASTM C260
 - 5. Air content: 6% maximum
 - 6. Water reducer conforming to ASTM C494
 - 7. Slump: 4" +/- 1"
- C. Structural Pea Gravel Concrete: use only where indicated.
 - 1. Minimum specified compressive strength at 28-days: 5000 psi.
 - 2. Minimum cementitious material content: 658 pounds per cubic yard
 - 3. Maximum coarse aggregate size: 3/8-inch
 - 4. Maximum water to cement ratio: 0.40
 - 5. High-range water reducer conforming to ASTM C494
 - 6. Slump: 7" +/- 2";

2.03 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation as selected by the Contractor.
- B. Form Ties:
 - 1. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form-tie fasteners having a circular cross-section shall not exceed 1-1/2 inches; and such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for walls shall include an integral waterstop.
 - 2. Acceptable Products:
 - a. MeadowBurke: ST-4 Hex Head Snaptide
 - b. Dayton Superior: A3 Snap-Ties
 - c. Approved Equal

C. Form Release Agent:

1. Material: Release agent shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of the concrete surfaces. A ready-to-use water-based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Release agent shall be environmentally safe and shall meet the requirements of the referenced standards.
2. Acceptable Products:
 - a. BASF: MBT Rheofinish 211.
 - b. Cresset Chemical Company: Crete-Lease 20-VOC or Crete-Lease 880-VOC.
 - c. US Mix Products Company: US SPEC Aqua Blue
 - d. Approved Equal

D. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.
2. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength than required for the concrete in which they are located. Where concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

E. Corners: Filleted, rigid plastic type; 3/4-inch x 3/4-inch size; maximum possible lengths

F. Epoxy Bonding Agent

1. Epoxy bonding agent shall be 2-component, 100% solids, moisture-tolerant, structural epoxy adhesive formulated for bonding fresh, plastic concrete to hardened concrete and steel.
2. Acceptable Products:
 - a. Sika: Sikadur-32 Hi-Mod LPL.
 - b. BASF/Master Builders: MasterEmaco ADH 326.
 - c. Approved Equal.

G. Evaporation Retardant

1. An evaporation retardant shall be used.
2. Acceptable Products:
 - a. BASF/Master Builders: MasterKure ER 50.
 - b. Euclid Chemical Company: Eucobar.
 - c. L & M Construction Chemicals, Inc.: E-CON.
 - d. Approved Equal.

H. Adhesive for post-installed reinforcement: in accordance with Section 05 05 19.

I. Preformed Hydrophilic Waterstop:

1. Hydrophilic (bentonite-free) waterstops shall be Hydro-Flex Waterstop as manufactured by Henry Co., or Earthshield Type 20, as manufactured by JP Specialties, or equal.
 2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.
 3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
 4. The waterstop shall be manufactured from butyl rubber with hydrophilic properties.
 5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.
 6. The minimum expansion ratio of modified chloroprene shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).
 7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.
- J. Fiber Reinforcing:
1. Fiber reinforcement shall be synthetic fiber reinforcement.
 - a. Material: 100-percent virgin homopolymer polypropylene-fibrillated fibers; containing no reprocessed olefin materials.
 - b. Conformance: ASTM C1116, Type III
 - c. Fire Classifications: UL Report File No. R8534-11; Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1
 - d. Fiber Length: one inch
 - e. Alkali Resistance: alkali-proof
 - f. Absorption: nil
 - g. Specific Gravity: 0.91
 - h. Melting Point: 324 degrees F (162 degrees C)
 2. Fiber reinforcing shall be batched at the plant at a rate of 1.5 pounds per cubic yard of concrete.
 3. Acceptable products:
 - a. Propex: Fibermesh 300
 - b. Approved Equal

PART 3 EXECUTION

3.01 EXISTING CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected meeting approval of the Project Representative.

3.02 EMBEDDED ITEMS

- A. Do not embed piping in structural concrete unless indicated on the drawings.
- B. Electrical Conduit:
 1. Locate to maintain maximum strength of the structure.
 2. Increase the thickness of the concrete if the outside diameter exceeds 30 percent of the thickness of the concrete. Obtain written approval of the Project Representative prior to increasing the thickness of the concrete.
 3. Electrical conduit to be embedded in concrete shall be rigid galvanized steel conduit. Aluminum conduit is prohibited for embedment in concrete.
- C. Set and secure bolts, inserts, and other required items in the precise locations needed so they are not displaced. Take photos to document locations of embedded items.
- D. Prior to concrete placement, assure the actual locations of embedded items are noted on the as-built set of drawings.

- E. Install post-installed reinforcing bars in accordance with the requirements on the Structural drawings and the adhesive manufacturer's recommendations.

3.03 FORMS

- A. Design, construction, maintenance, preparation, and removal of forms shall be in accordance with ACI 347 and the requirements herein.
- B. Design, erect, support, brace, and maintain formwork to safely support vertical and lateral loads, which will be applied until such loads can be supported safely by the concrete structure.
- C. Construct forms to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, grades, and level and plumb work in the finished structure.

3.04 MIXING CONCRETE

- A. On Site Mixing of the concrete shall be in accordance with provisions of ACI 301. Mix in drum type batch mixer, complying with ASTM C685.
- B. Transit Mixers: Concrete mixing shall be in accordance with ACI 301. Ready mix concrete shall conform to ASTM C94.
- C. Do not use concrete that has stood for over 30 minutes after leaving the batch plant, or concrete that is not placed within 90 minutes after water is first introduced into the mix.
- D. Do not add additional water to the concrete mix after it has left the batch plant unless prior approval is obtained from the Project Representative.

3.05 PLACING CONCRETE

- A. Preparation:
 - 1. Joint surfaces shall be cleaned of laitance, loose or defective concrete, and foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting. Pools of water shall be removed from the surface of construction joints and concrete surfaces before applying the epoxy bonding agent.
 - 2. Embedded Items:
 - a. No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the Project Representative at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.
 - b. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated or by Shop Drawings and shall be acceptable to the Project Representative before any concrete is placed. Accuracy of placement is the responsibility of the Contractor.
 - c. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.
 - 3. Remove foreign matter accumulated in the forms.
 - 4. Rigidly close openings left in the formwork.
 - 5. Wet wood forms sufficiently to tighten up cracks; wet other material sufficiently to maintain workability of the concrete.
 - 6. Use only clean tools.

- B. Epoxy Bonding Agent:
 - 1. Epoxy bonding agent shall be applied on all hardened concrete surfaces to be covered with fresh concrete.
 - 2. Prepare concrete surfaces in accordance with the manufacturer's written recommendations.
 - 3. Epoxy bonding agent shall not be applied to concrete reinforcement.
- C. Conveying:
 - 1. Perform concrete placing at such a rate that concrete, which is being integrated with fresh concrete is still plastic.
 - 2. Deposit concrete as nearly as practicable in its final location so as to avoid separation due to re-handling and flowing.
 - 3. Do not use concrete, which becomes non-plastic and unworkable, or does not meet required quality control limits, or has been contaminated by foreign materials.
 - 4. Remove concrete from the work site that does not meet specifications.
- D. Placing Concrete In Forms:
 - 1. Deposit concrete in horizontal layers not deeper than 24 inches; avoid inclined construction joints.
 - 2. Remove temporary spreaders in forms when concrete has reached the elevation of the spreaders.
- E. Placing Concrete Slabs:
 - 1. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
 - 2. Bring slab surfaces to the correct level with a straightedge, and then strike off.
 - 3. Use bullfloats or darbies to smooth the surface, leaving the surface free from bumps and hollows.
 - 4. Do not sprinkle water on the plastic surface.
 - 5. Do not disturb the slab surface prior to start of finishing operations.
- F. Place all concrete in accordance with ACI 301.
- G. Construction tolerances: in accordance with ACI 117.

3.06 CONSOLIDATION

- A. Consolidate each layer of concrete while placing by use of internal concrete vibrators and supplemented by hand spading, rodding, or tamping.
- B. Do not vibrate forms or reinforcement.
- C. Do not use vibrators to transport concrete inside the forms.

3.07 JOINTS

- A. Construction Joints:
 - 1. Unless shown otherwise, do not use horizontal construction joints.
 - 2. If construction joints are found to be required, submit for the Project Representative's approval of joint design and location prior to start of concrete placement.
 - 3. Extend all reinforcing continuous through construction joints or provide dowels with proper lap lengths at construction joints, unless indicated otherwise on the Drawings.
- B. Expansion Joints:
 - 1. Do not permit reinforcement or other embedded metal items that are being bonded with concrete (except dowels in floors bonded on only one side of the joints) to extend continuously through any expansion joint.
 - 2. Fill expansion joints full depth with expansion joint material.

3.08 CONCRETE FINISHING

A. General

1. Concrete surfaces shall be free from surface defects and shall present a finished, smooth, continuous hard surface. Surface defects are defined as fins, bulges, ridges, offsets, honeycombing, roughness of any kind, and surface holes larger than 1/2 inch in diameter or deeper than 1/4 inch.
2. Aluminum finishing tools shall not be used.

B. Formed Surfaces:

1. No treatment shall be required after form removal except for curing, repair of defective concrete, treatment of surface defects, and where indicated, installation of the fully-adhered plastic lining system.

C. Unformed Surfaces:

1. After proper and adequate vibration and tamping, unformed top surfaces of slabs, beams, walls, weirs, and curbs shall be brought to a uniform surface with suitable tools.
2. Immediately after the concrete has been screeded it shall be treated with a liquid evaporation retardant, and the retardant shall be used again after each operation as necessary to prevent drying shrinkage cracks.
3. After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats.
4. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted.
5. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture.
6. Surface irregularities shall not exceed 1/4 inch.
7. Joints shall be finished smooth and continuous with the adjacent concrete. Free edges shall be tooled to provide a 1/2 inch radiused surface.
8. After the surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks.
9. The finish shall be smooth and free of irregularities.
10. At access hatch walls, trowel the surface to remove local depressions or high points. Provide a light broom finish to provide a non-slip surface.

3.09 CURING AND PROTECTION

- A. Comply with requirements of ACI 301. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 1. Structural concrete: Not less than 7 days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
 1. Start initial curing as soon as free water has disappeared and before surface is dry. Keep continuously moist for specified curing period by water ponding, water-saturated sand, water-fog spray, saturated burlap, or special blankets designed for curing concrete and maintaining moist condition.
 2. Begin final curing after initial curing but before surface is dry.

- E. After completion of curing process, finished surface where indicated shall be protected by use of protection boards from workman, equipment, scaffolding, and any other form of damage throughout subsequent construction. Size, thickness, and material of board shall be determined by Contractor. Contractor is responsible for maintaining integrity of slab finish throughout construction.

3.10 FIELD QUALITY CONTROL

- A. Be responsible for Quality Control of Work for materials, placement, curing, and finishing.
- B. Perform tests of concrete and concrete materials to ensure conformance with specified requirements per ACI 301, ACI 318 and the Seattle Building Code. County may perform spot checks. County testing does not relieve the Contractor for quality control and documentation of its Work.
- C. Compressive Strength Tests: ASTM C39. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 50 cu yd or less of concrete placed per day.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies non shrink grout and epoxy grout for use in applications including but not limited to grouts for leveling machine bases to equipment pads, and grouting under base plates. Epoxy adhesives for concrete applications including but not limited to pressure injection of cracks.
- B. Grouts and adhesives for post-installed anchor bolts, anchor rods and reinforcing bar dowels shall be in accordance with Section 05 05 19.

1.02 REFERENCED STANDARDS

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 C33	Concrete Aggregates
ASTM C40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C117	Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing
ASTM C136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150	Portland Cement
ASTM C289	Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C494	Chemical Admixtures for Concrete
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C1017	Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
ASTM D2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
CRD-C-621	Corps of Engineers Specification for Non-shrink Grout

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Manufacturer's Data for the following:
 - 1. Non-shrink cementitious grout.
 - 2. Epoxy grout.
 - 3. Admixtures for cement grout.
 - 4. Adhesive for pressure injection of cracks.
 - 5. Retardants.
 - 6. Bonding compounds.

- C. Certified Test Reports: Before delivery of materials or grout, submit certified reports of the tests specified herein. Accompany the certified reports on previously tested materials with the manufacturer's certified statement that the previously tested material is of the same type, quality, manufacture, and make as that proposed for use in this Contract. Certified test reports are required for all cement grout constituents, including cement and aggregates.
- D. On a project-wide basis, provide the following:
 - 1. Total cement used, in pounds
 - 2. Total cement substitutes used, in pounds

PART 2 PRODUCTS

2.01 GENERAL

- A. Grout mixes and admixtures shall not contain more than 0.05 percent chloride ions.
- B. Water for washing aggregate, for mixing, and for curing:
 - 1. Shall be free from oil and deleterious amounts of acids, alkalis, and organic materials
 - 2. Shall not contain more than 1,000 mg/L of chlorides as Cl, nor more than 1,300 mg/L of sulfates as SO₄.
 - 3. Shall not contain an amount of impurities that may cause a change of more than 25 percent in the setting time of the cement nor a reduction of more than 5 percent in the compressive strength of the grout at 14 days when compared with the result obtained with distilled water.
 - 4. Water used for curing shall not contain an amount of impurities sufficient to discolor the grout.

2.02 GROUT

- A. Use grout specified on the contract Drawings or as specified in the equipment recommendations.
- B. Non-shrink cementitious grout:
 - 1. Cementitious grout that conforms to ASTM C1107, CRD-C-621, "Corps of Engineers Specification for Non-Shrink Grout", and the following requirements:
 - a. Non-metallic aggregate.
 - b. Minimum 28-day compressive strength of 5000 psi when mixed at a fluid consistency and tested per ASTM C109.
 - c. Acceptable manufacturers:
 - 1) US SPEC
 - 2) BASF
 - 3) Five Star Products, Inc.
 - 4) Approved Equal.
- C. Epoxy Grout:
 - 1. Multi-component, 100 percent solids compound conforming to the following requirements:
 - a. Suitable for use on dry or damp surfaces.
 - b. Comply with ASTM C881.
 - c. Acceptable manufacturer:
 - 1) Euclid Chemical Co.
 - 2) Sika Corp.
 - 3) BASF
 - 4) Approved Equal.
- D. Cement grout:
 - 1. A mixture of one part Portland cement, 1 to 2 parts fine aggregate, and with sufficient water to impart workability but not such that the grout will flow.
 - a. Cement shall be Portland cement, ASTM C150 Type II or Type V, and shall be low alkali cement, containing less than 0.60 percent alkalis.
 - b. Fine aggregate shall conform to ASTM C33 and to the following requirements:

- 1) Non-reactive and washed before use.
- 2) When sources of aggregate are changed, provide test reports for the new material. Perform the tests specified prior to commencing grout work.
- 3) Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine.
- 4) When tested in accordance with ASTM C136, gradation of fine aggregate shall be such that 100 percent by weight will pass a standard No. 8 mesh sieve and no less than 45 percent by weight will pass a standard No. 40 mesh sieve.
- 5) Variation from the specified gradations in individual tests of fine aggregates will be accepted if the average of 3 consecutive tests is within the specified limits and the variation is within the permissible variation listed below.
- 6) Comply with ASTM C33 as modified herein.

U.S. Standard Sieve Size	Permissible Variation, Percent
30 or coarser	2
50 or finer	0.5

- 7) Other tests shall be in accordance with the following specifications:

Test Method	Test	Requirements
ASTM C40	Organic Impurities	Color lighter than standard
ASTM C117	Passing 200 sieve	3 percent max.
ASTM C88	Soundness	10 percentage max loss with sodium sulfate
ASTM C289	Reactivity	Innocuous aggregate
ASTM D2419	Sand Equivalent	Minimum 80

E. Epoxy Admixtures:

1. Admixtures shall be compatible with the grout and shall conform to the following requirements:
 - a. Calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.
 - b. Use admixtures in accordance with the manufacturer's recommendations and add separately to the grout mix.
 - c. Chemical admixtures for flowing concrete grout shall comply with ASTM C1017.
 - d. Water reducing, retarding admixture:
 - 1) The admixture shall comply with ASTM C494 Type D requirements and not contain more chloride ions than are present in municipal drinking water.
 - 2) Acceptable manufacturers:
 - a) Euclid Chemical Co.
 - b) BASF
 - c) Sika Corp.
 - d) Approved Equal.

2.03 ADHESIVES

A. Adhesive for pressure injection of cracks in concrete:

1. A two-component, moisture tolerant, low viscosity, liquid epoxy adhesive conforming to ASTM C881 for load-bearing applications.
2. Acceptable manufacturers:
 - a. BASF
 - b. Sika Corp.
 - c. Euclid Chemical Co.
 - d. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Mix, place and cure in accordance with the manufacturer's instructions.
- B. For grouting of base plates, refer to manufacturer's instructions for appropriate procedures.

3.02 EXAMINATION

- A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and all loose material or foreign matter likely to affect the bond or performance of grout or mortar.
- B. Inspect base plates for rust, oil, and other deleterious substances that may affect the bond or performance of grout.
- C. Confirm that newly placed concrete has been cured sufficiently to attain its design strength and limit further shrinkage.
- D. Verify that temperature of cementitious or epoxy grout does not exceed manufacturer's recommendations.

3.03 PREPARATION

- A. Surface Preparation:
 - 1. Roughen all concrete surfaces by heavy sandblasting, chipping, or other mechanical means to assure bond. Loose or broken concrete shall be removed.
 - 2. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials that may affect bond that were identified in the inspection process shall be completely removed from concrete and bottoms of base plates. All metal surfaces should have a 2 to 3 mil peak-to-valley profile for epoxy grouts.
 - 3. For cementitious mortars and grouts, concrete shall be saturated surface damp. Any standing water shall be removed prior to placing grouts.
 - 4. For epoxy grouts, do not wet concrete surfaces with water. Instead, where required, wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grouts.
- B. Forms and Headboxes for Cementitious or Epoxy Grouts:
 - 1. Forms for grouts shall be built of material with adequate strength to withstand the placement of grouts.
 - 2. Forms must be rigid and liquid tight. All cracks and joints shall be caulked with an elastomeric sealant. All forms shall be lined with polyethylene for easy grout release. Forms carefully waxed with two coats of heavy-duty paste wax shall also be acceptable.
 - 3. Forms shall be 4 to 6 inches higher than the base plate on one side of the base plate configuration when using head pressure for placement.
 - 4. A sufficient number of headboxes shall be built to facilitate placement of grouts.
 - 5. Air relief holes a minimum 1/8 inch in diameter shall be provided when required by a base plate configuration to avoid entrapping air underneath.

3.04 NON-SHRINK CEMENTITIOUS GROUT

- A. Prepare concrete surfaces in accordance with the grout manufacturer's instructions.
- B. Do not retemper grout by adding more water after stiffening.

3.05 EPOXY GROUT

- A. Prime concrete in accordance with the grout manufacturer's instructions.
- B. Epoxy grouts shall be mixed in complete units. Do not vary the ratio of components or add solvent to change the consistency of the mix.
- C. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in the mix.

3.06 PRESSURE INJECTION OF CRACKS

- A. Design system to permit injection of adhesive resin at pressures up to 50 psi.
- B. Injection Equipment
 - 1. Include a mixer and holdover agitator tanks.
 - 2. Provide gages to indicate pressure used.
 - 3. Provide a meter capable of indicating the volume of grout used to 1/10 of a cubic foot.

3.07 CURING

- A. Cementitious Grouts:
 - 1. Clean equipment and tools as recommended by the grout manufacturer.
 - 2. Cure Grouts in accordance with manufacturer's specifications and recommendations. Keep grout moist for a minimum of 3 days. The method needed to protect grouts will depend on temperature, humidity, and wind. Wet burlap, a soaker hose, sun shading, ponding, and, in extreme conditions, a combination of methods shall be employed.
 - 3. Grouts shall be maintained above 40 degrees Fahrenheit until they have attained a compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for a minimum of 24 hours to avoid damage from subsequent freezing.
- B. Epoxy Grouts:
 - 1. Cure grouts in accordance with manufacturers' specifications and recommendations. Do not wet cure epoxy grouts.
 - 2. Consult the manufacturer for appropriate cure schedule. In no case should any surface in contact with epoxy grout be allowed to fall below 50 degrees Fahrenheit for a minimum of 48 hours after placement.

3.08 TESTING

- A. To ensure compliance with the specified requirements for grout, provide the services of an independent testing laboratory that complies with the requirements of ASTM E329, ASTM C109, and ASTM C579, Method B. See Section 01 15 00.
- B. The testing laboratory will sample and test grout materials and submit results to the Project Representative.
- C. During the course of construction, the Project Representative may take separate field samples of the following materials for confirming tests:
 - 1. Cement.
 - 2. Aggregates.
 - 3. Cement grout mixture.
 - 4. Commercially manufactured grout products.

END OF SECTION

SECTION 03 83 00

CONCRETE CUTTING AND PATCHING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the requirements and limitations for cutting and patching of work, including but not limited to the following:
1. Saw-cutting of new rectangular openings in existing concrete slabs and walls.
 2. Core drilling of new circular openings in existing concrete slabs and walls.
 3. Chipping of existing concrete to provide for construction of new concrete and/or placement of new patching material for building up or resurfacing of existing concrete.
 4. Saw-cutting and chipping of existing topping slab concrete to provide for construction of new structural concrete equipment pads and for repair of surface defects.
 5. Providing support for the cored and/or sawcut concrete, and removal and disposal of the cored and/or sawed concrete, control of drilling water and cleaning all slurry and debris that results from the operations.
 6. Cutting of existing reinforcing bars and/or anchors and patching over locations where bars have been cut.
 7. Preparation of concrete surface to receive new patching material and installation of new patching material.

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
ACI 117	Specification for Tolerances for Concrete Construction and Materials
International Concrete Repair Institute (ICRI)	110.1 - Guide Specifications for Structural Concrete Repair

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Submit written request in advance of cutting or altering elements which affects the following:
1. Structural integrity of the element.
 2. Integrity of weather exposed or moisture-resistant elements.
 3. Visual qualities of elements exposed to sight.
 4. Operations of the facility.
- C. Cutting and Patching Proposal: Submit a proposal describing procedures at least 2 weeks before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
1. Extent: At each occurrence indicated on the Drawings, describe cutting and patching, show how they will be performed, and indicate what construction equipment will be employed to complete the work, and equipment to be used to locate embedded reinforcing bars, pipe, and conduits.
 2. Products: List products to be used and firms or entities that will perform the Work.
 3. Dates: Indicate when cutting and patching will be performed.

4. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
5. Method to control drilling water and spoils.
6. Method to support and remove concrete cores and saw-cut debris.
7. Project Representative's Review: Obtain review of cutting and patching proposal before cutting and patching.

1.04 QUALITY ASSURANCE

- A. Qualifications: Employ skilled and experienced installer to perform cutting and patching work. Contractor performing cutting and patching work shall have at least 3 years prior experience performing similar work.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Acceptable repair mortar products for patching and/or resurfacing of damaged surface areas on existing concrete and/or defective and non-conforming work:
 1. SikaTop-122 Plus polymer modified cementitious trowel-grade mortar as manufactured by Sika Corporation.
 2. Eurocrete microsilica modified repair mortar as manufactured by The Euclid Chemical Company.
 3. Approved Equal.
- B. Acceptable products for reinforcement corrosion protection and bonding primer:
 1. Sika Armatec-100 EpoCem as manufactured by Sika Corporation.
 2. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Execute cutting, chipping, fitting, and patching to complete the work and to:
 1. Fit several parts together, to integrate with other work.
 2. Provide openings in elements of work for penetrations of mechanical and electrical work.
 3. Restore existing surfaces exposed by removal of work.
 4. Uncover work to install or replace ill-timed work.
 5. Remove concrete sections identified to be demolished.
 6. Remove and replace defective and non-conforming work.
- B. Execute work by methods which will avoid damage to other work and provide proper surfaces to receive patching and finishing. Inspect all cut surfaces to ensure that no electrical conduits or other piping (air, water, etc.) has been cut during the cutting operation. Report any issues to the Project Representative immediately. For patching of existing concrete surfaces, comply with applicable recommendations of patching material manufacturer and ICRI Guide Specifications for Structural Concrete Repair, including preparation and roughening of the surface to receive the new material, and curing of the new material after it has been placed. As a minimum, conform to tolerances listed in ACI 117.
- C. Cut rigid materials using masonry saw or core drill. When cutting rectangular openings in concrete slabs and walls, use method that will not overcut the opening dimensions at the corners of the opening. Acceptable methods may include the following:
 1. Cut the opening with a concrete chain saw and avoid any overcut at the corners.
 2. Prior to cutting the opening, core drill each corner and sawcut only up to the cored opening and chip the remaining concrete at each corner.

- D. Restore work with new products in accordance with requirements of Contract Documents.
- E. Fit work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces. Integrity of wall, ceiling, or floor construction: completely seal voids.
- F. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to the nearest intersection; for an assembly, refinish the entire unit.
- G. Water, slurry and debris from the core drilling and saw-cutting shall not be permitted to flow away from the immediate area of the work.
- H. Cut cores and sawed concrete sections shall be supported on scaffolding or similar means of support placed beneath the work. The cut sections shall not be permitted to drop free.
- I. The concrete cores and debris shall be removed and disposed of offsite without damage to existing facilities.
- J. The concrete slurry and debris shall be removed and disposed of offsite without damage to existing structures, paving, utilities, plantings or other improvements at the site.

3.02 NEW OPENINGS IN EXISTING CONCRETE SLABS AND WALLS

- A. New rectangular openings in existing concrete slabs and walls shall be cut using the following procedure or a similar procedure proposed by the Contractor that will avoid overcutting at the corners of the opening:
 - 1. Prior to sawcutting the opening in the slab or wall, a round hole shall be core-drilled at each corner of the rectangle to create a stopping point for the sawcut. The core-drilled hole shall be of sufficient diameter to allow the concrete saw to cut the slab or wall to the hole without having the saw blade extend beyond the hole. The limits of the hole shall not extend beyond the opening. (Do not center the hole at the corner of the opening.)
 - 2. The sides of the opening shall be sawcut from hole to hole at all four sides of the rectangle, using care to stop the cut at the core-drilled hole so as to not overcut at the corners of the opening.
 - 3. After removing the concrete that was cut in (ii) above, the remaining concrete at the corners of the rectangular opening shall be removed by chipping hammer to create the 90-degree corners required to complete the opening.
- B. New circular openings in existing concrete slabs and walls shall be cut using standard core-drilling methods unless approved otherwise.

3.03 REMOVAL OF EXISTING CONCRETE TOPPING SLABS

- A. Existing concrete topping slab sections shall be done using the following procedure or a similar procedure proposed by the Contractor that will avoid overcutting at the corners of the removal limits and which shall avoid cutting into, drilling into, or otherwise damaging the structural concrete slab below the topping slab:
 - 1. Prior to sawcutting the perimeter of the topping slab section to be removed, a round hole shall be core-drilled at each corner to create a stopping point for the sawcut. The core-drilled hole shall be of sufficient diameter to allow the concrete saw to cut the slab or wall to the hole without having the saw blade extend beyond the hole. The limits of the hole shall not extend beyond the opening. (Do not center the hole at the corner of the opening.) The hole shall not extend into the structural slab below the topping slab.
 - 2. The sides of the opening shall be sawcut from hole to hole along all sides of the section to be removed, using care to stop the cut at the core-drilled hole so as to not overcut at the corners of the opening.

3. Within the limits of the topping slab section to be removed, additional sawcuts are permitted to produce smaller sections of concrete for removal. Sawcuts shall not extend beyond the perimeter of the topping slab section to be removed.
4. After sawcutting, the topping slab shall be broken up and removed in a manner that does not damage the structural slab below nor the topping slab regions to remain.
5. Grinding or other approved methods shall be used to remove topping slab concrete that is bonded to the structural slab.
6. After removing the concrete topping slab as indicated above, the remaining concrete at the corners of the opening in the topping slab shall be removed by chipping hammer to create the 90-degree corners required to complete the opening.

3.04 CUTTING OF EXISTING REINFORCING BARS

- A. Existing reinforcing bars that become exposed due to demolition and/or removal of portions of existing concrete shall be treated as follows depending on the applicable condition:
 1. Reinforcing bars designated to be saved and protected and incorporated into new concrete pours shall be protected from damage as much as practical. Bars shall not be field bent from their existing configuration in order to facilitate concrete removal unless approved by the Project Representative or noted on the design drawings.
 2. Projecting reinforcing bars that are not to be incorporated into new concrete pours shall be cut off one and one-half inches below the concrete surface and the hole patched with epoxy grout.
 3. Reinforcing bars that are cut through by saw-cutting operations and are flush with the cut surface of the concrete shall have the cut ends coated with two coats of an approved reinforcement corrosion protection epoxy resin except for the following condition. If the cut ends of the bars will not be covered by at least 2 inches of concrete, then the bars shall be cut or ground down one and one-half inches below the finished concrete surface and the hole filled with epoxy grout.

3.05 EXISTING ANCHOR BOLTS OR ANCHOR RODS

- A. Existing anchor bolts or anchor rods projecting from the finished face of concrete due to removal of existing equipment or other installations and no longer needed shall be cut off one and one-half inches below the finished face of concrete and the hole filled with epoxy grout.

END OF SECTION

SECTION 05 05 19

POST-INSTALLED CONCRETE ANCHORS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies post-installed anchorage to concrete, complete with washers and nuts, and adhesives for post-installed reinforcing bars.
- B. Post-installed concrete anchorage systems required to secure the various parts together and provide a complete installation are generally indicated on the Drawings. Where the anchorage design is absent, or insufficiently detailed to complete the installation, provide the anchorage design and submit for approval.
- C. The tabulation of items herein is not intended to be all inclusive, and it shall be the Contractor's responsibility to provide all metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.
- D. Metal components of post-installed concrete anchors shall be Type 316 stainless steel.
- E. Post-installed concrete anchors shall be adhesive anchors. Mechanical anchors are not permitted. If mechanical anchors are called for in the contract documents, such anchors shall be adhesive anchors, except as indicated below.
 - 1. Anchors used for securing the floor plate covers required to close floor openings in the Grit Room shall be mechanical screw anchors.

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 A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
ASTM D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
AC 193	Acceptance Criteria for Mechanical Anchors in Concrete Elements
AC 308	Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
ACI 355.2	Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary
SBC	Seattle Building Code, 2018 Edition

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's product data.
 - 2. Manufacturer's information showing the recommended installation equipment and procedures for the following:
 - a. Mechanical screw anchors.
 - b. Adhesive anchor shall include instructions for the safe handling of adhesives.
 - 3. Design calculations and details showing the required diameter, length, embedment, edge distance, confinement, and other conditions, stamped and signed by a currently licensed State of Washington structural engineer, for post-installed anchors exceeding the capacities or not conforming to the configurations shown on the Drawings and as required by Section 01 73 00.

1.04 QUALITY ASSURANCE

- A. The diameter and capacity of post-installed concrete anchors shall be as recommended or required by the equipment or machinery manufacturer, including any recommended or required adjustment for seismic conditions listed in Section 01 73 00. In case of conflicting or ambiguous recommendations or requirements, the most stringent shall apply. Verify that the capacities and configurations conform to the Drawings.
- B. The diameter and embedment of post-installed reinforcing dowels shall be as indicated on the Structural drawings.

1.05 EXPOSURE CONDITIONS

- A. Dry: indoor spaces not subject to moisture, washdown, hydrogen sulfide gas or chemicals.
- B. Wet and/or corrosive: outdoor areas, or indoor areas subject to moisture, washdown, hydrogen sulfide gas or chemicals.
- C. Submerged: at or below a point 1.5 foot above maximum fluid surface.
- D. Unless otherwise indicated, all non-submerged surfaces shall be considered wet or corrosive.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials shall conform to the following:
 - 1. Anchor bolts and anchor rods:
 - a. Stainless steel: ASTM F593 Alloy Group 2 (AISI 316), Condition CW1 or CW2 as appropriate.
 - 2. Threaded rod:
 - a. Stainless steel: ASTM F593 Alloy Group 2 (AISI 316), Condition CW1 or CW2 as appropriate.
 - 3. Nuts: (Heavy Hex)
 - a. Stainless steel: ASTM F594 Alloy Group 2 (AISI 316), Condition CW1 or CW2 as appropriate.
 - 4. Washers:
 - a. Stainless steel: ASTM A194 Type 316.
 - 5. Reinforcing bars:
 - a. Per Section 03 30 01.
- B. Fasteners: all components of mating fasteners, bolts, nuts and washers, shall be of the same material.

2.02 CONCRETE ANCHORS

- A. Mechanical screw anchors:
 - 1. Mechanical anchors shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of SBC for use in cracked and uncracked concrete for the anchor type and concrete strength conditions for which the anchor will be used. The ESR shall indicate SBC compliance for use under seismic loading conditions. The basis of the ESR shall be Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193)
 - 2. Anchors shall be Type 316 stainless steel as indicated above.
 - 3. Anchors shall be countersunk type.
 - 4. Acceptable Manufacturers
 - a. Simpson Strong-Tie Company, Inc., Titen HD Countersunk Head Style
 - b. Hilti, Inc., KH-EZ C SS316 Countersunk Screw Anchor
 - c. Approved Equal
- B. Adhesive Anchors:
 - 1. Adhesive anchors shall have an ICC Evaluation Service Report (ESR) indicating compliance with the requirements of SBC for use in cracked and uncracked concrete for the anchor type and concrete strength conditions for which the anchor will be used. The ESR shall indicate SBC compliance for use under seismic loading conditions. The basis of the ESR shall be Post-Installed Adhesive Anchors in Concrete Elements (AC308)
 - 2. Anchors shall be Type 316 stainless steel as indicated above.
 - 3. Adhesive anchors installed horizontally or upwardly inclined shall be qualified in accordance with ACI 355.4 requirements for sensitivity to installation direction.
 - 4. Epoxy Adhesive:
 - a. Meet ASTM C881, Type 1, Grade 3, Class A, B, or C.
 - b. Two-component, 100 percent solids, non-sag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments, and gray in color. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
 - 5. Mixed Epoxy Adhesive: Non-sag paste consistency holding the following properties:
 - a. Slant Shear Strength, ASTM C881 and ASTM C882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
 - b. Compressive Strength, ASTM D695: 14,000 psi minimum.
 - c. Tensile Strength, ASTM D695: 4,500 psi.
 - d. Heat Deflection Temperature, ASTM D648: 135 degrees F, minimum.
 - 6. Epoxy Adhesive Packaging:
 - a. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio and fit into a manually or pneumatically operated caulking gun.
 - b. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
 - c. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of anchor rods.
 - d. Cartridge Markings: Include manufacturer's name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
 - 7. Storage of Epoxy adhesive:
 - a. Store epoxy cartridges on pallets or shelving in a covered storage area.
 - b. Control temperature above 60 degrees F and dispose of cartridges if shelf life has expired. If stored at temperatures below 60 degrees F, test adhesive prior to use to determine if adhesive meets specified requirements.
 - 8. Acceptable manufacturers:
 - a. Simpson Strong-Tie, "Set-XP"
 - b. Hilti, "HIT-RE 500 V3"
 - c. DeWalt, "PE1000+"
 - d. Approved Equal
- C. Post-installed anchors shall be qualified for earthquake loading in accordance with ACI 355.2 or ACI 355.4.

2.03 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

- A. Where stainless steel nuts and threaded fasteners are used, apply anti-seizing lubricant to the threads prior to making up the connections. Lubricant shall be manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

PART 3 EXECUTION

3.01 GENERAL

- A. Install per manufacturer's recommendations.
- B. Post-installed anchors shall be adhesive anchors, unless approved otherwise by the Structural Engineer of Record
- C. Cutting and welding: not permitted.
- D. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- E. Provide beveled washers where mating surface is not square with the anchor bolt.

3.02 ANCHOR BOLT HOLES IN EQUIPMENT AND PIPE SUPPORTS

- A. Shall not exceed the bolt diameters by more than:
 - 1. Bolts smaller than 1-inch: 25 percent
 - 2. Bolts 1-inch and larger: 1/4-inch.

3.03 ANCHOR INSTALLATION

- A. Installation shall not begin until the concrete receiving the anchors has attained its design strength and has been in place for a minimum of 21 days.
- B. Install in strict conformance with manufacturer's written instructions.
- C. Use manufacturer's recommended drills and equipment.
- D. Unless otherwise specified, embedded length shall not include housekeeping pads or fill grout.
- E. Adhesive anchors shall not be installed when the temperature of the concrete is below 35 degrees F or above 110 degrees F.
- F. Installation of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be performed by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
- G. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by an inspector specially approved for that purpose by Project Representative. The special inspector shall furnish a report to the licensed design professional and Project Representative that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved construction documents and the Manufacturer's Printed Installation Instructions (MPII).

- H. Furnish manufacturer's representative, for each type of concrete anchor used, to the jobsite to conduct jobsite training for proper installation, handling, and storage of each anchor system for personnel as required. Notify Project Representative of training session schedule.

END OF SECTION

SECTION 05 05 23

METAL FASTENINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies all metal fastenings, complete with washers and nuts, except cast-in concrete anchors and post-installed anchors.
- B. Metal fastening systems required to secure the various metal parts together and provide a complete installation are generally indicated on the Drawings. Where the fastening design is absent, or insufficiently detailed to complete the installation, provide the fastening design and submit for approval.
- C. The tabulation of items herein is not intended to be all inclusive, and it shall be the Contractor's responsibility to provide all metalwork and castings shown, specified, or which can reasonably be inferred as necessary to complete the project.
- D. Metal Fastenings shall be Type 316 stainless steel.

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 370	Specification for Structural Stainless Steel Buildings
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
RCSC 2020	Specification for Structural Joints Using High-Strength Bolts

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Detailed shop drawings.
 - 2. Preparation and installation or application instructions, as appropriate.
 - 3. Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.
 - 4. Manufacturer's inspection test report results for production lot(s) provided, to include:
 - a. Tensile strength.
 - b. Yield strength.
 - c. Reduction of area.
 - d. Elongation and hardness.
 - 5. Certified mill test reports for bolts and nuts:
 - a. Name and address of manufacturer.
 - b. Bolts correctly marked.
 - c. Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.

1.04 DELIVERY AND STORAGE

- A. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

PART 2 PRODUCTS

2.01 MATERIALS

- A. High-Strength Bolts:
 - 1. Stainless bolts: ASTM F593, Alloy Group 2, Condition CW1 or CW2, as specified. Manufacturers:
 - a. Eastwood Manufacturing, Houston, TX.
 - b. FM Stainless LLC, Ellijay, GA
 - c. USA Fastener Group Inc., Houston, TX
 - d. Approved Equal.
 - 2. Nuts: (Heavy Hex)
 - a. Stainless steel: ASTM F594, Type 316.
 - 3. Washers:
 - a. Stainless steel washers: Type 316.
 - b. Stainless steel washers shall comply with the requirements of hardness testing of ASTM F436, unless otherwise indicated.
 - c. Hardened stainless steel washers shall be hardened to at least 290 Brinell HBW (31 Rockwell HRC).

2.02 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

- A. Where stainless steel nuts and threaded fasteners are used, apply anti-seizing lubricant to the threads prior to making up the connections. Lubricant shall be manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper.

PART 3 EXECUTION

3.01 GENERAL

- A. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- B. Provide beveled washers where mating surface is not square with the bolt.

3.02 INSTALLATION OF HIGH-STRENGTH AND STAINLESS STEEL BOLTS

- A. Tighten in accordance with the applicable provisions of the AISC Specification for Structural Joints Using High-Strength Bolts, and as indicated in the Specification for Structural Stainless Steel Buildings Section J3.1.
- B. Hardened washers:
 - 1. Provide at slotted and oversized holes. Provide under both the bolt head and the nut.
- C. Bearing-type connections not fully tensioned: Tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

3.03 MISFITS AT BOLTED CONNECTIONS

- A. Where misfits in erection bolting are encountered, immediately notify Project Representative for approval of one of the following methods of corrections:
 - 1. Ream holes that must be enlarged to admit bolts and use oversize bolts.
 - 2. Plug weld misaligned holes and redrill holes to admit standard size bolts.

3. Drill additional holes in connection, conforming to AISC Standards for bolt spacing and end and edge distances, and add additional bolts.
4. Reject member containing misfit, incorrect sized, misaligned holes and fabricate new member to ensure proper fit.

B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

3.04 FIELD QUALITY CONTROL

- A. Inspect:
1. Marking identification and conformance to ASTM standards.
 2. Alignment of bolt holes.
 3. Placement, type, and thickness of hardened washers.
 4. Tightening of bolts.
- B. Bearing-type connections not fully tensioned: Snug tight condition with plies of joint in firm contact.
- C. Nondestructive testing (NDT) report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections as required to meet code acceptance criteria.
- D. Defective connections: Correct and re-inspect defective and improperly tightened bolted connections.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies fabricated metal items and other miscellaneous metalwork.
- B. Fabricated metal items and other miscellaneous metalwork shall be Type 316 stainless steel.

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 313	Code of Standard Practice for Structural Stainless Steel Buildings
AISC 370	Specification for Structural Stainless Steel Buildings
AISC Design Guide 27	Structural Stainless Steel, Second Edition
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials 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 A240	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications
ASTM A276	Stainless Steel Bars and Shapes
ASTM A320	Alloy Steel and Stainless Steel Bolting Materials for Low-Temperature Service
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWS D1.6	American Welding Society: Structural Welding Code – Stainless Steel
SBC	Seattle Building Code

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Manufacturer's product data showing conformance to the specifications:
 - a. Pipe hanger systems
 - 2. Detailed shop drawings.
 - 3. Welding/welding operator ASME Section IX and WABO certificates and qualifications for the work being performed.
 - 4. Welding Procedure Specifications (WPS).
 - 5. Procedure Qualification Records (PQR) for WPSs.
 - 6. Welding electrode data.

1.04 QUALITY ASSURANCE

- A. General
 - 1. The use of salvaged, reprocessed or scrap materials will not be permitted.

2. Shop and field welding shall conform to the requirements of:
 - a. Stainless steel: AWS D1.6.
 3. All welding shall be performed by ASME Section IX or WABO certified welders.
 4. Observation of Work: The Project Representative shall have access to any fabrication site or shop for the purpose of observing fabrication of items, structures, equipment, piping, electrical and other components which will be used in or incorporated in the work.
 5. Notification of Start of Work: Notify the Project Representative in advance of the start of fabrication. For fabrication sites within 50 miles of the project site, provide 48 hours' notice. For fabrication sites greater than 50 miles from the project site, provide 7 days' notice.
 6. Notification of Finish Work: Notify the Project Representative in advance of applying finish. For fabrication sites within 50 miles of the project site, provide 48 hours' notice. For fabrication sites greater than 50 miles from the project site, provide 7 days' notice.
- B. Quality Assurance for Structural Stainless Steel Work shall be provided as required by the SBC and AISC 370.
1. Quality Assurance requirements indicated in AISC 370 Chapter N will be provided by and paid for by the Owner.
 2. Structural Observations, if required by the Building Official or requested by the Owner, will be provided by and paid for by the Owner.
 3. Contractor Responsibility requirements indicated in the SBC Chapter 17 shall be provided by and paid for by the Contractor.
 4. The Contractor shall be aware of all Quality Assurance requirements and shall provide advance notice and full access to the Project Representative to conduct the inspections, tests, and observations as indicated above.
 5. The Contractor shall supply material for testing at no cost to the Owner and shall assist the Engineer in obtaining material for test samples.
 6. The Contractor shall correct or repair all defective Work. All costs associated with corrections, repairs, and retesting shall be paid for by the Contractor.
 7. Refer to PART 2 for Quality Control requirements.
- C. Shop and field welding shall conform to the requirements of:
1. Stainless Steel: AWS D1.6 minimum.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Stainless Steel:
1. Sheets and plates: ASTM A240, Type 316L
 2. Shapes, bars, and similar items: ASTM A276, Type 316L
 3. Headed Anchor Studs: ASTM A193 or A320, Type 316L
 4. Bolts, nuts, and washers: Per Section 05 05 23.
- B. Non-slip Plate:
1. Stainless steel: Type 316
 2. Acceptable Manufacturers:
 - a. Algrip Slip-Resistant Safety Floor, by Grating Pacific
 - b. SLIPNOT Grade 2, by SLIPNOT
- C. Welding Materials: AWS D1.6/D1.6M; type required for materials being welded.

2.02 QUALITY CONTROL FOR STRUCTURAL STAINLESS STEEL

- A. Quality Control for Structural Stainless Steel shall be provided as required by AISC 370.
- B. Quality Control requirements indicated in AISC 370 Chapter N shall be provided by and paid for by the Contractor.

2.03 ANCHORAGE

- A. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication. Anchorage to concrete: in accordance with Section 05 05 19.

2.04 FASTENERS

- A. As listed in Section 05 05 23.
- B. Thread lubricant for stainless steel fasteners: where stainless steel bolts and threaded fasteners are used, apply anti-seizing lubricant to the threads prior to making up the connections. Lubricant: manufactured and labeled for use with stainless steel and shall contain substantial amounts of molybdenum disulfide, graphite, mica, talc or copper.

2.05 PIPE HANGERS

- A. Pipe hanger and bracing systems shall be fabricated from Type 316 stainless steel.

2.06 LIFTING EYES

- A. Lifting eyes shall be shoulder type and fabricated from Type 316 stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify measurements at the site.
- B. Verify that field conditions are acceptable and are ready to receive work.
- C. Make provisions for erection loads with temporary bracing. Keep work in alignment.
- D. Supply items required to be cast into concrete with setting templates.

3.02 FABRICATION

- A. Conform to AISC 313, AISC 370, AISC Steel Design Guide 27, and AWS D1.6 minimum.
- B. Structural Stainless Steel shapes shall be hot rolled or welded. Dimensions and properties shall comply with AISC Design Guide 27 Section 4.3.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt-tight, flush, and hairline. Remove all burrs and weld splatter. Ease exposed edges to small uniform radius.
- D. Punch holes 1/16-inch larger than the nominal size of the bolts, unless otherwise indicated. Whenever needed because of the thickness of the metal, subpunch and ream or drill holes.

3.03 FINISH

- A. Welds and adjacent materials are to be prepared such that there are:
 - 1. No undercutting or reverse ridges on the weld beads.
 - 2. No weld spatter on or adjacent to the weld or any other area to be painted.
 - 3. No sharp peaks or ridges along the weld bead.
- B. All embedded pieces of electrode or wire and the adjacent weld: removed and replaced with new welds.

- C. Discoloration and the chromium-depleted layer along stainless steel welds shall be removed using electrochemical cleaning.

3.04 INSTALLATION

- A. Install items plumb, level and square, accurately fitted, and free from distortion or defects.
- B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.
- D. Protect encased or embedded dissimilar metals (both metals must be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.
- E. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if indicated, form recesses or blockouts in the concrete. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete. If accepted, recesses may be neatly cored in the concrete after it has attained its design strength and the metalwork grouted in place.

END OF SECTION

SECTION 05 52 00

METAL RAILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies prefabricated stainless steel railing 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 A276	Stainless Steel Bars and Shapes
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
IBC	International Building Code

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Complete structural design calculations and details, signed and sealed by a registered Professional Civil or Structural Engineer licensed by the State of Washington.
 2. Certified test reports: before fabrication of handrail, provide certificates which attest to their material complying with this Section.
 3. Layout or installation shop drawings.

1.04 DESIGN REQUIREMENTS

- A. Handrail shall meet the requirements of the standards of the Occupational Safety and Health Administration, the Division of Industrial Safety and Health of the State of Washington, and the Seattle Building Code.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Cushion wrap complete rails, modules and components to prevent scratching and denting during shipment, storage, and installation. Leave wrap intact, insofar as possible, until railing is completely installed.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide toeboards at guardrails of materials matching the guardrails except where concrete curbs are indicated.
- B. System shall accommodate field cutting of posts to fit, prior to installation or attachment to base connections.

2.02 STAINLESS STEEL RAILING SYSTEM

- A. Materials:
 - 1. Rails and posts: 1 1/2" diameter Type 304 or 316 Stainless Steel pipe, Schedule 40 minimum, as manufactured by:
 - a. Julius Blum, Connectorail System.
 - b. Approved Equal.
 - 2. Fasteners, connectors, baseplates and other appurtenances: Type 304 or Type 316 Stainless Steel, per manufacturer's standard product. Type 304 Stainless Steel fasteners are only permitted if the components being fastened together are Type 304 Stainless Steel.

2.03 FABRICATION

- A. Connections shall be mechanical, non-welded.
- B. Fit and assemble components in largest practical sizes, for delivery to the site.
- C. Pipe cuts shall be clean, straight, square, and accurate for minimum joint gap. Perform work in conformance with the handrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits that can affect durability, strength, or appearance.
- D. Unless otherwise indicated, punch holes 1/16 inch larger than the nominal size of the bolts. Whenever needed because of the thickness of the metal, sub-punch and ream or drill holes. Replace pieces with mismatched holes. No drifting of bolts or enlargement of holes will be allowed to correct misalignment.
- E. Unless otherwise indicated, supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication.
- F. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt-tight, flush and hairline. Ease exposed edges to small, uniform radius.
- G. Discoloration and the chromium-depleted layer along stainless steel welds shall be removed using electrochemical cleaning.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify measurements at the site. Before fabrication, verify that field measurements are as indicated on the Drawings, report deviations to the Project Representative.
- B. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Supply items required to be cast into concrete with setting templates.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators.
- C. Install components plumb and level, accurately fitted, free from distortion or defects.

- D. Place metal to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if specified, form recesses or blockouts in the concrete and grout the metalwork in place after concrete has attained its design strength in accordance with Section 03 30 01. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.
- E. No field welding of handrails shall be permitted.

3.04 TOLERANCES

- A. Maximum variance from plumb: ¼-inch per story.
- B. Maximum offset from true alignment: ¼-inch.

END OF SECTION

SECTION 06 84 02

FIBERGLASS REINFORCED PLASTIC (FRP) GRATING AND HANDRAILS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies vinyl ester fiberglass reinforced plastic (FRP) grating, stair treads, and associated elements.

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 C581	Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D635	Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D883	Standard Terminology Relating to Plastics
ASTM D3647	Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition
ASTM D3917	Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes
ASTM D3918	Standard Terminology Relating to Reinforced Plastic Pultruded Products
ASTM D4385	Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM D-2344	Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
NFPA No. 30	Flammable and Combustible Liquids Code
ASTM D-696	Coefficient of Linear Thermal Expansion for Plastics
IBC	International Building Code
ISO	International Standards Organization

1.03 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Design of Grating and Stair Treads:
1. Anti-slip surface, with manufacturer's standard abrasive surface cast integral with the grating. Adhesive, anti-slip tape is not acceptable.
 2. Structural:
 - a. A minimum structural safety factor of 5.
 - b. Unless otherwise indicated on drawings or by code or permit, design loads for FRP grating:
 - 1) 100 psf uniform live load.
 - 2) 300 pound concentrated load.

- 3) Maximum live load deflection: 0.25-inch or 1/300 of span under superimposed live load of 100 psf for the required spans, whichever is less.
3. Dimensions:
 - a. Grating depth: 1.5 inch minimum.
 - b. Nominal Grid: 1.5 inch X 1.5 inch square grid.
 - c. Grating sheet sizes shall be compatible with the support spans shown on the Drawings and shall require a minimum of field cutting.

1.04 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 1. Qualifications.
 2. Manufacturer's specifications of resin and reinforcement materials, dimensional tolerances, fabrication process.
 3. Manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
 4. Manufacturer's published literature including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, and design calculations for systems not sized or designed in the contract documents, sealed by a Professional Structural Engineer licensed in Washington State.
 5. Sample pieces of each item specified herein for acceptance by the Project Representative as to quality and color. Sample pieces shall be manufactured by the same method used to produce the members to be installed in the finished structure.

1.05 QUALITY ASSURANCE

- A. Qualifications:
 1. All items to be provided under this Section shall be furnished by a manufacturer having a minimum of ten (10) years of experience in the design and manufacture of similar products and systems. Additionally, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.
 2. Manufacturer shall be certified to the ISO 9001.
 3. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.
 4. Manufacturer shall provide proof, via independent testing less than six months old, that materials proposed for the intended use do not contain heavy metals in amounts greater than that allowed by current EPA requirements.
 5. Manufacturer shall provide independent testing data verifying that FRP products exhibit good corrosion resistance for exposure to a variety of corrosive liquids and gases normally encountered in the wastewater facility for which the product is intended to be used, taking into account the provision that temperatures may range from 30 to 100 degrees F. See section 2.01 below for a list of applicable corrosive compounds.
 6. The manufacturer shall certify that the stiffness of all grating panels manufactured are never more than 2.5% below the published load-deflection values.
 7. FRP Installer: Experience in erecting and installing similar FRP products for at least two similar projects in the last five years.

1.06 FIELD MEASUREMENTS

- A. Verify that field measurements prior to ordering are as indicated on drawings.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, and other types of damage. Store adhesives, resins and their catalysts and hardeners in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Grating and Stair Treads:
 - 1. "Fibergrate" Molded Grating and Stair Treads as manufactured by Fibergrate Composite Structures Inc.
 - 2. "DURAGRATE" Molded Fiberglass Grating and Stair Treads as manufactured by Strongwell Corporation.
 - 3. Approved Equal.

2.02 MATERIALS

- A. Vinyl ester resin and chemically resistant to:
 - 1. Sodium hydroxide: 25%.
 - 2. Sodium hypochlorite: 15%.
 - 3. Chlorine gas: 20%.
 - 4. Ferrous chloride: 30%.
 - 5. Sulfuric acid: 15%.
- B. Provide UV protection coating for all FRP located in the outside environment.
- C. Color: Molded FRP Grating: orange unless otherwise specified; stair treads: orange unless otherwise specified.
- D. Grating: Manufacture by molded process as follows: Grating shall be of a one piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square mesh pattern providing bidirectional strength. Grating shall be reinforced with continuous rovings of equal number of layers in each direction. The top layer of reinforcement shall be no more than 1/8" below the top surface of the grating so as to provide maximum stiffness and prevent resin chipping of unreinforced surfaces. Percentage of glass (by weight) shall not exceed 35% so as to achieve maximum corrosion resistance, and as required to maintain the structural requirements of the intended use. After molding, no dry glass fibers shall be visible on any surface of bearing bars or cross bars. All bars shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas. Grating bar intersections are to be filleted to a minimum radius of 1/16" to eliminate local stress concentrations and the possibility of resin cracking at these locations.
- E. Assembled and glued bar grating will not be acceptable.
- F. Embedded grating supports, hold-downs and attachments: 316 stainless steel.

- G. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- H. Fiberglass reinforcement shall be continuous roving in sufficient quantities as needed by the application and/or physical properties required.
- I. All finished surfaces of FRP items and fabrications shall be smooth, resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- J. All molded grating products shall be fire-retardant and shall have a tested flame spread rating of 25 or less per ASTM E 84 Tunnel Test. Gratings shall not burn past the 25 mm reference mark and will be classified HB per ASTM D635.

PART 3 EXECUTION

3.01 FABRICATION

- A. Measurements: Grating supplied shall meet the dimensional requirements and tolerances as shown or specified. Provide and/or verify measurements in field for work fabricated to fit field conditions. Determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.
- B. Layout: Each grating section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes where located on the contract drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.
- C. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly in accordance with the manufacturer's instructions.
- D. Hardware: Type 316 stainless steel hold down clips shall be provided and spaced at maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

3.02 INSTALLATION

- A. Install gratings and stair treads in accordance with manufacturer's assembly drawings. Fasten grating panels and stair treads securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation. Install all end panel attachments, and appurtenances as shown on the Contract Documents or on approved shop drawings to make the work secure and complete.
- B. Use Type 316 Stainless steel for nuts, bolts, embeds, clips and other required accessories.

END OF SECTION

SECTION 09 06 90

SCHEDULES FOR PAINTING AND COATING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies finishes and colors for equipment and other items which are to be painted, or coated.

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.
 - 1. Federal Standard 595 Paint Specification.

1.03 QUALITY ASSURANCE

- A. General: Unless otherwise specified, all materials and workmanship shall conform to the applicable requirements of Section 09 90 00.
- B. The King County Project Representative reserves the right to reselect any color, from the manufactures full range of available colors, during the submittal process. In case of conflict between requirements of this section and the specified or listed documents, the requirements of this section shall prevail.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. In the following schedule, the coating system for each specified surface shall comply with those listed in COATSPEC, Section 09 90 00. Coat surfaces indicated on this schedule unless specifically noted otherwise on the Drawings or in the Specifications. Color reference numbers are from the Federal Standard 595 Paint Spec.
- B. Special Equipment Colors: Paint equipment and piping as indicated, except as itemized below:
 - 1. Fire Protection Equipment, Pipes and Apparatus: OSHA Red.
 - 2. Physical hazards in normal operating area and energy lockout devices, included but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.
- C. Electrical conduit is not painted if coated with PVC or specifically noted otherwise on the Drawings or in the Specifications.

3.02 FINISH SCHEDULES

SURFACES	SERVICE ENVIRONMENT	COATING SYSTEM	COLOR
Concrete floor in Grit Classifier Room	Concrete in immersed, non-potable, non-immersed corrosive environment	A-2	# 36270
Miscellaneous metal-equipment, exposed conduit, piping, utilities, etc.	Interior/Exterior non-immersed, moderate corrosive environment, not exposed to sunlight	B-1	# 34089
Miscellaneous concrete-dry wells, wash down areas	Interior/Exterior non-immersed, moderate corrosive environment, not exposed to sunlight	B-1	# 33711
Miscellaneous metal-equipment, exposed conduit, piping, utilities, handrails, roof flashing, exterior doors	Interior/Exterior non-immersed, moderate corrosive environment, exposed to sunlight, salt air, abrasion resistance.	C-1	# 36270
Metal	Interior/Exterior exposed cast iron and steel piping, including supports and accessories, interior electrical conduits.	L-1a	# 33711
Aluminum, including flashings, doors, louvers, frames, and site accessories	Interior/Exterior	Anodize	To be selected.
For Special Equipment Colors see 3.01B.			

END OF SECTION

SECTION 09 90 00
COATING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies coatings and their surface preparation for field and shop-applied coating systems.
- B. Furnish all labor, equipment, including safety equipment, superintendence, materials, tools and incidentals necessary to prepare and coat the work as specified in this Section.

1.02 DEFINITIONS

- A. Coating systems: Includes surface description, surface preparation, required dry film thickness, and the number and application procedure of the prime and finish coatings. Systems are as specified within this Section on the Coating System Specification Sheets (COATSPEC).
- B. Field coating: The application of the coating system after installation of the surface at the work site.
- C. Dry film thickness (DFT): The thickness of a fully cured coating or coating system.
- D. Wet film thickness (WFT): The thickness of a coating while wet.
- E. Volatile organic content (VOC): The portion of the coating that is a compound of carbon, is photo-chemically reactive and evaporates during drying or curing, expressed in grams per liter or pounds per gallon as defined in ASTM D3960.
- F. Shop coat: One or more coats applied in a shop or plant prior to shipment to the site.
- G. Lead containing: Any coating that contains any detectable amount of lead.
- H. Stripe coat: A coat of the specified coating, applied prior to the final coat by brush to all edges (cut or fabricated) on steel shapes, crevices, projections, welds, nuts, bolts, pits, flanges, and splice plates.
- I. Hard to reach: Areas that may not be accessible with spray equipment but can be reached by brush, mitt or roller.
- J. Inaccessible areas: Areas such as back-to-back angles, skip welds, and other areas that a brush, mitt, or roller cannot contact the surface.
- K. pH: A measure indicating whether a solution is acidic, neutral, or alkaline.

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
ASTM D3359	Standard Test Methods to Measure Adhesion by Tape Test

ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4138	Standard Test Methods for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means
ASTM D 4258	Standard Practice for Surface Cleaning Concrete for Coating
ASTM D 4259	Standard Practice for Abrading Concrete
ASTM D4263	Standard Test Method Indicating Moisture in the Concrete by the Plastic Sheet Method
ASTM D4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4417	Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D4541	Standard Test Method for Pull-off Adhesion
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
ASTM E337	Standard Test Method for Measuring Humidity with a Psychrometer
EPA Method 1311	Toxicity Characteristic Leaching Procedure (TCLP) for Resource Conservation and Recovery Act (RCRA) 8 Metals
ICRI	International Concrete Repair Institute, Technical Guidelines
MIL-A-22262A (SH)	Military Specification, Abrasive Blasting Media, Ship Hull Blast Clean
NACE SP0188-2006	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0274-2011	High Voltage Electrical Inspection of Pipeline Coatings
NAPF 500-03	Surface Preparation Standard For Ductile Iron Pipe And Fittings In Exposed Locations Receiving Special External Coatings And/Or Special Internal Linings
SSPC	Steel Structures Painting Council, Volume 1 - Good Painting Practices
SSPC-Paint Application-PA-2	Measurement of Dry Paint Thickness with Type 2 Gauges
SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 3	Power Tool Cleaning
SSPC-SP 7	Brush-Off Blast Cleaning
SSPC-SP 10	Near-White Metal Blast Cleaning
SSPC-SP 11	Power Tool Cleaning to Bare Metal
SSPC-SP 13/NACE 6	Surface Preparation of Concrete
SSPC-SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
SSPC-VIS 1-67T	Visual Plates Used to Determine Blasting Standards
SSPC	Good Painting Practice Volume 1
SSPC - Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC - Guide 15	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates
SSPC Publication 91-12	Coating and Lining Inspection Manual

1.04 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 1. Contractor QC personnel
 2. A list of materials shall be provided before materials are delivered to the worksite.
 3. A Waste Disposal Plan.
 4. For each primer and finish coating, provide the manufacturer's application instructions, which shall include the following:

- a. Surface preparation recommendations.
 - b. Primer type, where required.
 - c. Maximum dry and wet mil thickness per coat.
 - d. Minimum and maximum curing time between coats, including atmospheric conditions for each.
 - e. Curing time before submergence in liquid.
 - f. Thinner to be used with each coating.
 - g. Ventilation requirements.
 - h. Allowable application methods.
 - i. Maximum storage life.
 - j. Material safety data sheets.
 - k. Interpretation of batch code numbers.
 - l. Minimum and maximum relative humidity requirements.
 - m. Minimum and maximum surface temperature requirements.
 - n. Minimum and maximum ambient temperature requirements.
 - o. Manufacturers recommended application procedure.
 - p. LEED Submittal.
 - q. When color is not specified, provide manufacturer's range of standard colors.
 - r. Contractor QC personnel qualifications.
5. Provide information on new abrasive blasting media including lab test report for RCRA 8 heavy metals testing per EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP) and coating manufacturer's recommended grit/shot size for coating systems specified.
 6. Provide a copy of the Toxicity Characteristic Leaching Procedure (TCLP) lab test report of the spent blast material to the Project Representative prior to Final Acceptance of the work.
 7. Field and/or draw-down samples may be requested by the Project Representative.
 8. For Systems A-2 and C-3, submit manufacturer's details for construction joints, penetrations, crack repair, and details at floor penetrations, wall bases, equipment bolts, embedded angle frames, transitions and terminations of the system and all other details specific to the structure being coated.

1.05 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) FOR SHOP AND FIELD

A. General:

1. Manufacturer's printed instructions: Deviations from the manufacturer's printed instructions will not be allowed unless approved in writing by the manufacturer's representative and the Project Representative before execution of said change.
2. In the event of a disagreement between the manufacturer's written instructions and the provisions of this Section, the provisions of this Section 09 90 00 shall prevail.
3. Test result disagreement: In the event of a discrepancy between the Contractor and Project Representative's testing equipment, both parties shall check equipment in question for proper function and calibration.
4. Make available all locations and phases of the work for access for inspection by the Project Representative or the manufacturer's representative. Contractor shall provide ventilation, egress, staging and any other means required to access the work area.
5. Contractor QC personnel shall be certified as an Association for Materials Protection and Performance (AMPP) Certified Coatings Inspector or National Association of Corrosion Engineers, (NACE) CIP Level 1 for coating work performed at the project site. Contractor QC personnel shall be certified as an Association for Materials Protection and Performance (AMPP) Senior Certified Coatings Inspector National Association of Corrosion Engineers, (NACE) CIP, Level 3 with Peer Review, for coating work performed away from the project site.
6. The Project Representative may approve the application of coatings specified under this section by the Contractor's fabricators and other suppliers without direct inspection by the County provided that the fabricators and suppliers meet the requirements of 1.04A.4 and 1.04B.

B. Contractor's responsibilities:

1. Quality control: responsible for the quality control of the coatings applied and performing check points as specified in this Section.

2. Schedule: prepare a schedule that is updated weekly or as necessary to show QC and QA Check Points as specified herein and distribute to all parties related to installation of the coating system. The schedule shall allow time for remedial work to be completed as identified by inspection at the given checkpoints. The Project Representative shall be informed within 24 hours prior to the Contractor performing the tests specified.
 3. Reports: prepare daily inspection reports when any work is performed on site. Project Representative may require ambient conditions to be recorded as often as needed to ensure specified application conditions are met, but not less than twice daily. Tests shall be conducted in accordance with ASTM E337 or in accordance with surface temperature instrument and dew point instrument manufacturer's instructions. Use the "Daily Coating Inspection" form found in Section 01 33 10. Submit copies of this report within 24 hours of coating application to the Project Representative for signature to acknowledge the report was produced in a timely manner. Submit all reports in bound form at the completion of coating work.
 4. Over coating: verify coating compatibility and primer quality to be equal to the specified primer when over-coating a primer or coating that was applied by others. Follow the coating manufacturer's recommendations for over coating primers beyond the recoat window.
 5. Provide testing equipment required in this Section and as required to verify compliance with the Specifications. Record of equipment calibration must also be provided.
- C. Project Representative's responsibility:
1. QA: determine acceptance or rejection of a coating based on the given specifications.
 2. Testing: may conduct tests on ambient conditions, surface temperature, coating(s) applied, target mil thickness, coating type (i.e. stripe coat), and coating batch numbers in accordance with SSPC Publication 91-12.
- D. Inspection Checkpoints: Contractor is responsible to perform the inspection checkpoints specified below and as required in COATSPEC. If the Project Representative performs any or all of the inspection checkpoints listed this does not relieve the requirement for the Contractor to perform the inspection checkpoints as specified below.
1. Blotter test: Upon start-up of abrasive blasting, compressed air shall be checked daily for oil and water by blotter test per ASTM D4285.
 2. Anchor profile: Anchor profile of an abrasively blasted surface shall be tested using Testex tape per ASTM D4417 or with a calibrated digital surface profile gauge. Test shall be conducted on the start-up of the blasting operation to insure proper selection of blast media and prior to prime coat application.
 3. Intermediate DFT readings: DFT readings shall be taken between coats to check consistency of the application and progress toward total system thickness.
 4. Final DFT readings: DFT readings shall be taken per SSPC PA-2 on total system thickness as criteria for final acceptance of a coating. If recoat time has been exceeded or if recommended by the manufacturer, deficient areas shall be scarified prior to top coating. Dry film thickness measurements in excess of the amounts specified in SSPC PA-2 may be acceptable if approved by the Project Representative.
 5. Holiday testing: Perform for the entire coating per NACE SP0188-2006 in the presence of the Project Representative except for coating system M-1 and M-2. Any holidays detected shall be repaired and retested after cure of the coating is complete. For coating system M-1 test for holidays in accordance with NACE SP0274-2011 High Voltage Electrical Inspection of Pipeline Coatings and manufacturer's instructions. In cases of conflicting holiday testing requirements for M-1, the manufacturer's instructions shall prevail.
 6. Surface preparation: Shall be accepted by the Project Representative prior to the application of a coating.
 7. Ambient conditions: Perform tests for relative humidity, surface temperature, dew point and ambient temperature to ensure compliance for materials applied. Tests shall be conducted in accordance with ASTM E337 or surface temperature instrument and dew point instrument manufacturer's instructions
 8. Adhesion: perform adhesion tests per ASTM D4541, ASTM D3359 Test Method B, or ASTM D7234 depending upon the substrate. It is the responsibility of the Contractor to repair any damage to the coating resulting from adhesion testing.

- a. Minimum adhesion values for coating systems A-1, A-2, and A-3: 400 psi with 20 mm dolly or 64 psi with 50 mm dolly
 - b. The minimum adhesion score for coating system L-1a using ASTM D3359 Test Method B shall be Classification 2B.
 9. Test to Determine Salt Contamination: Using the Bresle Method, the Contractor shall take 3 tests each day at randomly selected locations during surface preparation prior to coating application. For immersed surfaces, the reading shall not exceed 30 microsiemens/cm (30 us/cm). For non-immersed surfaces, the reading shall not exceed 70 microsiemens/cm (70 us/cm). If conductivity measurements exceed the respective values, the affected surfaces shall be cleaned until conductivity levels are acceptable. Tests shall be conducted in accordance with SSPC - Guide 15 or soluble salt test kit manufacturer's instructions. This test may be waived by the Project Representative if initial tests indicate low salt concentrations.
 10. Moisture in Concrete: perform ASTM 4263-88, Standard Test Method Indicating Moisture in the Concrete by the Plastic Sheet Method. If the presence of moisture is indicated, dry the substrate prior to coating application. Perform this test once for every 200 square feet of area to be coated and more frequently at darkened concrete areas. Perform Calcium Chloride Moisture Vapor Emissions Tests in accordance with ASTM F-1869 for all floors, containment, below grade applications or any other moisture tests required by the manufacturer. The Project Representative may approve adhesion testing of a small coating test patch per ASTM D7234 in lieu of moisture testing.
 11. Test for de-passivation of galvanized steel: After cleaning galvanized steel by pressure wash and soap or other manufacturer-approved method, test every 100 square feet by applying a drop of Copper Sulfate test solution. Black color indicates that the galvanized steel has been de-passivated. Refer to paragraph 3.01B5.
 12. Pressure washing QA/QC:
 - a. Wash water temperature verification: Dispense wash water into a 5 gallon bucket. Verify that wash water is between 120F and 130F with a calibrated infrared thermometer.
 - b. Pump flow rate- Spray wash water into a 5 gallon bucket. Water level shall rise to 3 gallon mark in 60 seconds or less.
 - c. Pump pressure- For a 3,000 PSI rated machine, the pressure at spray gun inlet shall be not less than 2,900 PSI with the trigger pulled and nozzle discharging water on a calibrated pressure gauge.
 - d. Nozzle orifice size: Example: A properly sized new #3.5 (.048") pressure washing nozzle will pass a # 56 (.0465") drill bit or drill blank but will not pass a # 55 (.052") drill bit or drill blank. A nozzle shall be replaced when its orifice passes a drill bit or drill blank .004" larger than the original orifice diameter.
 13. Wet Film Thickness (WFT) readings: Shall be taken per ASTM D4414 and recorded on the Daily Inspection Report at least every 15 minutes or every 100 square feet of coating area, whichever is more frequent, during coating application.
- E. Disputes: If questions arise concerning the acceptability of an applied coating, Tooke, adhesion, and other destructive/non-destructive tests per ASTM D 4138 may be performed to aid in resolution of the dispute. If the coating is determined to be defective, the Contractor will be responsible for the cost of repairs resulting from testing. If the coating is shown to be properly applied, the County will be responsible for the cost of inspection repairs.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials for field application to the job site in their original, unopened containers. Each container shall bear the manufacturer's name brand, batch number, date of manufacture, and storage life.
- B. Coatings shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold. Coatings, exceeding storage life recommended by the manufacturer or that have been visibly damaged shall be removed from the site. Flammable materials shall be stored in accordance with state and local codes.

1.07 SITE CONDITIONS

- A. Coatings shall be applied only to surfaces that are dry, and only under such combination of humidity and temperatures of the atmosphere and surfaces to be coated as will cause evaporation rather than condensation.
- B. During coating and for a period of at least 8 hours after the coating has been applied, the temperature of the surface and the atmosphere shall be maintained at a minimum of 5 degrees above the dew point unless the curing schedule for the coating permits otherwise.
- C. Provide environmental controls such as heaters and/or dehumidification if atmospheric requirements as specified in this Section are not met or workdays are lost due to weather.
- D. Provide ventilation if the cure time of the coating is slowed by the presence of coating or solvent vapor.

1.08 CONTAINMENT

- A. Containment shall conform to SSPC-Guide 6. Level of containment shall be as specified to capture debris, contain dust, protect from adverse weather, control overspray, and provide means to control ambient conditions, and shall be as specified for the material and service conditions in the COATSPEC.
- B. Containment is required whenever abrasive blasting is performed. The Contractor is responsible for any damage resulting from surface preparation or painting operations.

SSPC-GUIDE 6 - TABLE A

COMBINATIONS OF CONTAINMENT AND VENTILATION SYSTEMS COMPONENTS

Containment Classification	CONTAINMENT SYSTEM (5.3 of Guide)						VENTILATION (5.4 of Guide)				
	5.3.1 Containment Materials	5.3.2 Penetrability	5.3.3 Support Structure	5.3.4 Joints	5.3.4 Joints	5.3.5 Entryway	5.4.1 Make-up	5.4.2 Input Air Flow	5.4.3 Air Pressure	5.4.4 Air Movement	5.4.5 Exhaust Dust Filtration
Class 1A		B1-Air Impenetrable	C1-Rigid C2-Flexible	D1-Full Seal	D1-Full Seal	E1-Airlock E2-Resealable	F1-Controlled	G1-Forced G2-Natural	H1-Instrument Verification H2-Visual Verification	I1-Minimum Specified	J1-Air Filtration
Class 2A	A1-Rigid A2-Flexible	B1-Air Impenetrable	C1-Rigid C2-Flexible	D1-Full Seal	D1-Full Seal	E2-Resealable E3-Overlap	F1-Controlled F2-Open	G1-Forced G2-Natural	H2-Visual Verification	I1-Minimum Specified	J1-Air Filtration
Class 3A	A1-Rigid A2-Flexible	B1-Air Impenetrable B2-Air Penetrable	C1-Rigid C2-Flexible	D1-Full Seal D2-Partial Seal	D1-Full Seal D2-Partial Seal	E4-Open Seam	F1-Controlled F2-Open	G1-Forced G2-Natural	H3-Not required	I2-Not specified	J1-Air Filtration
Class 4A	A1-Rigid A2-Flexible	B1-Air Impenetrable B2-Air Penetrable	C3-Minimal	D2-Partial Seal	D2-Partial Seal	E4-Open Seam	F2-Open	G2-Natural	H3-Not required	I2-Not specified	J2-No Controls on Exhaust

Note:

- The information in this table is provided for guidance only and does not guarantee that any specific levels of containment will be achieved by following the suggestions. The type of structure, wind conditions, soundness of the materials of construction, and many other factors play a role in containing dust and debris.*
- The table occasionally identifies two options for a given component. For example, containment materials (5.3.1) are shown as being either rigid or flexible. If the specifier requires the use of rigid materials only, this restriction must be specified separately.*
- The design suggestions made in this table are based on the use of open abrasive blast cleaning inside containment. The classifications are ordered from the greatest degree of dust and debris containment (Class 1A). Normally, the higher the degree of containment, the higher the cost.*
- Many other combinations of the components beyond those suggested above can be used to provide similar*

results. The method preparation can also be adjusted to reduce or eliminate dust emissions.

5. *Certain combinations of components within which each class may not be suitable when removing hazardous paints (e.g., forced air input in combination with penetrable containment materials in Class 3A).*
6. *When designing a ventilation system, care must be taken to balance the static pressure with the input air flow to avoid collapsing the containment due to high negative pressure.*

1.09 WARRANTY

- A. For the Work of this Section, provide all warranties as described in Section 00 72 00 General Terms and Conditions, and special warranties as specified in the Technical Specifications

PART 2 PRODUCTS

2.01 MATERIALS

- A. Standardization:
 1. Materials, supplies, and articles provided shall be the standard products of manufacturers. Coatings within a particular system shall be the products of a single manufacturer.
 2. The standard products of manufacturers other than those specified may be accepted when it is demonstrated that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for substitutions will be considered when submitted per Section 01 33 00 provided the following minimum conditions are met:
 - a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required dry film thickness.
 - b. The proposed coating system shall use coatings of the same generic type. The directions for application and descriptive literature which includes generic type, non-volatile content by volume, material safety data sheets, VOC's by grams per liter, and other information confirms that the substitution is equal to the specified coating system.
- B. All coating materials shall be benzene and lead free and shall not exceed 250 grams per liter of volatile organic compounds (VOC).
- C. Abrasive blasting material shall meet MIL-A-22262A (SH) and shall contain RCRA 8 heavy metal concentrations for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver below EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP) regulatory limits. Blasting material shall not be reused. The Contractor is responsible for removing and legally disposing of the spent abrasive blasting material from the job site.
- D. Nonskid additive shall be 20 to 40 mesh alumina oxide unless alternate nonskid media is recommended by the manufacturer.

2.02 EQUIPMENT

- A. The Contractor is responsible for ensuring that all King County equipment including mechanical working parts and/or moving parts within the work area are protected from damage. Protection of equipment will be coordinated with the Project Representative.

PART 3 EXECUTION

3.01 PREPARATION

- A. General:
 1. The surface preparation instructions in paragraph 3.01 are general only and are not intended to replace the specific requirements of the individual COATSPECS or coating manufacturer's requirements.
 2. Surfaces to be coated shall be clean. Before applying coating, oil and grease shall be removed per

SSPC-SP 1. All dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be cleaned according to the SSPC standards specified in the COATSPEC. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded, and free of contaminants, which might interfere with the adhesion of the coatings.

3. Clean cloths and clean fluids shall be used in solvent cleaning. Cleaning and coating shall be scheduled so that dust and spray from the cleaning process will not fall on wet, newly coated surfaces. Ensure that field coating is compatible with factory applied or existing coatings.

B. Metallic surfaces:

1. Metallic surfaces shall be prepared in accordance with applicable portions of the NACE, SSPC, or ASTM surface preparation specifications. Specific applicable standards are specified in each coating system. The solvent in solvent cleaning operations shall be as recommended by the manufacturer.
2. Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS-1-67T, or as described herein. To facilitate inspection on the first day of sandblasting operations, sandblast a sample area to the standards specified. Plates of light metal steel shall measure a minimum of 8-1/2 inches x 11 inches. The blasted sample area meeting the requirements of the Specifications shall be initialed by the Contractor and the Project Representative and covered with clear plastic and tape. One of these sample areas shall be prepared for each type of sandblasting and shall be used as the comparison standard throughout the work.
3. Profile of blasted surfaces of new steel or previously coated steel shall be per the manufacturer's recommendation for each coating system but be no less than two mils. Tightly adhered, existing coating remaining on surface following SSPC-SP-7, cleaning shall have a minimum surface profile of 2 mils.
4. Surface preparation for aluminum, copper, brass, and stainless steel shall be as specified for the coating in the COATSPEC.
5. Surface preparation for galvanized metal shall include a pressure wash with a cleaning solution recommended by the coating manufacturer, mixed and rinsed with 130-degree water and applied at 3000 psi, 2.8 GPM minimum. When the surface is dry, prepare for coating application by providing a cleaning per SSPC-SP 2 or 3. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application. Perform de-passivation test listed in paragraph 1.05 D.11.
6. Areas not accessible or appropriate for blast cleaning may be hand or power tool cleaned with written approval of the Project Representative.

C. Concrete, masonry and plaster surfaces:

1. Surfaces, which are to be coated shall be allowed to age for at least 28 days or longer, to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested per ASTM D4263. The presence of moisture indicates additional cure time will be required. Retest as required until concrete is sufficiently dry for coating.
2. Muriatic acid solution shall not be used.
3. Loose concrete and laitance shall be removed by blasting or chipping. Voids and cracks shall be repaired as specified in Section 03 30 01 or applicable COATSPEC. When repair work in Section 03 30 01 is complete, prepare the surface per the following:
 - a. Concrete floors shall be prepared with "blast track" style equipment or an Approved Equal.
 - b. All concrete surfaces shall be inspected per SSPC-SP 13 to ICRI Technical Guideline #310.2 and per the manufacturer's recommendations.
4. Surfaces shall be dry and clean and free from grit, loose plaster, and surface irregularities.
5. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sanded smooth. Surfaces may require additional repair to provide a smooth surface prior to application of final coat.
6. The pH of the surface shall register a '7', which indicates a neutral surface condition, before coating is applied. If indicator reads above '7', the alkali shall be neutralized.
7. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.

8. Steam cleaning shall be used to clean wall surfaces of existing process channels, structures and tanks to be coated.
9. Surfaces to be coated shall be repaired as specified in the COATSPEC and cleaned and finished to the standards as specified herein.

D. Ductile Iron Pipe:

1. As specified in Section 40 05 19.
2. When an epoxy lining system is specified for ductile iron pipe in the drawings or Section 40 05 19, refer to Coating System P-1 in this Section.
3. Refer to Section 09 06 90 for exterior topcoat or finish coating systems.
4. Refer to Section 40 05 01 for interior pipe, valve, and fitting lining systems.

E. Plastic surfaces:

1. Clean with solvent compatible with the specified primer and hand sanded with a medium grit sandpaper to provide sufficient profile for the coating system.
2. Large areas may be power sanded or brush off blasted provided sufficient controls are employed so the surface is roughened without removing excess material.

3.02 APPLICATION

A. Workmanship: Coating shall be conducted in accordance with the requirements of SSPC, Good Painting Practice Volume 1.

1. Coated surfaces shall be free from runs, drips, ridges, waves, laps and brush marks. Coats shall be applied so as to produce an even film of uniform thickness.
2. Coating equipment shall be designed for application of the materials specified.
 - a. Compressors shall have traps and filters to remove water and oils.
 - b. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes and functioning in a manner suitable to perform the work.
3. Each coat of paint shall be applied evenly and sharply cut to line.

B. Coating properties, mixing, and thinning:

1. Coating shall provide a satisfactory film with smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Orange Peel, overspray, pinholes and other surface defects shall be repaired.
2. Coating shall be thoroughly stirred, strained, and kept at a uniform consistency during application.
3. Coatings shall be mixed in accordance with the manufacturer's instructions.

C. Method of coating application:

1. Prime coatings may be shop or field applied. Shop-applied primer shall be as specified in each system.
2. Provide mechanical equipment, including, but not limited to, pumps, valves, pipe, blowers, fittings, and miscellaneous appurtenances, with shop-applied primer and shop-applied finish coats.
3. If the shop coating meets the requirements of this Section, the field coating may consist of touching up the shop prime coat to achieve the film thickness, continuity, and coating specified in the COATSPEC. Damaged and poorly applied shop coatings that do not meet the specified requirements shall be removed, surface prepared, and then recoated in accordance with the COATSPEC.
4. Where two or more coats are required, alternate coats shall contain sufficient compatible color additive, to act as indicator of coverage or the alternate coats shall be of contrasting colors.
5. Mechanical equipment on which the manufacturer's shop-applied coating is acceptable shall be touch-up primed and coated with the specified coating system to match the color scheduled.
6. Coating shall not be applied to a surface until it has been prepared as specified.
7. A stripe coat shall be applied by brush to all edges (cut or fabricated), crevices, projections, nuts, bolts, pits, welds, flanges and splice plates. Subsequent coats may be either brush or spray applied.

8. Where nonskid surface is scheduled, broadcast nonskid additive at 5 pounds per 30 square feet. Back-roll on horizontal surfaces.
- D. Film thickness and continuity:
 1. Coating system thickness is the total thickness of primer and finish coats and does not include sealers, patching mortars or galvanized coatings.
 2. Coatings shall be applied to the thickness specified. No less than two coats shall be applied.
- E. Unsatisfactory Application:
 1. If an item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
 2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
 3. Repair defects in accordance with written recommendations of coating manufacturer.
- F. Damaged Coatings, Pinholes, and Holidays:
 1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
 3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.03 CLEANUP AND WASTE DISPOSAL

- A. Minimize onsite storage of paint waste materials. At the end of each shift, remove surplus materials, protective coverings, and accumulated rubbish.
- B. Thoroughly clean all surfaces and repair any overspray or other paint-related damage when the work is complete.
- C. All solvents, unused coatings and cleaning solutions shall be removed from the site and disposed of legally when coating work is complete or if directed by the Project Representative.
- D. Prepare a Waste Disposal Plan to demonstrate all waste material is to be properly disposed; Include:
 1. Specify the Contractor is the generator of all waste materials generated by their business activities.
 2. Provide details on procedures to be used for properly managing and disposing of waste materials in accordance all applicable laws and regulations.
 3. Procedures to document waste types and quantities generated and their disposition.
 4. Appoint an employee who is qualified and authorized to enforce proper waste disposal and document the disposal.
- E. Submit completed Waste Disposal Plan and supporting documentation to demonstrate quantities and proper disposal of wastes.
- F. Provide a copy of the Toxicity Characteristic Leaching Procedure (TCLP) lab test report of the spent blast material to the Project Representative prior to Final Acceptance of the work. The lab test report shall be within the lab's current TCLP certification period.

3.04 PROTECTION

- A. Where protection is provided for coated surfaces, such protection shall be preserved in place until the coating film has properly dried, and removal of the protection is authorized by the Project Representative. Items, which have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard.

- B. Hardware, electrical fixtures, nameplates, shims and similar accessories shall be removed or masked during preparation and coating operations or shall otherwise be satisfactorily protected. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and coating of equipment and walls and, following coating, shall be replaced and reconnected. Any removal or disconnecting of equipment shall be coordinated with the Project Representative.

3.05 MANUFACTURER'S SERVICES

- A. Coating manufacturer's representative shall be present at site as follows:
 - 1. Within 48 hours of first application of any coating system.
 - 2. As required to resolve field problems attributable to or associated with manufacturer's product.
 - 3. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.06 COATING SYSTEMS

- A. Surfaces to be coated, surfaces not to be coated, coating systems to be used, and required finishes and colors are specified in Section 09 06 90.

3.07 COATING SYSTEM SPECIFICATION SHEET - COATSPEC

- A. Coating Systems specified for use appear on the following pages. Each of the Coating Systems and their requirements appear on individual pages.

COATING SYSTEM IDENTIFICATION:	A-1
Coating Material:	High Build Epoxy, 16 mils DFT nominal, 250 g/l max VOC
Surfaces:	Metal
Available Colors:	Gray, White, or Beige
Service Condition:	Immersed, highly corrosive environment.
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 10. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces in accordance with SSPC-SP 2. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP 11 and recoated with the primer specified. Previously coated surfaces shall be feathered in at the edges. Shop primed surfaces shall receive light abrasive blasting prior to application of finish coats.
Non-Ferrous and Galvanized Metal:	Non-ferrous and galvanized metal shall be cleaned using a 3,000 PSI minimum, 2.8 GPM minimum, 110F minimum (130F maximum) hot water pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Hard to reach areas shall be cleaned using a solvent wipe or scrubbing with a firm bristle deck brush using 110F minimum wash water mixed with biodegradable cleaner. When the surface is dry, prepare for coating application by providing a SSPC SP 7, 11, or 16. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Inspection Check Points:	Check points 1, 2, 6, 7, 11, and 12.
Application:	Shop or field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 3-5, 7, 8, and 13.
System Thickness:	16 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 635 VOC Epoxy
Stripecoat:	One coat of Carboline Carboguard 635 VOC Epoxy
Intermediate:	One coat of Carboline Carboguard 635 VOC Epoxy
Finish:	One or more coats of Carboline Carboguard 635 VOC Epoxy
ALTERNATIVE 2	
Primer:	One coat of Devoe Bar Rust 236 Multi-Purpose Epoxy
Stripecoat:	One coat of Devoe Bar Rust 236 Multi-Purpose Epoxy
Intermediate:	One coat of Devoe Bar Rust 236 Multi-Purpose Epoxy
Finish:	One or more coats of Devoe Bar Rust 236 Multi-Purpose Epoxy
ALTERNATIVE 3	
Primer:	One coat of ENECON Chemclad SC
Stripecoat:	One coat of ENECON Chemclad SC
Intermediate:	One coat of ENECON Chemclad SC
Finish:	One or more coats of ENECON Chemclad SC
ALTERNATIVE 4	
Primer:	One coat of PPG Novaguard 840
Stripecoat:	One coat of PPG Novaguard 840
Intermediate:	One coat of PPG Novaguard 840
Finish:	One or more coats of PPG Novaguard 840
ALTERNATIVE 5	
Primer:	One coat of Sherwin Williams Dura-Plate 235LV
Stripecoat:	One coat of Sherwin Williams Dura-Plate 235LV
Intermediate:	One coat of Sherwin William Dura-Plate 235LV
Finish:	One or more coats of Sherwin Williams Dura-Plate 235LV
ALTERNATIVE 6	
Primer:	One coat of Tnemec Series V69 Epoxoline.
Stripecoat:	One coat of Tnemec Series V69 Epoxoline
Intermediate:	One coat of Tnemec Series V69 Epoxoline
Finish:	One or more coats of Tnemec's Series V69 Epoxoline
ALTERNATIVE 7	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	A-2
Coating Material:	High Build Epoxy, 16 mils DFT nominal, 250 g/l max VOC
Surfaces:	Concrete, masonry
Available Colors:	Gray, White, or Beige
Service Condition:	Immersed, highly corrosive environment.
Surface Preparation:	For concrete and masonry.
New:	Surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content will be tested by the Contractor and witnessed by the Project Representative. Loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces and voids and cracks shall be repaired per Section 03 30 01. When repair work in Section 03 30 01 is complete, prepare concrete per SSPC-SP 13 to ICRI Technical Guideline #03732 CSP 3 minimum profile. Holes or other joint defects shall be filled with mortar and re-pointed. Loose or splattered mortar shall be removed by scraping and chipping.
Existing:	Surfaces shall be cleaned with a minimum 5,000 PSI pressure wash using a new turbo nozzle in accordance with SSPC-SP 13. Muriatic acid shall not be used. After cleaning, apply skim coat of specified patching mortar to 100% of the surface to repair bugholes, other imperfections and provide a monolithic surface.
Inspection Check Points:	Check points 2, 6, 7, and 10-12.
Application:	Field. Patching mortar shall dry a minimum of 48 hours prior to primer application. Prime coat shall be applied as recommended by the coating manufacturer, provided the coating as applied, complies with prevailing air pollution control regulations. Drying time between coats shall be as recommended by coating manufacturer.
Inspection Check points:	Check points 3-5, 7, 8, and 13.
System Thickness:	16 mils dry film, excluding patching mortar.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Patching Mortar:	One or more coats of Carboline Carboguard 501 Epoxy Filler.
Primer:	One coat of Carboline Carboguard 635 VOC Epoxy, applied at 10 mils wet film.
Finish:	One Three or more coats of Carboline Carboguard 635 VOC Epoxy, applied at 5 mils wet film each coat.
ALTERNATIVE 2	
Patching Mortar:	One or more coats of Devoe Devfil 145 Epoxy Filler. Note that epoxy filler shall be applied after application of primer.
Primer:	One coat of Devoe's Pre-Prime 167, applied at 3 mils wet film.
Finish:	Three or more coats of Devoe Bar Rust 236 Multi-Purpose Epoxy, applied at 5 mils wet film each coat.
ALTERNATIVE 3	
Patching Mortar:	One or more coats of ENECON Enecrete DuraQuartz.
Primer:	One coat of ENECON Chemclad SC, applied at 10 mils wet film.
Finish:	Two or more coats of ENECON Chemclad SC, applied at 10 mils wet film each coat.
ALTERNATIVE 4	
Patching Mortar:	One or more coats of PPG Amercoat 114A Epoxy Filler Compound.
Primer:	One coat of PPG Novaguard 840, applied at 10 mils wet film.
Finish:	Two or more coats of PPG Novaguard 840, applied at 10 mils wet film each coat.
ALTERNATIVE 5	
Patching Mortar:	One or more coats of Sherwin-Williams Dura-Plate 2300.
Primer:	One coat of Sherwin Williams Dura-Plate 235LV, applied at 10 mils wet film.
Finish:	Two or more coats of Sherwin Williams Dura-Plate 235LV, applied at 10 mils wet film each coat.
ALTERNATIVE 6	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	A-3
Coating Material:	Surface Filler and 100% Solids Sprayable Lining System, 125 mils DFT nominal
Surfaces:	Concrete, Masonry, and Miscellaneous Metals.
Service Condition:	Immersed, moderately corrosive environment.
Surface Preparation:	
	Follow Manufacturer's recommendation for crack repair and details at penetrations, construction joints, equipment bolts, anchors, transitions and terminations at edge of system, and other details specific to the structure being coated. The Contractor may use a trowel-applied formulation of the approved lining system if available from the manufacturer.
New:	Surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Concrete and masonry surfaces shall be cleaned with a minimum 5,000 PSI at 3 gpm pressure wash using a new turbo nozzle in accordance with SSPC-SP 13 to ICRI Technical Guideline #03732 CSP 3 minimum profile. Metals shall be prepared to SSPC-SP10 Near White Blast Cleaning.
Existing:	Concrete and masonry surfaces shall be cleaned with a minimum 5,000 PSI at 3 gpm pressure wash using a new turbo nozzle in accordance with SSPC-SP 13 to ICRI Technical Guideline #03732 CSP 5 minimum profile. Metals shall be prepared to SSPC-SP 10 Near White Blast Cleaning.
Inspection Check points:	Check points 2, 6, 7, and 10.
Application:	<p>Allow patching mortar/surface filler shall to cure according to manufacturer's instructions prior to coating application.</p> <p>Prime coat shall be applied as recommended by the coating manufacturer, provided the coating as applied, complies with prevailing air pollution control regulations.</p> <p>Drying time between coats shall be as recommended by coating manufacturer.</p>
Inspection Check points:	Check points 3-5, 7, 8, and 13.
System Thickness:	125 mils dry film, excluding patching mortar/surface filler.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Patching Mortar/Surface Filler:	APM Permaform COR+ROC
Sprayable Lining:	APM Permaform COR+ROC, 125 mils dry film thickness.
ALTERNATIVE 2	
Patching Mortar/Surface Filler:	Prime as required by manufacturer then apply Epoxytec Mortartec Ceramico, as required to fill bugholes and other surface imperfections.
Sprayable Lining:	Epoxytec CPP Sprayable, 125 mils minimum dry film thickness.
ALTERNATIVE 3	
Patching Mortar/Surface Filler:	Prime as required by manufacturer then apply Quadex QM-1s Restore, as required to fill bugholes and other surface imperfections.
Sprayable Lining:	Quadex Structure Guard, 125 mils dry film thickness.
ALTERNATIVE 4	
Patching Mortar/Surface Filler:	Prime as required by manufacturer then apply Raven 240 surface filler, as required to fill bugholes and other surface imperfections.
Sprayable Lining:	Raven AquataFlex 505, 125 mils dry film thickness.
ALTERNATIVE 5	
Patching Mortar/Surface Filler:	Prime as required by manufacturer then apply Speed Crete PM, Speed Crete Redline, or Approved Equal as required to fill bugholes and other surface imperfections.
Sprayable Lining:	SprayRoq Spraywall, 125 mils dry film thickness.
ALTERNATIVE 6	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	B-1
Coating Material:	Surface Tolerant Epoxy, 8 mils DFT nominal, 299 g/l max VOC
Surfaces:	Metal, concrete, masonry, previously painted surfaces
Available Colors:	Fully tintable custom colors
Service Condition:	Interior, mild corrosion service or washdown areas
Surface Preparation:	
Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 2 or SP 3.
Galvanized Metal:	Non-ferrous and galvanized metal shall be cleaned using a 3,000 PSI minimum, 2.8 GPM minimum, 110F minimum (130F maximum) hot water pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Hard to reach areas shall be cleaned using a solvent wipe or scrubbing with a firm bristle deck brush using 110F minimum wash water mixed with biodegradable cleaner. When the surface is dry, prepare for coating application by providing an SSPC-SP 7, 11, or 16. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Non-Ferrous Metal:	Prepare surfaces in accordance with SSPC-SP 7, 11, or 16. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Concrete and masonry	Prepare surfaces in accordance with ASTM D4259 Paragraph 6 Mechanical Abrading and ASTM D4258 Paragraph 6.5 Detergent Water Cleaning. The prepared surface shall be as described in ASTM D 4259.
Previously painted surfaces	Previously painted surfaces shall be prepared in accordance with SSPC-SP 2 or SP 3.
Inspection Check Points:	Check points 6, 7, and 10-12.
Application:	Shop or field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check points:	Check points 3, 4, 7 and 13.
System Thickness:	8 mils dry film minimum.
Level of Containment:	Refer to 1.08.

Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 60 Epoxy
Finish:	One or more coats of Carboline Carboguard 635 VOC Epoxy
ALTERNATIVE 2	
Primer:	One coat of Devoe Devran 203 Epoxy
Finish:	One or more coats of Devoe Bar Rust 235 Multi-Purpose Epoxy
ALTERNATIVE 3	
Primer:	One coat of International Ceilcote 680M
Finish:	One or more coats of International Interseal 670HS
ALTERNATIVE 4	
Primer:	One coat of PPG Amerlock 2 High Solids Epoxy Coating
Finish:	One or more coats of PPG Amerlock 2 High Solids Epoxy Coating
ALTERNATIVE 5	
Primer:	One coat of Sherwin Williams Macropoxy 5000
Finish:	One or more coats of Sherwin Williams Dura-Plate 235 Multi-Purpose Epoxy with LV Hardener, B67V240
ALTERNATIVE 6	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	B-3
Coating Material:	Epoxy, 8 mils DFT nominal
Surfaces:	Aluminum
Service Condition:	Interior, exterior, where aluminum is in contact with concrete or dissimilar metals
Surface Preparation:	Surface preparation for nonferrous and galvanized metal shall include a pressure wash with a cleaning solution recommended by the coating manufacturer, mixed with 160-degree water and applied at 2500 psi. Rinse with 160 degree water 2500 psi. When the surface is dry, prepare for coating application by providing a SSPC-SP 7. See Preparation paragraph within this Section for alternative methods.
Inspection Check points:	Check points 1 through 9 apply.
Application:	Shop or field.
Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 60 Epoxy, 2 to 3 mils dry film.
Finish:	One coat of Carboline Carboguard 635 VOC Epoxy, 4 to 6 mils dry film.
ALTERNATIVE 2	
Primer:	One coat of Devoe Devran 203 WB Epoxy, 2 to 3 mils dry film.
Finish:	One coat of Devoe Bar Rust 236 Multi-Purpose Epoxy, 6 to 8 mils dry film thickness.
ALTERNATIVE 3	
Primer:	One coat of PPG Amerlock 2 High Solids Epoxy Coating, 2 to 3 mils dry film.
Finish:	One coat of PPG Amerlock 2 High Solids Epoxy Coating, 6 to 8 mils dry film thickness.
ALTERNATIVE 4	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	B-4
Coating Material:	Fusion Bonded Epoxy
Surfaces:	Steel Dowels
Service Condition:	Steel expansion dowels embedded in concrete.
Surface Preparation:	SSPC-SP-10
Application:	Shop
General:	TFE lube shall be shop applied. Grease lube alternative shall be field applied just prior to installation.
System Thickness:	7 mils dry film, minimum for fusion-bonded epoxy. Apply one coat of TFE lube or grease lube, as required to provide a slip surface.
Coatings:	
ALTERNATIVE 1	
Coating:	3M Scotchkote 413, 1 or 2 coats. DuPont NapGuard 7-2719, 1 or 2 coats.
Lube:	TFE liquid coating compatible with fusion bonded epoxy. RL 736 manufactured by Amrep, Inc., Marietta, GA.
ALTERNATIVE 2	
	Approved Equal.

COATING SYSTEMS IDENTIFICATION:	C-1
Coating Material:	Epoxy primer, polyurethane finish
Surface:	Metal
Service Condition:	Non-immersed, exposure to moisture and sunlight, color required.
Surface Preparation:	
Ferrous Metal:	<ol style="list-style-type: none"> 1. Ferrous metal surfaces shall be prepared in accordance with SSPC-SP-10. 2. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces in accordance with SSPC-SP 2. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP 11 and recoated with the primer specified. Previously coated surfaces shall be feathered in at the edges.
Nonferrous and Galvanized Metal:	Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Inspection Check Points:	Check points 1, 2, 6, 7, and 10-12.
Application:	Shop or field.
General:	Drying time between coats shall be as specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 3, 4, 5, 7, 8 and 13.
System Thickness:	8 mils dry film minimum.
Level of Containment:	Refer to 1.08.
Coatings:	
ALTERNATIVE 1	
Primer:	One coat of Carboline Carboguard 635 VOC Epoxy
Finish:	One or more coats of Carboguard Carbothane 134 HG Polyurethane
ALTERNATIVE 2	
Primer:	One coat of Devoe Devran 203 Epoxy
Finish:	One or more coats of Devoe Devthane 379H Polyurethane
ALTERNATIVE 3	
Primer:	One coat of PPG Amerlock 2 High Solids Epoxy Coating
Finish:	One or more coats of PPG Amershield VOC
ALTERNATIVE 4	
Primer:	One coat of Sherwin Williams Macropoxy HS
Finish:	One or more coats of Sherwin Williams Hi-Solids Polyurethane 250
ALTERNATIVE 5	
	Approved Equal.

COATING SYSTEMS IDENTIFICATION:	C-3
Coating Material:	Vinyl Ester, 40-60 mils DFT nominal
Surfaces:	Concrete, secondary containment: all vertical and horizontal surfaces within the containment area including the top of the containment wall. Concrete exposed to chemical leakage: Pipe trenches and equipment pads associated with conveying the chemicals listed below.
Service Condition:	Exposure to moisture and sunlight. Chemicals stored in containment or conveyed are: sodium hydroxide (25% concentration), ferric chloride (35-40% concentration), sodium hypochlorite (15% concentration), citric acid (50% concentration), and both liquid and dry polymers (50% concentration). Exposure: splash-spill up to 48 hours
Surface Preparation: concrete and masonry	Allow new concrete and mortar to cure 28 days. Abrasive blast or mechanically abrade concrete to remove laitance, form release agents, curing compounds, hardeners, sealers, dirt, oil and other contaminants. Surfaces must be clean, dry and sound. Voids and cracks shall be repaired per Section 03 30 01. When repair work in Section 03 30 01 is complete, prepare concrete per SSPC-SP 13 to ICRI Technical Guideline #310.2. Following surface cleaning, apply a coat of the manufacturer's recommended patching mortar to entire surface to repair bug holes and other imperfections.
Surface Preparation: metals	Metals shall be prepared to SSPC-SP 10 Near White Blast Cleaning.
Inspection Check Points:	Check points 2, 6, 7, 10, and 11.
General:	Follow manufacturer's recommendation for crack repair and details at floor penetrations, wall bases, construction joints, equipment bolts, metal angle frames at trenches, transitions and terminations at edge of system, and other details specific to the structure being coated.
Application:	<ol style="list-style-type: none"> 1. Patching mortar shall cure per manufacturer's requirements prior to primer application. 2. Prime coat shall be thinned and applied as recommended by the coating manufacturer. 3. Drying time between coats shall be as recommended by coating manufacturer. 4. Extend coating completely under structures and equipment. 5. Provide continuous sealant, backing material, and joint-lining treatment recommended by the coating manufacturer at all expansion, isolation, and construction joints. 6. Coat over equipment anchors and base plates installed in areas receiving coating to maintain continuous liquid-tight seal.
Inspection Check points:	Check points 3-5, 7, 8 and 13.
System Thickness:	40 mils dry film minimum, excluding patching mortar.

Coatings:	
ALTERNATIVE 1	
Patching Mortar:	Coating manufacturer's recommendation.
Primer:	One coat of Carboline Semstone 800 series primer.
Finish:	One or more coats of Carboline Semstone 870.
ALTERNATIVE 2	
Patching Mortar:	Coating manufacturer's recommendation.
Primer:	One coat of International Ceilcote 380 primer.
Finish:	One or more coats of International Ceilcote 242 Flakeline.
ALTERNATIVE 3	
Patching Mortar:	One or more coats of Sherwin-Williams Dura-Plate 2300.
Primer:	One coat of Sherwin Williams Corobond Vinyl Ester primer.
Finish:	One or more coats of Sherwin Williams Cor-Cote VEN GF.
ALTERNATIVE 4	
	Approved Equal.

Coating System Identification:	D-1
Coating Material:	Urethane semi-gloss or gloss, 5 mils DFT
Surfaces:	Existing and new FRP and steel doors and frames, factory primed architectural metals and specialties.
Available Colors:	Fully tintable custom colors
Service Condition:	Noncorrosive, exposure to moisture and sunlight, washdown areas
Surface Preparation:	
New Steel Doors; Steel Sheet: Hot-dipped galvanized steel, ASTM A653, A60 coating and other galvanized metals;	Perform Brush-Off Blast Cleaning of all galvanized surfaces per SSPC-SP 16. Surface preparation may be reduced to SSPC-SP 2 or SSPC-SP 3 with written approval from coating manufacturer.
Fiberglass Reinforced Plastic (FRP) Doors and Previously Painted Surfaces; factory primed architectural metals and specialties	Prepare surfaces in accordance with SSPC-SP 2 or SP 3. Alternative surface preparation methods shall be per the manufacturer's written direction for profile and surface cleanliness for the given application.
Inspection Checkpoints:	Checkpoints 6 and 7 apply.
Application:	Drying time between coats shall be as recommended by the coating manufacturer. Apply coats at Wet Film Thicknesses equal to or greater than manufacturer's minimum recommended thicknesses.
Inspection Checkpoints:	Checkpoints 4, 6, 7, and 13 apply.
System Thickness:	5 mils dry film, minimum.

Coatings:	
Sheen: SEMI-GLOSS or GLOSS	
ALTERNATIVE 1	
Primer:	Hot-dipped galvanized steel: One coat of Carbolite Galoseal WB.
Primer:	FRP and previously painted surfaces; factory primed architectural metals and specialties: One coat of Carbolite Sanitile 120.
Finish:	Two coats of Carbothane 134 HG.
ALTERNATIVE 2	
Primer:	Hot-dipped galvanized steel: N/A
Primer:	FRP and previously painted surfaces; factory primed architectural metals and specialties: N/A
Finish:	Two coats of PPG Durethane DTM 95-3300.
ALTERNATIVE 3	
Primer:	Hot-dipped galvanized steel: One coat of Sherwin-Williams DTM Wash Primer.
Primer:	FRP and previously painted surfaces; factory primed architectural metals and specialties: N/A
Finish:	Two coats of Sherwin-Williams Acrolon 218HS Acrylic Polyurethane.
ALTERNATIVE 4	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	H-1
Coating Material:	High temperature silicone, 1.5 mils DFT nominal
Surface:	Metal
Service Condition:	Temperature to 600 degrees F, continuous
Surface Preparation:	Metal surfaces shall be prepared in accordance with SSPC-SP 10 (Near White Metal Blast Cleaning).
Inspection Check points:	Check points 1 through 9 apply.
Application:	1. Field 2. Curing as required by coating manufacturer.
Coatings:	
ALTERNATIVE 1	Three coats of International Intertherm 50
ALTERNATIVE 2	
Primer:	One coat of PPG Hi-Temp 1027 Inorganic Ceramic Coating
Finish:	One or more coats of PPG Hi-Temp 1000 Universal Silicone Topcoat
ALTERNATIVE3	Two coats of Sherwin-Williams KEM HI-TEMP HEAT-FLEX II 450
ALTERNATIVE 4	Approved Equal.

COATING SYSTEM IDENTIFICATION:	J-1
Coating Material:	Clear acrylic urethane.
Surfaces:	Concrete floors, interior.
Service Condition:	Traffic area, some standing water.
Surface Preparation:	
New Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested by the Contractor and witnessed by the Project Representative in accordance with ASTM D4263, or approved equal. If the floor is trowel-finished the surface shall be etched with a non-acid etching chemical such as NewLook QuickEtch or Eco Safety Eco-Etch Pro and then cleaned by 2,500 psi minimum pressure wash. If the floor is broom-finished the surface shall be cleaned by 2,500 psi minimum pressure wash.
Existing Concrete:	Previous coatings shall be removed with a "blastrac" and then cleaned by 2,500 psi minimum pressure wash. Voids and cracks shall be repaired.
Application:	Field. Sealer or filler shall dry a minimum of 48 hours prior to application of prime coat. Prime coat shall be thinned and applied as recommended by the coating manufacturer, provided the coating as applied complies with prevailing air pollution control regulations.
Inspection Check points:	Checkpoints 6, 7, 10 and 13 apply.
System Thickness:	Two coats at 3 mils wet film each.
Coatings:	
ALTERNATIVE 1	Two coats Rainguard Clear-Seal Low Gloss Acrylic Urethane Sealer
ALTERNATIVE 2	Two coats of Eagle Armor Seal
ALTERNATIVE 3	Approved Equal.

COATING SYSTEM IDENTIFICATION:	J-3
Coating Material:	Water reducible epoxy, 5 mils DFT nominal
Surfaces:	Concrete floors, interior.
Service Condition:	Traffic area, some standing water.
Surface Preparation:	
New Concrete:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested by the Contractor and witnessed by the Project Representative in accordance with ASTM D4263, or approved equal. Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by steam cleaning and abraded with a "blastrac". Voids and cracks shall be repaired.
Existing Concrete:	Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by steam cleaning and abraded with a "blastrac". Voids and cracks shall be repaired.
Application:	Field.
General:	Follow manufacturer's instructions for mixing and "sweat-in" time.
Inspection Check points:	Checkpoints 6, 7, 10, and 13 apply.
System Thickness:	Two coats at 5 mils wet film each.
Color:	As selected by Project Representative from manufacturer's standard colors.
Coatings:	
ALTERNATIVE 1	Two coats of Carbolite Sanitile 555
ALTERNATIVE 2	Two coats of International 4426/4428 TruGlaze WB Epoxy
ALTERNATIVE 3	Two coats of Rust-Oleum Sierra S40 Epoxy
ALTERNATIVE 4	Two coats of PPG Aquapon WB epoxy
ALTERNATIVE 5	Two coats of Sherwin-Williams ArmorSeal 8100
ALTERNATIVE 6	Approved Equal.

COATING SYSTEM IDENTIFICATION:	J-5
Coating Material:	Silane water repellent clear sealer.
Surfaces:	Unpainted CMU and Concrete
Service Condition:	Non-corrosive environment.
Surface Preparation:	
New Concrete and Masonry:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Pressure wash or solvent wipe to ensure that surfaces are free from laitance, dust, paint, grease, and oil.
Existing Concrete and Masonry:	Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by pressure washing. Voids and cracks shall be repaired.
Application:	Field.
General:	Follow manufacturer's instructions.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Coat to surface saturation.
Color:	Clear.
Coatings:	
ALTERNATIVE 1	One coat of BASF MasterProtect H 1000
ALTERNATIVE 2	One coat of OKON S-20
ALTERNATIVE 3	Approved Equal.

COATING SYSTEM IDENTIFICATION:	J-6
Coating Material:	Anti-Graffiti Coating
Surfaces:	Exterior masonry, vertical concrete, and doors and door frames.
Service Condition:	Non-corrosive environment.
Surface Preparation:	
New Concrete and Masonry:	Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Pressure wash or solvent wipe to ensure that surfaces are free from laitance, dust, paint, grease, and oil.
Existing Concrete and Masonry:	Loose concrete, form oils, surface hardeners, curing compounds and laitance shall be removed. Surface shall be cleaned by pressure washing. Voids and cracks shall be repaired.
Doors and door frames:	Clean by solvent wiping.
Application:	Field.
General:	Follow manufacturer's instructions.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Coat to surface saturation.
Color:	Clear.
Coatings:	
ALTERNATIVE 1	One coat of OKON Graffiti Barrier Coat
ALTERNATIVE 2	One coat of Rainguard Vandlguard One
ALTERNATIVE 3	Approved Equal.

COATING SYSTEM IDENTIFICATION:	J-7
Coating Material:	Anti-Slip Coating
Surfaces:	Any primed surface.
Service Condition:	Any wastewater environment.
Surface Preparation:	
New Concrete:	Prepare and prime per manufacturer's instructions.
Previously Painted or Primed Surfaces:	Pressure wash or solvent wipe to ensure that surfaces are free from laitance, dust, paint, grease, and oil.
Application:	Field.
General:	Follow manufacturer's instructions.
Inspection Check points:	Checkpoints 6, 7, and 10 apply.
System Thickness:	Follow manufacturer's instructions.
Color:	Gray or as selected by Project Representative from manufacturer's standard colors.
Coatings:	
ALTERNATIVE 1	American Safety Technologies AS-175
ALTERNATIVE 2	PPG SFT610 Waterborne Epoxy Low Profile Anti-Slip
ALTERNATIVE 3	Sherwin Williams EPIDEK M339
ALTERNATIVE 4	Approved Equal.

COATING SYSTEM IDENTIFICATION:	L-1A
Coating Material:	100% Acrylic semi-gloss or eggshell/satin, 4.5 mils DFT nominal
Surfaces:	Concrete, masonry, plaster, gypsum board, metals, and previously painted surfaces.
Service Condition:	Interior or exterior, exposure to moisture and sunlight, color required. Not for washdown or corrosion service.
Surface Preparation:	
Concrete and Masonry:	<p>Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the coating manufacturer. Moisture content shall be tested by the Contractor and witnessed by the Project Representative per ASTM D4263, or approved equal. Loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by grinding and chipping, and voids and cracks shall be repaired. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be cleaned and filled with block filler compatible with the specified primer.</p> <p>When pressure washing is not possible, as determined by the Project Representative, alternate surface prep method as approved by Project Representative: Solvent wipe per coating manufacturer's instructions.</p>
Metals and previously painted surfaces:	<p>Clean using a 3,000 PSI, 2.8 GPM minimum, 110F minimum (130F maximum) hot water pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. The pressure washing nozzle orifice size shall be selected from industry standard nozzle charts for the rated flow and pressure of the pump. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Follow the additional requirements of ASTM D 4258 Detergent Water Cleaning. Hard to reach areas and all areas where pressure washing will cause damage shall be cleaned using a solvent wipe or scrubbing with a firm bristle deck brush using 110F minimum wash water mixed with a biodegradable cleaner listed in L-1a for "Previously painted surfaces". Rinse with potable water after pressure washing or scrubbing.</p> <p>When pressure washing is not possible, as determined by the Project Representative, alternate surface prep method as approved by Project Representative: Abrade and solvent wipe per coating manufacturer's instructions.</p>
Plaster:	<p>Plaster surfaces shall be dry and clean and free from grit, loose plaster and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sanded smooth. Surfaces shall be cleaned with clean water by washing and scrubbing to remove foreign substances. After cleaning, surfaces shall be sealed with a compatible sealer.</p>
Gypsum Wallboard:	Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer.
Inspection Checkpoints:	Checkpoints 6, 7, 11, and 12 apply.
Application:	Sealer or filler shall cure according to manufacturer's recommendations prior to priming. Drying time between coats shall be as recommended by the coating manufacturer. Apply coats at Wet Film Thicknesses equal to or greater than manufacturer's minimum recommended thicknesses.
Inspection Checkpoints:	Checkpoints 6, 7, and 13 apply.
System Thickness:	4.5 mils dry film, minimum, for 1 prime coat and 2 topcoats.

Coatings:	
Sheen: SEMI-GLOSS	
ALTERNATIVE 1	
Primer: Concrete, Metals, and previously painted surfaces	One coat of PPG Hydrosealer Primer 6001.
Finish:	Two coats of PPG Pitt Tech Plus 4216HP.
ALTERNATIVE 2	
Primer: Concrete and previously painted surfaces	One coat of Sherwin-Williams Loxon Concrete & Masonry Primer #A24W8300.
Primer: Metals	One coat of Sherwin-Williams DTM Acrylic Primer #B66W1.
Finish:	Two coats of Sherwin-Williams Sher-Cryl HPA Acrylic #B66-350.
ALTERNATIVE 3	
	Approved Equal.
Sheen: EGGSHELL/SATIN	
ALTERNATIVE 1	
Primer: Concrete, Metals, and previously painted surfaces	One coat of PPG Hydrosealer Primer 6001.
Finish:	Two coats of PPG Pitt-Tech Plus 90-1110.
ALTERNATIVE 2	
Primer: Concrete and previously painted surfaces	One coat of Sherwin-Williams Loxon Concrete & Masonry Primer #A24W8300 tinted to near-topcoat color if possible.
Primer: Metals	One coat of Sherwin-Williams DTM Acrylic Primer #B66W1.
Finish:	Two coats of Sherwin-Williams Pro Industrial Acrylic #B66-660.
ALTERNATIVE 3	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	M-1
Coating Material:	Petrolatum, wax, asphalt, or polyolefin wrapping tapes, 50 mils DFT nominal coating thickness prior to application of over wrap
Surfaces:	Buried metal, where minimal surface preparation is possible.
Service Condition:	Buried or locations where metals are in contact with soil.
Surface Preparation:	Refer to coating manufacturer's instructions. Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC-SP 2 Hand Tool Cleaning or SSPC-SP 3 Power Tool Cleaning.
Inspection Checkpoints:	Checkpoints 6, 7 and all manufacturer's recommended inspection procedures apply.
Application:	Refer to coating manufacturer's instructions. Apply sufficient wraps of coating tape to achieve a minimum coating thickness of 50 mils prior to the application of over wrap or the manufacturer's minimum recommended thicknesses, whichever is greater. Apply sufficient wraps of coating tape or surface filler to nuts, bolts, and sharp projections to achieve a minimum coating thickness of 100 mils prior to the application of over wrap.
Inspection Checkpoints:	Checkpoint 5 and all manufacturer's recommended inspection procedures apply.
System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils prior to the application of over wrap.

Coatings:	
ALTERNATIVE 1	AMCORR
Primer:	None
Coating:	VISCOTAQ Viscowrap-ST
Over wrap:	PE Outer Wrap
Surface filler:	Viscopaste
ALTERNATIVE 2	Berry
Primer:	None
Coating:	Stopaq Wrappingband CZ
Over wrap:	Stopaq Outerwrap PE
Surface filler:	Stopaq 4100 Putty
ALTERNATIVE 3	Chase
Primer:	Omniprime
Coating:	Tapecoat H35
Over wrap:	Tapecoat Terrashield
Surface filler:	Tapecoat Profile Putty
ALTERNATIVE 4	Denso
Primer:	MP Primer
Coating:	Densyl Tape
Over wrap:	PVC Self adhesive Tape
Surface filler:	Profiling Mastic
ALTERNATIVE 5	Polyguard
Primer:	600 Liquid Adhesive
Coating:	RD-6
Over wrap:	SP-6 Outerwrap
Surface filler:	606 Filler Tape
ALTERNATIVE 6	Trenton
Primer:	Temcoat 3000
Coating:	Wax-Tape #1
Over wrap:	Guard-Wrap
Surface filler:	Fill-Pro PM-GP
ALTERNATIVE 7	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	M-2
Coating Material:	Epoxy or bituminous mastic, 16 mils DFT
Surfaces:	Metal
Service Condition:	Confined enclosures with corrosive environment, where minimal surface preparation is possible.
Surface Preparation:	Refer to coating manufacturer's instructions. Remove loose scale, rust and dirt from the surface in accordance with SSPC-SP 2 Hand Tool Cleaning or SSPC-SP 3 Power Tool Cleaning.
Inspection Check Points:	Checkpoints 6, 7 and all manufacturer's recommended inspection procedures apply.
Application:	Refer to coating manufacturer's instructions. Apply sufficient coats to achieve 16 mils dry film minimum or manufacturer's minimum coating thickness, whichever is greater.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Checkpoints 4 and 7.
System Thickness:	16 mils dry film minimum.
Coatings:	
ALTERNATIVE 1	
	Two or more coats of Carboline Carbomastic 94 Epoxy
ALTERNATIVE 2	
	Two or more coats of Denso Protal ST Epoxy Mastic
ALTERNATIVE 3	
	Two or more coats of Jotun Jotamastic 90
ALTERNATIVE 4	
	Two or more coats of Polyguard CA- 14 Mastic
ALTERNATIVE 5	
	Two or more coats of PPG Pitt-Guard 95-245 Rapid Coat DTR Epoxy Mastic Coating
ALTERNATIVE 6	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	P-1
Coating Material:	Ceramic or glass reinforced epoxy lining for ductile iron pipe in wastewater service, 40 mils nominal DFT, 84% solids (minimum)
Surfaces:	Ductile Iron Pipe
Available Colors:	Green, White, or Black
Service Condition:	Immersed, highly corrosive environment.
Surface Preparation:	
Ductile Iron Pipe:	The interior surfaces of Ductile Iron Pipe shall be prepared in accordance with NAPF 500-03-04.
Inspection Check Points:	Ambient Conditions: Check point 7 Anchor Profile: Check point 2 or as specified by coating manufacturer
Application:	Shop or field.
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Ambient Conditions: Check point 7 DFT readings: Check point 4 or as specified by coating manufacturer Holiday testing: Check point 5 or as specified by coating manufacturer
Touch-Up:	As specified by coating manufacturer
Bells and Sockets:	Apply coating as required by manufacturer to facilitate gasket fit.
System Thickness:	40 mils dry film (nominal), 35 mils dry film (minimum), 50 mils dry film (maximum).
Coatings:	
ALTERNATIVE 1	
	One or more coats of Carboline Plasite 4500
ALTERNATIVE 2	
	One or more coats of Induron Protecto 401 Epoxy
ALTERNATIVE 3	
	One or more coats of PPG Sigmashield 880 GF Epoxy
ALTERNATIVE 4	
	One or more coats of Sherwin-Williams Dura-Plate 6000 Epoxy
ALTERNATIVE 5	
	One or more coats of Tnemec 431 Epoxy
ALTERNATIVE 6	
	Approved Equal.

COATING SYSTEM IDENTIFICATION:	S-1
Coating Material:	Acrylic Stain, Solid Color, 6 mils DFT nominal
Surfaces:	Exterior Wood
Available Colors:	Fully Tintable
Service Condition:	Atmospheric
Surface Preparation:	
Exterior Wood:	Sand or abrade all wood surfaces to expose the wood grain. Clean using a 1,500 PSI, 1 GPM minimum, pressure washer using a new 15 degree or 25 degree fan tip held at 12" or less from the surface. The pressure washing nozzle orifice size shall be selected from industry standard nozzle charts for the rated flow and pressure of the pump. Use a phosphate-free biodegradable cleaner in the wash water such as Simple Green House & Siding Cleaner Pressure Washer Concentrate, Hotsy Enviro-Clean, or Krud Kutter House & Siding Pressure Washer Concentrate. Scrub with deck brush or similar tool all areas that are inaccessible to pressure washing. The County shall provide a cold potable water source. Rinse with potable water after pressure washing or scrubbing.
Inspection Check Points:	Checkpoints 6, 7, and 12 apply.
Application:	
General:	Drying time between coats shall be specified by the manufacturer for the site conditions.
Inspection Check Points:	Check points 4, 7, 8, and 13 apply.
System Thickness:	6 mils dry film minimum. Refer to coating system alternates for numbers of coats. Apply coats at Wet Film Thicknesses equal to or greater than manufacturer's minimum recommended thicknesses.
Coatings:	
ALTERNATIVE 1	
	Two or more coats of PPG Flood Pro FLD820 Acrylic Solid Color stain
ALTERNATIVE 2	
	Two or more coats of Rodda Sharkskin Acrylic Urethane Solid Wood Stain
ALTERNATIVE 3	
	Two or more coats of Sherwin-Williams SuperDeck Coating
ALTERNATIVE 4	
	Approved Equal.

END OF SECTION

SECTION 09 97 50

FULLY ADHERED PLASTIC LINING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes a fully adhered polyvinyl chloride (PVC) sheet lining system on prepared concrete surfaces, including the surface preparation, installation, and testing.

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 C805	Standard Test Method for Rebound Number of Hardened Concrete (Swiss Hammer)
ASTM D4262	Standard Test Method for Chemically Cleaned or Etched Concrete Surfaces
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings using Portable Adhesion Tester
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
EPA Method 1311	Toxicity Characteristic Leaching Procedure (TCLP) for Resource Conservation and Recovery Act (RCRA) 8 Metals
SSPC-SP5	"White Metal" Abrasive Blast Cleaning

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
1. Proposed method(s) of repairing joint leaks.
 2. Surface preparation plan indicating which manufacturer-approved methods will be used by Contractor for all substrates which may be encountered on this project.
 3. Complete liner layout and application sequencing plan which includes individual sheet dimensions, details of liner openings, terminations, and order of application. This plan shall include a complete list of primers, adhesives, grouts, and any other materials which will be used. The layout and sequencing plan must be approved before installation.
 4. Manufacturer certification of each applicator proposed for the lining installation.
 5. Manufacturer's Technical Representative: Authorized representative of the manufacturer, factory trained, and experienced in the technical application, installation, operation, and maintenance of the lining system and all of its components, with full authority by the manufacturer to issue the certification of proper installation.
 6. Field Inspector: In the event that the Manufacturer's Technical Representative is not available a Field Inspector authorized by the manufacturer to continuously perform testing and provide daily field documentation and inspection services to the lining Contractor during all phases of protective lining application.
 7. Provide information on new abrasive blasting media including lab test report for RCRA 8 heavy metals testing per EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP) and coating manufacturer's recommended grit/shot size for coating systems specified. The lab test report shall be within the lab's current TCLP certification period.

1.04 QUALITY ASSURANCE

- A. Licensing and Certification:
 - 1. Each applicator performing the installation shall be certified by the manufacturer.
 - 2. Lining application done under this specification shall be directed by the Manufacturer's Technical Representative and shall be subject to inspection by the Project Representative.

1.05 SHIPMENT, PROTECTION, AND STORAGE

- A. Shipment, protection, and storage: Section 01 67 00.
- B. Deliver materials to the job site in their original, unopened containers. Each container shall bear the manufacturer's brand name, product name, batch number, storage life and special directions.
- C. Protect stored materials from weather and excessive heat or cold, and store in accordance with the manufacturer's instructions. Store flammable materials in accordance with the state and local codes. Remove materials exceeding storage life recommended by the manufacturer from the site.
- D. Safety precautions recommended by the lining manufacturer in printed instructions or special bulletins shall be obtained and followed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. ArmorLok ShieldLok System.
1420 Richardson St
San Bernardino CA 92408
(909) 260-0336
armorlok1@gmail.com
<https://www.armorlok.net/>
 - 2. Linabond SP Mastic System.
German Gilli
1161 Avenida Acaso
Camarillo, CA 93012
805-484-7373 office
310-345-1084 cell
g_gilli@linabond.com
www.linabond.com
 - 3. Approved Equal. Engineer knows of no other alternates.

2.02 MATERIALS

- A. Primer: As recommended by manufacturer.
- B. Adhesive: As recommended by manufacturer.
- C. Exposed Rebar Coating: As recommended by manufacturer.
- D. Patching Grout: As recommended by manufacturer.
- E. PVC Sheet Liner: Minimum 0.030 inch thick
- F. All other lining system accessories to seal seams, connect to existing plastic liner, and provide for a complete installation: As recommended by manufacturer.

- G. Abrasive Blasting material shall meet MIL-A-22262A (SH) and shall contain RCRA 8 heavy metal concentrations for Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver below EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP) regulatory limits.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. General:

1. Prepare the existing concrete and grout surfaces to be lined using one of the scarification methods outlined in this Section, as approved by the lining manufacturer, to provide a contamination-free, roughened, and sound surface. This scarification is expected to alter the surface profile in areas where the concrete is deteriorated.
2. Adequately prepare concrete and grout surfaces and make them ready for lining by making them sound, surface-dry, porous, and free of dust, dirt, oil, grease, fat, efflorescence, concrete hardening or sealing chemicals, previous coatings, rust, form-release agents, laitance, other penetrating contaminants, Hydrogen Sulfide corrosion products, fins, projections, thin crusts, bridging voids, and loosely adhering concrete, grout, and dirt particles.
3. The pH of the prepared surface shall be between 7 and 12 when tested per ASTM D4262.
4. The minimum surface profile amplitude shall be in accordance with the manufacturer's recommendations.
5. The maximum surface profile amplitude allowed when a 10-foot straight edge is contacted on the surface in any direction shall be ½ inch maximum for corroded concrete surfaces, and ¼-inch for new concrete. Areas that do not meet the maximum allowed surface profile amplitude shall be repaired with cementitious mortar and shall be blasted to remove laitance, efflorescence, and loose materials.
6. Clean exposed rebar to a 'White Metal,' SSPC-SP5 finish profile. After cleaning exposed rebar, coat with rebar primer according to manufacturer's recommended application procedures.
7. Prior to lining, new concrete and grout surfaces shall be allowed to cure for a minimum of 28 days, and surfaces repaired with cementitious mortar shall be allowed to cure for a minimum of 10 days.
8. Repair joint leaks. The repair is to be approved by the Project Representative prior to installation of the lining system.
9. Retain particulate waste created by scarification that is larger than a U.S. No. 8 sieve and remove from the pipeline or structure. Arrange for disposal of such material at a legal dumpsite or as determined by the Project Representative.
10. At interfaces with the existing plastic liner, prepare the existing liner in accordance with the manufacturer's recommendations.

B. Methods:

1. Wet abrasive blast:
 - a. Use clean, fresh water in combination with blasting material at sufficient pressures (minimum of 80 psi at the nozzle as measured with a common nozzle pressure gauge) to achieve the specified level of preparation.
 - b. Blasting material shall have a maximum particle size no larger than that passing through a No. 16 mesh screen, U.S. sieve series.
 - c. After a wet abrasive blast, clean the surface by rinsing with fresh water. If necessary, supplement this cleaning by brushing to remove any residue. Dry the cleaned surface as required for lining adhesion.
2. High Pressure Water Cleaning:
 - a. Use clean, fresh water.
 - b. Equipment shall sustain water pressures of at least 6,000 psi at the nozzle.
 - c. Remove all dust and debris.
 - d. Dry the cleaned surface as required for lining adhesion.
3. Dry sandblasting:
 - a. Equipment shall be capable of supplying at least 375 cfm of air with a minimum pressure of 80 psi at the blast nozzle, as measured with a common nozzle pressure gauge. Abrasive blast

nozzles shall have a minimum diameter of 0.5-inch and shall be of the venturi or other high velocity type.

- b. Blasting material should have a maximum particle size no larger than that passing through a No. 16 mesh screen, U.S. sieve series.
- c. After dry sandblasting, clean the surface for the purpose of removing any traces of blast products from the surface and also for the removal of abrasives from pockets and corners.
- d. Wash down the surface to remove all dust particles.
- e. Dry the cleaned surface as required for lining adhesion.
- f. The compressed air used for nozzle blasting shall be free of detrimental amounts of condensed water or oil.
- g. Provide adequate separators and traps.

C. Inspection and Testing:

1. All parts of the work shall be accessible to the Project Representative. Defective work shall be corrected as directed by the Manufacturer's Technical Representative and the Project Representative.
2. The prepared surface will be visually inspected by the Project Representative to ensure the acceptability of the concrete for lining.
3. The pH of the prepared surface will be tested by the Project Representative in accordance with ASTM D4262.
4. Test the prepared surface by Swiss impact hammer per ASTM C805 or other manufacturer-approved physical testing method to determine soundness.
5. In addition, the prepared surface, including pH, moisture, surface profile and soundness, shall be approved by the Manufacturer's Technical Representative prior to installation of the lining. Contractor shall not apply the lining system until such approval has been issued.

3.02 APPLICATION

- A. Contractor shall be responsible for obtaining the services of the Manufacturer's Technical Representative or a Field Inspector approved by the manufacturer. The Field Inspector shall continuously perform testing and provide daily field documentation and inspection services to the lining Contractor during all phases of protective lining application to monitor that the work, including surface preparation, mixing, drying times and application procedures, are performed per the manufacturer's recommendations. The Manufacturer's Technical Representative or Field Inspector shall review performance, quality, and progress of the lining system work, and shall inform the Project Representative of their findings.
- B. Control of Ambient and Substrate Conditions in Structures to be lined: Contractor shall control ambient conditions in the structures to be lined, and provide protective enclosures during surface preparation, application, and curing to meet the ambient conditions specified by the manufacturer. Contractor shall continue to meet the ambient conditions throughout the lining system work.
- C. Primer:
 1. Mix and apply material per the manufacturer's recommendations.
- D. Adhesive:
 1. Apply per manufacturer recommendations.
- E. Sheet Liner:
 1. Install per the manufacturer's recommendations.
 2. Install seam sealants or PVC seam strips per the Manufacturer's Technical Representative's recommendations.
 3. Temporary supports to hold the PVC sheets may be necessary on curved or otherwise stressed areas.
 4. Terminate lining as shown on the Drawings or using manufacturer's requirements for termination details.

F. Inspection and Testing:

1. All parts of the work shall be accessible to the Project Representative. Defective work shall be corrected as directed by the Manufacturer's Technical Representative and the Project Representative.
2. After installation, the surface of the liner shall be visually inspected by the Manufacturer's Technical Representative or Field Inspector for areas of poor adhesion, air pockets, edges or seam defects, rips, tears and punctures, insufficient overlap, inadequate bond or any other defects in the lining preventing a complete seal of the protected surfaces.
3. The lining system shall have a "pull-off test" performed at locations previously designated by the Project Representative and prepared by the lining Contractor at a minimum rate of one test per 500 square feet of installed lining or at least one test per structure, whichever is greater. The test shall be the "Standard Test Method for Pull-Off Strength of Coatings using Portable Adhesion Tester" per ASTM D4541 and modified as follows. The 1 square inch area to be tested shall be cored through the lining system past the bond area with the concrete substrate. The allowable minimum value for the pull-off strength test shall be per the protective lining system manufacturer's recommendation.
4. Perform holiday testing per ASTM D5162 as required by Manufacturer's Technical Representative or Field Inspector.
5. Provide access to the work including scaffolding as needed to facilitate testing and inspection.

G. Repair of Defects:

1. Repair defects in the lining system where directed by the Project Representative.
2. Patch torn, cut, or badly abraded areas using manufacturer's approved repair methods.
3. Patch holes in liner resulting from testing using manufacturer's approved repair methods.

H. Curing of Protective Lining System:

1. The finished lining shall be protected from damage during curing and shall be cured as recommended by the lining manufacturer but in all cases no less than 3 days of curing time must elapse before the lined area can be placed into service.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies informational and accident prevention signs. Exit signs are not covered in 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
29 CFR 1910.145	OSHA Specification for Accident Prevention Signs and Tags
ANSI Z535.1	Safety Color Code
ANSI Z535.2	Environmental and Facility Safety Signs
IFC	International Fire Code
WAC 296-24 (Part B-2)	WISHA Marking Physical Hazards
NFPA	SIGNS REQUIRED BY NFPA 704

1.03 DESIGN REQUIREMENTS

- A. General
- Accident prevention signs shall conform to requirements of WISHA Chapter 296-24 WAC (Part B-2), OSHA 29 CFR 1910.145, ANSI Z535.1 and ANSI Z535.2.
 - Exit signs shall conform to the requirements of IFC 1011 and the local administrative authority.
 - All signs shall have rounded corners and four mounting holes.
 - Number, size, type and placement of signs shall be as indicated in the schedules in Paragraph 1.05 of this Section.
 - The hazardous material numerical grading signs shall be provided and installed on the material storage room entry door and storage container per NFPA 704 requirements.
- B. Sign size shall be as follows:

SIZE	WIDTH X HEIGHT
A	14 inches x 20 inches
B	10 inches x 14 inches
C	7 inches x 10 inches
D	14 inches x 10 inches
E	24 inches x 18 inches
F	12 inches x 18 inches

- C. Sign type shall be as follows:

TYPE	MESSAGE	SIZE
101	DANGER - 480 VOLTS	C
102	DANGER - 4160 VOLTS	C

TYPE	MESSAGE	SIZE
103	DANGER - HIGH VOLTAGE	C
104	DANGER - CONFINED SPACE ENTER BY PERMIT ONLY	B
105	DANGER - CONFINED SPACE AUTHORIZED PERSONNEL ONLY	B
106	DANGER - HOT	C
201	WARNING – HAZARDOUSE MATERIALS	C
202	WARNING -	
203	WARNING -	
204	WARNING -	
205	WARNING -	
206	WARNING -	
301	CAUTION - NON POTABLE WATER DO NOT DRINK	B
302	CAUTION - CORROSIVE MATERIALS WEAR REQUIRED PROTECTION	B
303	CAUTION - HEARING PROTECTION REQUIRED	B
304	CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME	B
305	CAUTION - LOW CLEARANCE	C
306	CAUTION - HIGH TEMPERATURE	C
401	NOTICE - AUTHORIZED PERSONNEL ONLY	C
402	NOTICE - KEEP THIS DOOR CLOSED	C
403	NOTICE -	
404	NOTICE -	
405	NOTICE -	
406	NOTICE -	
501	SAFETY FIRST - EMERGENCY SHOWER AND EYEWASH	D
502	SAFETY FIRST - PROTECTIVE GEAR REQUIRED WHILE SERVICING	B
503	SAFETY FIRST	
504	SAFETY FIRST	
505	SAFETY FIRST	
506	SAFETY FIRST	
601	PUMP ROOM	B
602	DIESEL GENERATOR ROOM	B
603	FUEL TANK ROOM	B
604	ODOR CONTROL ROOM	B
605	WET WELL	B
606	DRY WELL	B
607	CSO TANK ACCESS	B
608	REST ROOM	B
609	FIRE SPRINKLER CONTROL VALVE ROOM	B
610	ELECTRICAL ROOM	B
701	LIVE LOAD 125 PSF	D
901	FACILITY ADDRESS	F
902	FACILITY IDENTIFICATION	E
903	STAIR	C

1.04 SUBMITTALS

A. Procedure: 01 33 00

- B. Samples of sign materials and mounting hardware and shop drawings of all signs.

1.05 SCHEDULE

- A. Distribute signs as listed in the following schedules.
1. Schedule 1: Informational and Accident Prevention Signs:

LOCATION	QUANTITY	SIZE	TYPE	MOUNTING TYPE
Grit Classifier Room	2	B	301	Wall
Grit Classifier Room	2	B	304	Wall
Grit Classifier Room – eastern half	2	D	701	Wall
Grit Classifier Room – western half	2	D	701	Wall

2. All utility stations shall be equipped with sign 301, size B as shown on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
1. Brady.
 2. Seton.
 3. Approved Equal.

2.02 FABRICATION

- A. Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, those symbols shall be used.
- B. Accident prevention signs: fade-proof graphic permanently embedded 1/8-inch thick fiberglass reinforced plastic. Guaranteed not to chip, fade, or peel for 15 years.
- C. Informational signs:
1. Signs shall be fiberglass with fade-proof graphic permanently embedded 1/8 -inch-thick fiberglass reinforced plastic. Guaranteed not to chip, fade, or peel for 15 years.
 2. Brown background with a white border and white lettering.
 3. Helvetica light of medium lettering.
 4. Upper case lettering: 3 inches high.
 5. Lower case lettering: 2¼-inches high.
 6. Identical in appearance to the existing building signs.
- D. Blade-type signs: Wall or ceiling mounted, projecting outward with information on both sides.
- E. Chain-mounted signs: Provide information on both sides.
- F. Rest room signs shall be raised 1/32 inch white lettering on brown background, with minimum 3"x14" size. The rest room signs shall have both wording and the standard rest room symbol. Rest room signs shall conform to current ADA regulation and requirements.

- G. Facility identification signs shall be 1/4" thick and minimum 24"Wx18"H sign, aluminum plate, painted with weather resistant paint. Facility name Lettering shall be 1-3/4"x3/8", street address lettering shall be 4"x1/2", street name shall be 1 1/2"x3/8". Sign size, lettering size, and paint color to be submitted for approved by the Project Representative.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Do not begin production until all shop drawings of the signs have been approved.
- B. Fasten surface-mounted signs to wall with expansion bolts or suitable anchors.
- C. Conceal all fasteners as much as possible.
- D. Use backup materials as required to achieve concealed mounting.
- E. Mount posts in accordance with drawings.
- F. All signs fasteners shall be stainless steel type 316.

END OF SECTION

SECTION 23 05 00

COMMON WORKS RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. The Contractor shall provide heating, ventilating, and air conditioning systems and associated equipment complete with supports, mounting frames, ventilators, ductwork, piping, louvers, panels, filters, grilles, electric drive units and controls, mechanical equipment, electrical work, appurtenances, testing, and balancing, as indicated in accordance with the Contract Documents.
- B. The equipment shall be installed ready for operation.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Reference Specifications:

01 33 00	Submittal Procedures
01 73 00	Bracing and Anchorage
09 90 00	Coating Systems
26 05 00	Common Work Results for Electrical
26 27 16	Local Control Panels
26 05 33	Raceway, Boxes, and Supports
26 24 19	Motor Control Centers
40 05 41	Piping Hangers and Supports

B. Reference Standards:

Air Movement and Control Association International, Inc. (AMCA)	
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)	
ASHRAE Standard 52-76/ASHRAE 52.1-1992 Standard	Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
American Society of Civil Engineers (ASCE)	
ASCE 7-10	(2010; Errata 2011; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
American Society of Mechanical Engineers (ASME)	
Institute of Electrical and Electronics Engineers (IEEE)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 72	(2022) National Fire Alarm and Signaling Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
Underwriters Laboratories (UL)	

UL 900	(2015) Standard for Air Filter Units
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1.03 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. Submit complete shop drawings and certificates, test reports, affidavits of compliance, for all equipment, ductwork and piping systems, in accordance with the requirements in Section 01 33 00– Submittal Procedures, and as indicated in the individual equipment, piping or ductwork Sections.
2. Construction Drawings
 - a. The HVAC Drawings define the general layout, configuration, routing, size and the general intent of the design. and are not fabrication drawings.
 - b. The ductwork dimensions provided on the design drawings represent a free area and they are clear inside dimensions. The contractor shall be responsible to account for the loss of free area due acoustical lining, or any internal obstructions, and oversize the ductwork to provide the same free area as the one shown on the design drawings.
 - c. It shall be the Contactor's responsibility to develop the Shop Drawings required for the construction of the HVAC system.
3. The Shop Drawings shall include all necessary dimensions and details regarding equipment, pipe and ductwork joints, fittings, valves, appurtenances, design calculations, and material lists.
4. The submittals shall include detailed layout, spool, or fabrication drawings which shall show all fittings, and supports as necessary to accommodate the equipment as a complete and functional system.

B. Equipment Numbers

1. Equipment is identified by assigned numbers for reference and location purposes in the Contract Documents.
2. Indicate the appropriate equipment numbers on the Shop Drawings and other submittals.

C. Furnish certified fan curves for each fan.

1.04 WARRANTY

- A. Air conditioners, heaters, fans, ventilators, grilles, and the like, that are provided by the Contractor shall carry the manufacturer's standard warranty.
- B. Warranties shall be furnished to the Engineer upon final acceptance of the completed systems by the Owner.
- C. Refrigerant compressors shall carry a manufacturer's 5-year warranty.
- D. Control System
 1. The temperature and equipment control system shall be warranted free from defects in workmanship and material under normal use and service for a period of one year after acceptance by the Engineer.
 2. Equipment that proves to be defective in workmanship or material during the warranty period shall be adjusted, repaired, or replaced by the automatic control manufacturer as part of the Contract.

PART 2 PRODUCTS

2.01 GENERAL

A. Quality

1. Mechanisms and other parts shall be amply proportioned for the stresses which may occur during operation and for any other stresses which may occur during fabrication and erection.
2. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials, and shall be of the manufacturer's top-line, industrial-commercial grade.

B. Supports

1. Equipment and appurtenances shall be firmly anchored or connected to supporting members.
2. Equipment shall be supported on restrained spring-type vibration isolators.
3. Support as required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided unless otherwise indicated.

C. Noise and Vibration Control

1. The system shall be free of objectionable vibrations and noise.
2. Provide flexible connections in ducts and piping connections to fans, compressors, and other vibrating equipment.

D. Seismic Restraints

1. Design the equipment, duct and piping supports and restraints for static, dynamic, and seismic loads in identified in Specification Section 01 73 00 and the structural drawings.
2. Seismic restraints shall not induce stresses in the equipment, ductwork and piping caused by thermal expansion and contraction.
3. Comply with Section 01 73 00— Bracing and Anchorage.

2.02 MOTORS

- A. Motors provided with the equipment shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics, including service factors.
- B. Each motor shall bear the manufacturer's nameplate with complete motor data.
- C. Each motor shall be of ample size and construction to continuously carry the loads which might be imposed by the equipment throughout the full range of operation of the equipment.
- D. The maximum motor loading shall be less than or equal to the nameplate horsepower rating, exclusive of the service factor.

2.03 ELECTRICAL WORK

A. The Work of this section shall include:

1. Provide controls, sensors and control panels relating to the HVAC systems, including starters, thermostats, motorized dampers, louver operators and other equipment as indicated.

2. Provide control wiring of 120-volt and less as indicated in this Section and in conformance with the requirements of Division 26 – Electrical and Division 40 – Instrumentation and Control.
- B. The Work of Division 26 shall include:
1. Provide local power disconnects, where required.
 2. Provide circuit breakers, starters in motor control centers, and 120-, 208-, 240- and 480-volt power feeders from the starters and circuit breakers to the HVAC equipment, as indicated.
- C. Starters in motor control centers shall be in accordance with the requirements of Section 26 24 19- Motor Control Centers.
- D. Enclosures shall be of the same NEMA class as the electrical equipment in the same area.
- E. Starters shall be of the same manufacturer as the starters indicated under Section 26 24 19 – Motor Control Centers.
- F. Low-voltage control wiring shall be in accordance with the National Electric Code.
- G. Control wiring for line voltage 120-volt and higher shall be in conformance with the requirements of Electrical Specification.
- H. Control Panels shall be in conformance with the requirements of Section 26 27 16
- I. Conduit shall be in conformance with the requirements of Section 26 05 33– Raceways, Boxes, and Supports.

2.04 FLASHING

- A. Equipment that passes through roofs of buildings or structures shall be provided with flashing as indicated.

2.05 WELDING

- A. The welding of black steel or alloy pipe shall be carried out in strict accordance with AWS procedures and the codes and ordinance of the King County and the State of Washington pertaining to welded steel pipelines.
- B. Welding shall be accomplished by means of the shielded electric arc process and performed by workers who are certified for this Work.

2.06 EXPANSION JOINTS AND LOOPS

- A. Provide expansion loops or expansion joints at the indicated locations and as necessary to provide for the expansion of piping.
- B. The maximum straight run of pipe without an expansion joint or loop installed shall not exceed 75 feet.
- C. Provide an expansion joint or loop at every building construction joint.
- D. Construction

1. The pipe expansion joints on metal piping 3-inches and smaller shall be of the 2-ply stainless steel bellows type, with a 1 ½-inches compression stroke, a ½-inch and smaller shall be of the 2-ply stainless steel bellows type, with a 1 ½-inches extension and a total stroke of 2-inches.
2. The joints shall be suitable for a maximum operating temperature of 750 deg Fahrenheit and a maximum working pressure of 175 psig .
3. The compensator shall have male pipe thread ends for steel pipe and female sweat ends for copper pipe.

E. Pipe Expansion Joints Manufacturers, or Equal

1. Flexonics, Model H for steel piping and Model HB for copper piping
2. Keflex Series 7Q
3. Adsco Compensators

2.07 HANGERS AND SUPPORTS

- A. All Piping shall be supported in accordance with Spec section 40 05 41- Piping Hangers and Supports.
- B. Pipe support lengths shall be in conformance with the requirements of Section 40 05 41– Piping Hangers and Supports.

2.08 PIPING AND EQUIPMENT INSULATION

- A. Cold and hot water piping shall be insulated and jacketed in accordance with Spec section 40 42 00 – Process Piping and Equipment Insulation.

2.09 TEMPERATURE AND EQUIPMENT CONTROL

A. General

1. Design and provide a complete electric-electronic system of HVAC control as indicated.
2. The temperature control equipment and devices shall be furnished by Johnson Controls, Honeywell, or Barber Colman.

B. Wiring and Switches

1. Provide wiring incidental to the temperature control system, including electrical interlock.
2. Furnish detailed wiring diagrams along with necessary supervision.
3. Provide control wiring (line voltage or low voltage) as required to complete the temperature control system (by interconnecting starters, thermostats, PE switches, relays, and like devices) in accordance with the requirements of Section 26 05 00– Common Work Results for Electrical.
4. Switches shall be UL-listed and of a type to meet the current and voltage requirements of the particular application.

C. Thermostats - Line Voltage

1. Materials: cold-rolled steel; beige thermoplastic; liquid sensing element
2. Contact Rating
 - a. 6 amps running; 36 amps locked rotor; 120 VAC
 - b. 3.5 amps running; 21 amps locked rotor; 208 VAC

- c. 3.0 amps running; 8 amps locked rotor; 240 VAC
- 3. Switch Action: single-pole, double-throw; open on rising temperature
- 4. Sensing Element: coiled bulb and capillary
- 5. Range: 0 to 130 deg F
- 6. Manufacturer, or Equal
 - a. Dry Locations (no hose valves or open water processes in room): Johnson Controls Model A19BAC-1 in NEMA 1 enclosure
 - b. Wet (hose valves or open water processes in room) or Outdoor Locations: Johnson Controls Model A19PRC-1 in NEMA 4X enclosure.

D. Relays

- 1. Provide 2-position relays, capacity relays, sequencing relays, and other controls as necessary in order to provide a properly operating automatic control system.
- 2. Relays shall be UL-listed and of a type to meet the current and voltage requirements of the particular application.

2.10 PAINTING

- A. Painting of the equipment and materials shall comply with the requirements of Section 09 90 00– Coating Systems.
- B. Touch-Ups
 - 1. Touch up factory-painted surfaces that are rusted or scratched.
- C. Clean finishes to be touched up to bright metal, prime with a corrosion inhibitor, and finish with a coating to match the original finish.

PART 3 EXECUTION

3.01 GENERAL

- A. Openings - Existing Construction
 - 1. Provide openings required in the existing construction for piping and equipment that are not specifically indicated.
 - 2. Openings shall be cut in a neat and orderly manner with as little damage to existing structures as possible.
 - 3. The patching of openings that have been cut shall match the existing construction.
 - 4. Provide hangers and supporting members installed in the existing masonry or structural steel as required for proper completion of the Work.

3.02 INSTALLATION OF PIPING

- A. Drain Piping
 - 1. Valve-Drain Piping
 - a. Provide valve-drain piping where valves are equipped with a drain connection.
 - b. Fabricate piping from Type L copper tube, and solder-joint drainage fittings.

2. Provide piping system and equipment drains fabricated from copper tube with solder-joint fittings, or from black steel piping with fittings as indicated.
3. Install drain piping at the low points of supply and return piping, at abrupt changes in vertical offsets in horizontal runs, and in piping at mechanical equipment including pumps.
4. Extend drain piping to the nearest drain.

B. Bypass Piping

1. Except as otherwise indicated, fabricate, and install bypass piping using the same materials and in the same plane as connected piping, but one pipe size smaller or as indicated.
2. Provide a valve in the bypass piping.

3.03 INSTALLATION OF VALVES

- A. Set the valves carefully regarding their location with respect to accessibility and the equipment being controlled.
- B. Consider the location of valves with respect to the proper drainage of the piping system.
- C. Install valves where required for proper operation of piping and equipment, including valves in branch lines necessary to isolate sections of piping.
- D. Locate valves to be accessible and such that separate support can be provided where necessary.
- E. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward.
- F. Where insulation is indicated, install extended-stem valves, arranged in the proper manner to receive insulation.
- G. Control Valve Installation
 1. Coordinate valve submittals for type, quantity, size, and piping configuration, in order to ensure compatibility with pipe design.
 2. Slip-stem control valves shall be installed such that the stem position is not more than 60 degrees from the vertical up position.
 3. Install ball-type control valves with the stem in the horizontal position.
 4. Install valves in accordance with the manufacturer's recommendations.
 5. Install valves such that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes or equipment.
 6. Install isolation valves such that the control valve body may be serviced without draining the supply- or return-side piping system.
 7. Install unions at connections to screw-type control valves.
 8. Identification Tags
 - a. Provide tags for control valves, indicating service and number.

- b. Tags shall be brass, 1 ½-in in diameter, and with ¼-in high letters.
- c. Securely fasten tags with chain and hook.
- d. Match identification numbers as shown on approved control Shop Drawings.

3.04 BALANCING TESTING

A. Balancing Subcontractor

- 1. After the installation Work has been completed, the Contractor shall provide the services of an independent balancing subcontractor who shall perform necessary adjustments of volume dampers, volume controllers, exhaust blowers, exhaust fans, supply blowers, supply and return registers, and heating units, chilled water, and hot water.

B. Balancing Procedures

- 1. Balancing and testing shall be in conformance with the requirements of Section 23 05 93—Testing, Adjusting and Balancing for HVAC.

3.05 TEMPERATURE AND EQUIPMENT CONTROL

- A. After completion of the installation, use trained personnel to adjust thermostats, and sensors in the motors and other provided equipment, and place them in complete operating condition subject to the approval of the Engineer.
- B. Instruct the operating personnel in the operation of the control system.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies the labor and services necessary to test, adjust, and balance under actual operating conditions air and hydronic systems design flow rates.
- B. The Work under this Section shall include the following items:
 - 1. Preparation for balancing of air systems
 - 2. Preparation for balancing of hydronic systems
 - 3. Preparation of control systems
 - 4. Notification requirements by the General Contractor of systems readiness

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revision of the following documents. These references are 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
AABC	Associated Air Balance Council, National Standards for Total System Balance
ASHRAE 70	Standards--Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets
NEBB	National Environmental Balancing Bureau, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Balancing report as specified.
 - 2. A description of each air and hydronic system including list equipment to be balanced.
 - 3. Certificate of Completion as specified

1.04 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Comply with applicable procedures and standards of the certification sponsoring association:
 - a. National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution and Hydronic Systems, AABC.
 - b. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, NEBB.
 - c. Method of Testing for Rating the Air Flow Performance of Outlets and Inlets, ASHRAE.
 - 2. Calibration and maintenance of instruments and accuracy of measurements shall comply with the requirements of the standards.
- B. Testing Agency: Procure the services of an independent air and hydronic balancing and testing agency, belonging to the AABC or the NEBB, to perform balancing, testing and adjustment of systems. One organization shall perform the testing and balancing services.

1.05 SPECIAL REQUIREMENTS

- A. Tests and adjustments shall include the complete testing and balancing of all new or modified hydronic systems and heating, ventilating, and air conditioning systems and necessary adjustments to the heating, air conditioning, and ventilating equipment to accomplish the specified design flow rates.
- B. Should any apparatus, material or work fail to meet the specified requirements in these tests, make the necessary corrections and retest the apparatus, material, or work at no additional cost to King County.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. The balancing agency shall conduct the field tests in the presence of the Project Representative as specified in following paragraphs.
- B. Following completion of testing and balancing, leave the system in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- C. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment shall be performed by a certified, independent third-party, AABC Agency, selected and employed by the Contractor and approved by the Owner.
- D. The preparation for and corrections necessary for the testing, adjusting, and balancing of these systems, as described herein, are the responsibility of the Contractor.
- E. Make changes or replacements to fan sheaves and belts, dampers, valves, and the like, as may be required for correct balance as advised by the TAB firm, as part of the Work.
- F. Provide and coordinate the services of qualified, responsible subcontractors, suppliers, and personnel, as required to correct, repair, or replace deficient items or conditions found during the course of the Project, including the testing, adjusting, and balancing period.
- G. Operate the systems for the length of time necessary to properly verify their completion and readiness for TAB.
- H. Scheduling
 - 1. Project completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy.
 - 2. Allow adequate time for coordinating Owner-required services associated with the testing and balancing activities during the construction period and prior to Substantial Completion.
- I. Accessibility
 - 1. Install valves, dampers, and miscellaneous adjustment devices in a manner that will leave them accessible and readily adjustable.
 - 2. Should any such device not be readily accessible, provide access as requested by the TAB firm.
 - 3. Malfunctions encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately such that the balancing work can proceed with minimal delays.
- J. The TAB firm shall check, adjust, and balance the components of the HVAC system in order to obtain the optimal performance of the equipment.

- K. The Work is intended to be accomplished after the system components are installed and operating as indicated and required.
- L. It shall be the responsibility of the Contractor to place the equipment into service.
- M. The following components of the HVAC systems shall be tested, adjusted, and balanced:
 - 1. Air moving equipment
 - 2. Air distribution systems
 - 3. HVAC pumps (hot water)
 - 4. Control systems (testing and verification)

3.02 FIELD TESTING

- A. During the progress of the work, tests shall be performed as indicated and as required by authorities having jurisdiction, including the local building department, the Owner, the Owner's insuring agency, and the Engineer.
- B. Perform such tests as part of the Work, including qualified personnel, equipment apparatus, additional thermometer wells, gauge connections, instrument connections, and services as required to perform the tests.
- C. Submit 3 copies of each complete test report to the Engineer for review and send 2 copies of the accepted report to the Owner.

3.03 DEFECTIVE WORK

- A. Leaks, damage, and defects discovered or resulting from tests shall be repaired or replaced to a like-new condition.
- B. Leaky pipe joints, ductwork, and the like, shall be removed and replaced with acceptable materials.
- C. Reporting
 - 1. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the TAB firm shall advise the Engineer and Owner in writing such that the conditions may be corrected by the Contractor.
 - 2. The written document need not be formal but must be understandable and legible.
 - 3. The TAB firm shall not instructor direct subcontractors in any of the Work.

3.04 CONTRACTOR'S RESPONSIBILITIES

- A. Have the building and air conditioning systems in complete operational readiness for the TAB Work to begin.
- B. Allow sufficient time for the TAB firm to perform their Work within the construction schedule.
- C. Complete the W by systems or floors, whichever is the more efficient method for testing systems.
- D. Scheduling
 - 1. Within 2 weeks after the construction schedule has been developed, schedule a TAB coordination meeting to include the TAB firm, the Contractor and primary subcontractors, the Engineer, and the Owner for the purpose of developing a testing schedule for the Project.
 - 2. Submit copies of the proposed schedule to the TAB firm at least one week prior to the coordination meeting.
- E. Promptly correct deficiencies of materials and workmanship identified as delaying completion of the TAB firm's Work.

- F. Assume responsibility for added costs to the Owner resulting from failure to have the building and air conditioning systems ready for TAB when scheduled, and from failure to correct deficiencies promptly.
- G. Coordinate with the TAB firm to compile and submit:
 - 1. one set of HVAC specifications
 - 2. one copy of relevant revisions, clarifications, and modifications
 - 3. one complete set of Drawings, less the Civil and Structural sheets
 - 4. one set of the HVAC floor plans of the conditioned spaces
 - 5. one copy of approved submittal data for installed equipment
 - 6. one copy of related changes as required to accomplish the indicated test procedures

3.05 TAB FIRM RESPONSIBILITIES

- A. The following observations and tests shall be performed by the TAB firm:
 - 1. During the construction submittal stage and before the submittal documents are finalized, review the mechanical and HVAC submittals, drawings and specifications for balance-ability and furnish commentary.
 - 2. During construction, review approved HVAC submittals such as control diagrams, air handling devices, and the like, that pertain to TAB work and balancing.
 - 3. Perform construction observations and submit a written report including the following topics.
 - a. The ductwork prior to insulation and ceiling cover-up
 - b. The piping prior to insulation and ceiling cover-up
 - 4. Perform a pre-balance site review and submit a written report.

3.06 OPERATIONAL READINESS

- A. "Operational readiness," as referred to in this Section, shall be defined as the time when the construction status of the building permits the closing of doors, windows, ceilings, and the like, to obtain simulated or projected operating conditions.
- B. Operational readiness of the HVAC system shall require that the following items have been accomplished:
 - 1. Air Distribution Systems
 - a. The installation conforms to the indicated design requirements.
 - b. Volume, smoke, and smoke/fire dampers have been properly located and are functional.
 - c. Dampers have tight closure and open fully with smooth and free operation.
 - d. Exhaust grilles, registers, diffusers have been installed and secured in a fully open position.
 - e. Air handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, and the like, have been sealed to eliminate uncontrolled bypass or leakage of air.
 - f. Final clean filters are in place, coils are clean with fins straightened, bearings are properly greased, belts are aligned and tightened, and the system is completely operational.
 - g. It has been verified that all systems are operating within the design pressure limits of the piping and ductwork.
 - h. Fans (exhaust) are operating and verified for freedom from vibration, proper fan rotation and belt tension.
 - i. Heater elements in motor starters are of proper size and rating, in accordance with the starter manufacturer's requirements.
 - j. Motor amperage and voltage have been recorded on each phase at start-up and verified that they do not exceed nameplate ratings.
 - 2. Water Circulating Systems
 - a. The installation has been verified for conformity to design requirements.
 - b. Pressure Testing
 - 1) Piping has been terminated and pressure-tested for leakage as required.
 - 2) Pressure testing shall take place before piping has been insulated.

- c. Valves have been set to their full-open position, bypass stop valves closed, and mixing valves set to full-flow through the system components.
 - d. After the system has been flushed and checked for proper operation, all strainers have been removed and cleaned.
 - 1) The Contractor shall repeat the operation until circulating water is clean and then the start-up strainers shall be discarded.
 - e. Pump motor amperage on each phase and voltage after reaching rated speed have been recorded.
 - 1) Readings shall not exceed nameplate rating.
 - f. In preparation of TAB, ensure that water circulating systems are full and free of air, expansion tanks have been set for proper water level, and air vents have been installed at high points of systems and are operating freely.
 - g. Chemicals have been added to closed systems in order to treat piping and inhibit corrosion.
 - h. It has been verified that the system static pressure is adequate to completely fill the system without operating the pumps.
 - i. Check and set operating parameters of the heat exchangers and control devices to their design requirements.
 - j. Proper balancing devices are in place and located correctly.
 - 1) Such devices include flow meters, pressure taps, thermometer wells, balancing valves, and the like.
3. Automatic Controls
- a. A meeting has been held with the Engineer, the TAB firm, and the Owner, for a pre-submittal review of the proposed controls strategy.
 - b. Control components have been installed in accordance with project requirements and are functional, including electrical interlocks, damper sequences, air and water resets, high- and low-temperature thermostats, safeties, and the like.
 - c. Controlling instruments have been calibrated and set for design operating conditions, with the exception of components that require input from the TAB firm, but a default has been set.
 - 1) Cooperate with the TAB firm and provide all software and interfaces to communicate with the system.
 - d. Controls, sensors, operators, sequences, and the like, have been checked before notifying the TAB firm that the Energy Management System is operational.
 - 1) Furnish technical support (technicians and necessary computers) for a complete check of these systems.
 - e. Fire alarm detection devices, sequences, inter-locks, and the like, have been checked before notifying the TAB firm that the system is operational.
 - 1) Checked devices shall include the Fireman's Override Panel.
 - 2) Provide all detection devices (fire and smoke), complete with all smoke zones identified along with all alarm and event chart devices identified.
 - 3) Certify that the systems are totally operational prior to the TAB beginning.
 - f. A start-up report has been submitted.
 - 1) The start-up report shall include the submitted and actual RPM, and the actual and nameplate voltage and amperage of all motors.
 - 2) This requirement applies to each piece of electrically driven air conditioning equipment in the system, including exhaust fans, other fans of fractional horsepower, pumps, and the like.
 - 3) Furnish the addresses and initial set points of all controlled devices.

3.07 NOTIFICATION OF SYSTEM READINESS

- A. After the above operational readiness items have been accomplished, notify the Engineer in writing, certifying that the Work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing.
- B. With the notification, include a copy of tabulated data as required.

- C. The Engineer will notify the TAB firm of the readiness for balancing, and forward copies of the Contractor's certification and tabulated motor voltages, currents, and RPM.
- D. If the TAB firm has been notified as described above and the inspection reveals that the TAB services notification is premature, costs of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriate parties by the Contractor.

3.08 TESTING AND BALANCING

- A. In coordination with the TAB firm, submit an overview of system TAB procedures including:
 - 1. An agenda
 - 2. Field observation reports
 - 3. System testing, including:
 - a. Traverses to be made
 - b. Instrumentation to be used
 - c. How correction factors for grilles and diffusers will be obtained
 - d. How measurements will be verified at maximum and minimum
 - e. How control components will be verified
 - 4. Report forms with each systems components identified and numbered.

3.09 INSTRUMENTATION

- A. Ensure that instruments being used are currently calibrated and listed in the TAB report, showing instrument description, serial number, and date of calibration.
- B. The accuracy of instruments used shall be as indicated in the current AABC National Standards.

3.10 PERFORMANCE OF WORK

- A. Perform testing, adjusting, and balancing after the system installation is complete but prior to acceptance of the project.
- B. Air Systems Measurements:
 - 1. Measure and adjust air exhaust units to deliver at least 100 percent of the design air volume.
 - 2. Measure static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
 - 3. Adjust fan speeds and motor drives within drive limitations, for required air volume. Set a speed to provide air volume farthest distance from the fan without excess static pressure. Check draw amps of fans on initial start-up. If running amps exceed nameplate, shut off motor immediately, notify Project Representative, and make necessary drive changes as directed.
 - 4. Measure airflow rates with supply, return, and exhaust systems operating between design values specified for clean and dirty filters with auxiliary systems in operation.
 - 5. Airflow rates supplied, exhausted, or returned shall be within plus or minus 5 percent of the design values specified.
 - 6. Measure Outlet Air Flow by
 - a. Adjust each exhaust inlet, register and grille to within the tolerances shown in the AABC Standard.
 - b. Include all terminal points of air supply and all points of exhaust.
 - 7. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
- C. Hydronic Systems Measurements:
 - 1. Measure and adjust pumps to deliver at least 100 percent of the design water flow. Check draw amps of running pumps. If in excess of nameplate, shut off immediately and notify the Project Representative. Proceed as directed by the Project Representative.
 - 2. Measure and adjust water flow at coils for design conditions, plus or minus 10 percent. Check conditions at coils for required performance at design conditions.

3. Measure and adjust total water flow rates at each control valve.
- D. The general scope of balancing by the TAB firm shall include the following items:
 1. Adjusted System Tests
 - a. Adjust balancing valves at each coil and heat exchanger for design flow in accordance with the AABC Standard.
 - b. Adjust balancing valves at pumps in order to obtain design water flow.
 - c. Record the pressure rise across pumps and the GPM flow rate from pump curves.
 - d. Permanently mark the balanced position for each valve; if discharge valves on the pumps are used for balancing, record the head being restricted by the valves.
 2. Temperature Readings
 - a. Read and record the entering and leaving water temperature at each water coil, converter, and heat exchanger at design flow.
 - b. Adjust as necessary to secure design operating conditions.
 - c. Provide final readings at all thermometer well locations.
 3. Pressure Readings
 - a. Record the water pressure at all gauge connections.
 - b. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow rate and through flow measuring stations (if provided), at each air handler.
 - c. Adjust the flow rate of the water through coils by balancing valves until the rated pressure drops across each coil have been obtained and the total water flow rate has been verified by the flow measuring station.
 - d. Coils with 3-way valves
 - 1) For coils equipped with 3-way valves, the rated pressure drop shall first be adjusted through the coils.
 - 2) The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.
 - 3) Voltage and Amperage Readings: Read and record the final operating amperages and voltage for each pump motor.
- E. Systems to be balanced: Balance all heating, ventilating, and air conditioning and foul air systems and equipment.

3.11 BALANCING

- A. Characteristics to be tested and adjusted to conform to the values specified include the following:
 1. Total airflow rates delivered by fans and air-handling units.
 2. Flow rates at all grilles, registers, diffusers, and exhaust ducts.
 3. Capacity and temperature rise or drop across each heating coil.
 4. Total water flow rates at each heating and cooling coil, control valve, and pump.
 5. Operation and modulation of each control valve.
- B. Air Flow Rate Measurements:
 1. Airflow rates shall be obtained by adjustment of the fan speeds, dampers, or registers. All flow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between the design values specified for clean and dirty filters, with auxiliary systems in operation and with all doors and windows closed.
 2. Flow rates at grilles, registers, branch ductwork and air distribution patterns shall be tested in strict accordance with ASHRAE Standard 70.
- C. Water Flow Rate Measurements:
 1. Total water flow rates shall be measured at each heating coil, unit heater, valves, and fittings.
 2. All flow rates shall be measured with control valves 100 percent open.
 3. Pump capacities shall be determined by differential pressure measurement.
 4. Temperature shall be measured across the heat transfer elements in the system.

3.12 BALANCING REPORT

- A. The final certified balancing report shall include the following actual field-verified data:
 - 1. Equipment data
 - a. Manufacturer and model, size, arrangement, class, location, and equipment number.
 - b. Motor horsepower, voltage, phase, and full load amperage.
 - c. Fan cfm, static pressure, rpm, and operating motor BHP.
 - d. Pump gpm, discharge pressure, suction pressure, pressure change across pump, total discharge head, gpm at major equipment and operating motor BHP.
 - 2. Duct size, supply or exhaust recorded cfm, velocity, pressure measurements, and location of all measurements.
 - 3. Pipe size, recorded gpm, velocity, pressure measurements, balancing valve size and model, location of all measurements.
- B. Report Requirements:
 - 1. Each individual final reporting form must bear the signature of the person who recorded the data and that of the supervisor of the reporting organization.
 - 2. All instruments which were used shall be listed and identified including the last date each was calibrated.
- C. Final report shall be submitted prior to Contractor's request for final inspection. In addition to providing all specified data and information on applicable reporting forms, report shall include the following:
 - 1. A schedule for testing and balancing parts of the systems which must be delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor. Delayed work shall be completed as early as the proper conditions will allow, after consultation with the Project Representative.
 - 2. Due to delayed testing, reports shall be submitted after execution of those services.
 - 3. A total balance report shall include the following components:
 - a. General Information and Summary
 - b. Instrument Calibration
 - c. Air Systems
 - d. Hydronic Systems
 - e. Sound and Vibration Systems.
 - f. Temperature Control Systems
 - g. Record drawings with specified and measured flow rates

3.13 FINAL INSPECTION

- A. Following completion of testing and balancing, but prior to submitting the balancing report, the Contractor shall recheck, in the presence of the Project Representative, random selections of data water and air quantities, air motion, and sound levels recorded in the report. Points and areas for recheck shall be as selected by the Project Representative. Measurement and test procedure shall be as approved for work forming basis of the report.
- B. Selection for recheck will not exceed 25 percent of the total tabulated in the report.
- C. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new reports submitted, and new inspection test made.
- D. Following acceptance of the reports by the Project Representative, permanently mark all damper positions so that they can be restored to their correct position if disturbed at any time. If a balancing device is provided with a memory stop, set it and lock it. Do not mark devices until after final inspection.

3.14 CERTIFICATE OF COMPLIANCE

- A. At completion of testing and balancing, Contractor shall submit a Certificate of Compliance stating that each apparatus, device, outlet, and system has been tested, adjusted, and balanced so that it is operating in conformance with manufacturer's recommendations and with the specified and shown conditions.

END OF SECTION

SECTION 23 21 00

HYDRONIC PIPING AND VALVES

PART 1 -- GENERAL

1.01 SUMMARY

- A. The Contractor shall supply and install hydronic piping and specialties, complete and operable, in accordance with the Contract Documents.
- B. Where two or more hydronic units or appurtenances of the same type or size are required, they shall be furnished by the same manufacturer.

1.02 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00.
- B. The submittals shall include operation, maintenance and inspection data, replacement part numbers and availability, and service depot locations and telephone number.

1.03 CODE REQUIREMENTS

- A. The work shall be performed in strict accordance with the Washington Mechanical Code, City of Seattle, and other authorities having jurisdiction.
- B. The Contractor shall obtain the required certifications and shall be thoroughly familiar with local codes.
- C. The Contractor shall obtain and pay for all necessary permits.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Reference Specifications

01 33 00	Submittal Procedures
01 73 00	Bracing and Anchoring
40 05 41	Pipe Hangers and Supports
40 42 00	Process Piping and Equipment Insulation

- B. Reference Standards

American National Standards Institute (ANSI)	
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)	
American Society of Mechanical Engineers (ASME)	
ASME (BPV VIII, 1)	Boiler and Pressure Vessel Code, Section VIII, Division 1 – Rules for Construction of Pressure Vessels
American Society for Testing and Materials (ASTM)	
American Welding Society (AWS)	

1.05 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.

1.06 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Hot-Water Heating Piping: 95 psi at 200 degrees F.
 - 2. Safety-Valve-Inlet and –Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.07 ACTION SUBMITTALS

- A. Product Data for each type of the following:
 - 1. piping, fittings, connections, solvent.
 - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 3. Chemical treatment.
 - 4. Hydronic specialties.
- B. Shop Drawings: Indicate the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.08 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control test reports.
- D. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.09 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

- B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.11 QUALITY ASSURANCE

A. Installer Qualification:

- 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 – PRODUCTS

2.01 GENERAL

- A. All heating hot water piping shall be stainless steel in accordance with Specification Section 40 05 23. For fittings, joints, couplings and connections, refer to Specification Section 40 05 23.

2.02 VALVES

A. Comply with requirements specified in Division 40.

B. Bronze, Balancing Valves with Flow Meter

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco, Inc.
- 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
- 3. Ball: Brass or stainless steel.
- 4. Plug: Resin.
- 5. Seat: PTFE.

6. End Connections: Threaded or socket.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 145 psi.
9. Maximum Operating Temperature: 230 degrees F.
10. Bypass circuit with flow meter on the valve body with capability to be turned off during normal functioning.
11. Flow meter:
 - a. Body: Brass
 - b. Headwork: Brass
 - c. Flow meter float: PSU
 - d. Indicator Cover: PSU
12. Provide dielectric fitting to connect to Stainless steel pipe.

2.03 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for DN 50 and smaller; flanged ends for DN 65 and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psi.

B. Stainless-Steel Bellow, Flexible Connectors

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of ¾ inch misalignment.
4. CWP Rating: 150 psi.
5. Maximum Operating Temperature: 250 degrees F.

C. Expansion fittings are specified in Section 40 05 44

2.04 EXPANSION JOINTS AND LOOPS

A. Construction

1. Expansion loops and joints shall be constructed from 3 lengths of annular corrugated Type 321 stainless steel bronze close-pitch hose made in the USA, with stainless steel overbraid made in the USA that will absorb or compensate for pipe movements in all 6 degrees of freedom (3 coordinate axes, plus rotation about those axes) simultaneously.
2. The corrugated metal hose, braid(s), and a ring-ferrule/band shall be integrally seal-welded using 100-percent circumferential, full-penetration TIG welds.
3. The ring-ferrule/band material shall be composed of stainless steel, of a gauge not less than 0.048 inch.
4. End fittings shall be selected in accordance with the application.
5. Fittings shall be attached using a 100-percent circumferential TIG weld or oxy-acetylene process with phos-copper filler.

B. Braided Loops

1. Braided stainless steel pre-manufactured loops shall be suitable for operating temperatures up to 850 degrees F.
2. Braided bronze pre-manufactured loops shall be suitable for operating temperatures up to 400 degrees F.
3. The pre-manufactured loops shall be designed for test pressures to 1.5 times their maximum rated working pressure and a minimum 4:1 (burst-to-working) safety factor.
4. Each braided pre-manufactured loop shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure.

C. Shipping

1. Pre-manufactured loops shall be prepared for shipment using a cut-to-length metal shipping bar, tacked securely between the elbows of the two parallel legs, in order to maintain the manufactured length during shipping.
2. The shipping bar shall be removed prior to system start-up.

D. Support

1. A hanger assembly kit shall be used to support and hang the pre-manufactured loop.
2. The wire/cable assemblies shall conform to the requirements of the ASCE Guidelines for Structural Applications of Wire Rope, including that the cable shall be pre-stretched and the permanent end fittings shall maintain the break strength of the cable with a safety factor of 2.

E. Pre-manufactured loops shall be Flex Hose Co. "Tri-Flex," or equal.

2.05 STRAINERS

- A. Provide, whether indicated or not, a strainer ahead of each pump, control valve and hot water heating coil in the hydronic system.
- B. Strainer screens shall be constructed of perforated Monel.
- C. Strainers up to and including 2 inches shall be screwed and as manufactured by: Crane Company, Series 988-1/2; Armstrong; or equal.

- D. Strainers larger than 2 inches shall be flanged and as manufactured by: Crane Company, Series 989-1/2; Armstrong; or equal.

2.06 PRESSURE GAUGES AND THERMOMETERS

- A. Pressure gauges and thermometers shall be arranged such that they may be read from the floor.
- B. Pressure gauges shall consist of:
 - 1. minimum 4-1/2-inch diameter dial;
 - 2. cast aluminum case;
 - 3. phenolic or PET case
 - 4. zero adjustment;
 - 5. stainless bourdon tube and socket;
 - 6. stainless steel movement;
 - 7. double strength safety glass window and
 - 8. white face with black embossed figures and graduations; and
 - 9. solid front case with blow-out back, underload stop. Overload stop, adjustable pointer, and stainless steel tag attached with stainless steel wire.
- C. Pressure gauges shall have a guaranteed accuracy of 1/2 to one percent of the scale range.
- D. The pressure range shall be 0-60 psig.
- E. Provide each pressure gauge with a pigtail siphon and a 3-way cock.
- F. Pressure gauges shall be arranged such that they may be read from the operating floor.
- G. Manufacturers, or Equal
 - 1. Ashcroft Duragauge with XLL Plus performance option;
 - 2. Ametek/US gauge model 1981 Advantage with damped movement;
- H. Thermometers shall have a temperature range of 50-250 degrees F.
- I. Thermometers shall be of an "every angle" design, and shall include a 9-inch aluminum case and a chrome plated brass joint with a locking device.
- J. The bulb material shall be copper plated steel.
- K. Thermometers shall be bimetal liquid-filled thermometer with every angle connection, stainless steel construction, shatterproof glass, +/- 1% accuracy, 5 inch dial.
- L. Stem
 - 1. The stem shall be located in an elbow or tee.

2. The stem length shall be not less than 9 inches, and shall extend into the piping being served not less than 3/4 of the diameter of the pipe.
- M. Thermometers shall be arranged such that they may be read from the operating floor.
- N. Manufacturers, or Equal
1. Ashcroft, EI Series;
 2. Wexsler;

2.07 PRESSURE RELIEF VALVES

- A. Pressure relief valves shall be provided with a relieving capacity and pressure as required to permit a rise in pressure within the vessel or piping not more than 25 percent above the working pressure when the valve is relieving.
- B. Each valve shall be constructed with a semi-steel body and stainless steel trim suitable for tight shutoff.
- C. The valves shall be equipped with a manual lift lever for testing and shall be field-adjustable to a minimum of plus or minus 10 percent of the normal setting.
- D. Each valve shall be constructed to the requirements of the ASME Code for Unfired Vessels and stamped as such.
- E. Pressure Relief Valve Manufacturers, or Equal
1. Lunkenheimer, Figure 629
 2. Consolidated, Type 1851
- F. Combination Relief Valves and Reducing Valves:
1. Furnish and install a combination water pressure reducing valve and pressure relief valve on the cold water line serving the hot water heating piping system. This valve unit shall be designed to feed water automatically to the systems at approximately 10 psig.
 2. This valve unit shall contain a check valve, a stainless steel strainer, all bronze bodies and domes, bronze seats, stainless steel compensating springs, non-sticking high temperature discs, high temperature reinforced diaphragms, pressure relief valve set to relieve pressure on the system above 30 psig, and a manual test lever.
- G. The combination relief valve and reducing valve shall be as manufactured by Taco; Bell and Gossett; Thrush; or equal.

2.08 AIR VENTS

- A. Provide an air vent at each high point in the heating hot water supply and return lines.
- B. Vents shall be automatic operation.
- C. Provide a 1/2-inch shut-off globe valve between each air vent and the piping system.
- D. Air Vent Manufacturers, or Equal
1. Taco

2. Hy-Vent No. 426.

PART 3 – EXECUTION

3.01 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, DN 80 and smaller, shall be any of the following:
 1. Schedule 40 stainless steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints per specification section 40 05 23.
- B. Hot-water heating piping, aboveground, DN 100 and larger, shall be the following:
 1. Schedule 40 stainless steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints per specification section 40 05 23.
- C. Air-Vent Piping:
 1. Inlet: Same as service where installed.
 2. Outlet: Type A, annealed-temper copper tubing with soldered or flared joints.
- D. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.02 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- D. Install safety valves at hot-water boilers and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.03 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, DN 20 ball valve, and short DN 20 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions or flanges in piping, DN 80 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, DN 100 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, and elsewhere as indicated. Install DN 20 nipple and ball valve in blowdown connection of strainers DN 50 and larger. Match size of strainer blowoff connection for strainers smaller than DN 50.

3.04 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Section 40 05 41. Comply with the following requirements for maximum spacing of supports.
- B. Comply with Section 01 73 00 and provide seismic restraints if required.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 ft. long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 6 m or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. DN 20: Maximum span, 7 ft.; minimum rod size, 1/4 in.
 2. DN 25: Maximum span, 7 ft.; minimum rod size, 1/4 in.
 3. DN 40: Maximum span, 8.5 ft.; minimum rod size, 1/2 in.
 4. DN 50: Maximum span, 10 ft.; minimum rod size, 1/2 in.
 5. DN 65: Maximum span, 11 ft.; minimum rod size, 1/2 in.
 6. DN 80: Maximum span, 12 ft.; minimum rod size, 1/2 in.
 7. DN 100: Maximum span, 14 ft.; minimum rod size 3/4 in.
 8. DN 150: Maximum span, 17 ft.; minimum rod size, 3/4 in.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. DN 20: Maximum span, 5 ft.; minimum rod size, 1/4 in.
 2. DN 25: Maximum span, 6 ft.; minimum rod size, 1/4 in.
 3. DN 40: Maximum span, 8 ft.; minimum rod size, 1/2 in.
 4. DN 50: Maximum span, 8 ft.; minimum rod size, 1/2 in.
 5. DN 65: Maximum span, 9 ft.; minimum rod size, 1/2 in.
 6. DN 80: Maximum span, 10 ft.; minimum rod size, 1/2 in.
- F. Support vertical runs at roof, at each floor, and at 3-m intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.06 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- E. Install bypass chemical feeders in each hydronic system in upright position with top of funnel not more than 4-ft above the floor. Install feeder in minimum DN 20 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install DN 20 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.07 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.

3.08 CHEMICAL TREATMENT

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.

- B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.09 GLYCOL SOLUTION

- A. The hot and chilled water system media shall be a 30 percent glycol, 70 percent water solution.
- B. The propylene glycol concentrate shall be Dow Chemical Co. "Dowfrost", multitherm, or equal.
- C. Feed glycol solution to system through make-up line pressure regulator and venting system high points.
- D. Perform tests determining strength of glycol and water solution and submit written test results.

3.10 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 - 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 6. Prepare written report of testing.

C. Perform the following before operating the system

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 31 13
SHEET METAL DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies HVAC systems plenums, sheet metal housings, ductwork, equipment connections, reinforcing and other devices required to make the air distribution systems complete and operational.

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	Handbook - Equipment Volume, Duct Construction
ASHRAE	Handbook - Fundamentals Volume, Duct Design
ASTM A525	General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A527	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM B211	Aluminum and Aluminum Alloy Bar, Rod, and Wire
ASTM B308	Aluminum - Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
IBC	International Building Code
IMC	International Mechanical Code
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
SMACNA	HVAC Duct Construction Standards Metal and Flexible
UL 181	Factory-made Air Ducts and Connectors

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. An 8-1/2-inch by 11-inch manual with detail sheets or catalog data of flexible duct connectors, duct sleeves, duct access doors, turning vanes, volume dampers, supports, hangers, etc.

1.04 QUALITY ASSURANCE

- A. Ductwork construction, installation, and air system performance shall comply with UMC, ASHRAE CH-1 and CH-33, and SMACNA Duct Construction Standards.
- B. The manufacturer shall perform their own sheet metal fabrication and coating processes.
- C. The Owner shall have the right to tour the manufacturer's plant any time that fabrication is being performed on duct intended for the Project.
- D. Installer Qualifications: The installation contractor shall have at least 3 years of successful experience on duct projects, specifically industrial exhaust systems.

E. Inspection and Testing

1. All ductwork shall be inspected and approved by a qualified QC person in order to ensure proper welding and dimensional tolerances. The Inspector shall provide a written approval to the resident engineer or owner, stating that the ductwork has been inspect and is free of any defects.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide all ductwork, plenums, and all auxiliary work and products of any kind necessary to make the ventilation systems complete and ready for operation. Ductwork shall comply with the following restrictions and conditions:
1. Snap lock seams shall be fully sealed and fastened with screws every 18 inches.
 2. Where space conditions permit, full radius turns shall be used at offsets.
 3. Turning vanes shall be provided where tees, bends, and elbows are not 1-1/2 times the width at centerline and in all rectangular elbows.
 4. Ductwork elbows, take-offs, and fittings shall be in accordance with the SMACNA and ASHRAE standards for the medium pressure air duct.
 5. Visible duct deflection, loss of shape, or unwarranted noise or vibration resulting from faulty or inadequate support, reinforcing, metal gauge, fabrication, or joint spacing shall be corrected at no expense to King County.

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
Duct	Aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211,
Duct sleeve	Aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211,
Access doors	Aluminum, alloy 3003-H14, conforming to ASTM B209 and ASTM B211,
Flexible duct connector	Noncombustible, weather and ozone resistant, abrasion-proof woven fiberglass fabric with coating weighing not less than 24 ounces per square yard. Maximum flame spread rating of 25, smoke rating of 50 for all materials including connecting tape, etc. UL 181 approved.
Turning vanes	Aluminum to match duct material.
Hangers and supports, rivets, and bolts reinforcing	Aluminum alloy 6061-T6 conforming to ASTM B308, to match duct material.

- C. Unless otherwise indicated, all HVAC systems supply air, return air and exhaust air ductwork material shall be aluminum.

2.03 WARRANTY

- A. Provide the ductwork manufacturer's standard warranty.
- B. Furnish the warranty to the Engineer upon final acceptance of the completed systems by the Owner.

2.04 DESIGN CRITERIA AND CONSIDERATIONS

- A. Provide air-tight and well-braced aluminum ductwork at all locations indicated on drawings.

- B. General: Unless otherwise indicated, sheet metal gage, reinforcing, hanger and support systems, ductwork joint types and other basic design construction details shall be in accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards. Ductwork shall be fabricated to meet the configurations and dimensions specified on the Drawings. Dimensions specified indicate net free area.
- C. Low Pressure Ductwork: Low pressure ductwork shall convey air with a velocity less than 2000 fpm and to 2 inches of water column positive or negative static pressure. Low-pressure ductwork shall conform to 2-inch w.c. pressure class. All ductwork shall be low pressure, unless noted otherwise.
- D. Medium Pressure Ductwork: Medium pressure ductwork, where specified, shall convey air with a velocity greater than 2000 fpm and 6 inches of water column positive or negative static pressure. Medium pressure ductwork shall conform to 6-inch w.c. pressure class.
- E. Provide the following duct gauges, as a minimum:

Maximum Dimension of Duct (inches)	Aluminum B and S Gauge
12 and less	24
13 through 30	22
31 through 54	20
55 through 84	18

- F. System Leakage: All joints shall be sealed as required to limit total system leakage to a maximum of 1 percent of the specified equipment air flows.
- G. Change in Duct Size: Change in duct size shall be made by a uniformly tapering section. The change in direction of the tapering section shall not be more than 1 inch in 5 inches of run, unless otherwise specified.
- H. Bends in Duct: With the exception of mitered bends, all bends in ducts shall have inside radii equal to the duct width or diameter. Double wall turning vanes shall be provided at all 90-degree mitered bends.
- I. Duct Sleeves: Whenever ducts extend through concrete or masonry walls, floors or ceilings, they shall be provided with a sleeve as specified and shown on the drawings.
- J. Duct Openings: Access doors or hand holes shall be provided in ducts at locations to reach modulating dampers, fusible links, controllers and any other moveable devices in the ducts. The opening shall be 1 inch less duct size or of adequate size to reach in and maintain these devices.
- K. Vibration Isolation Flexible Connections: Flexible connections shall be provided at duct connections to motor-driven air handling equipment and other locations specified. Flexible connections shall be UL approved and provided with the necessary angle, straps, bolts, clips, or other fasteners to secure the flexible material to the equipment and ducts. Flexible connections exposed to the weather shall be provided with approved sheet metal weather covers.

2.05 JOINTS AND REINFORCING

- A. Transverse stiffeners and joints shall be appropriately spaced to maintain duct cross-section integrity in accordance with the pressure class specified and at the prevailing operating velocities.

- B. After joints are crimped, they shall be further secured by bottom punching or riveting.
- C. Longitudinal seams shall be Pittsburgh lock and shall be cross-broken outward. Intake, or exhaust, side ducts shall be cross-broken inward. Discharge ducts shall be cross-broken outward. All plenums and casings shall be similarly cross-broken and further reinforced with 1-inch x 1-inch x 1/8-inch angles running diagonally between joints, riveted to the casings.
- D. Low pressure ductwork shall have slip joints.
- E. Medium pressure ductwork shall have flanged or welded joints.
- F. Joints shall not interfere with airflow in the ducts.
- G. Exterior ducts shall be stiffened, braced, and supported in a manner designed to maintain duct integrity and cross-section under wind and snow loads specified in the appropriate codes or standards.
- H. Interior ducts shall be suitably braced and stiffened at floor and roof penetrations as well as over their unsupported length in a manner designed to maintain duct integrity and limit vibration and noise in accordance with recognized standards of the industry.
- I. Ducts over 17 inches in largest dimension shall be cross-broken or beaded on all four sides. In ducts over 72 inches, 3/8-inch stay rods shall be installed at each transverse joint. Spacing between rods or rods on side of duct shall not exceed 48 inches.
- J. Properly insulate aluminum duct and supports from concrete or dissimilar metals by an applied bituminous coating or by rubber gaskets at contact points.
- K. Construct interior partitions from aluminum, in accordance with the latest ASHRAE guide recommendations for construction for high-pressure rectangular duct work.
- L. Provide rectangular casing seams in the corners of the silencer shell in order to provide maximum unit strength and rigidity.
- M. Provide interior partitions with die-formed entrance and exit shapes in order to provide the maximum aerodynamic efficiency and minimum self-noise characteristics in the sound attenuator.
- N. Blunt noses or squared off partitions will not be accepted.
- O. In addition to the above attachments, secure the interior partitions to the outer casing with welded nose clips at both ends of the sound attenuator.
- P. Achieve airtight construction by the use of a duct-sealing compound applied at the Site.
- Q. Sound traps shall not fail structurally when subjected to a differential air pressure of 8 inches w.g. inside-to-outside of casing.

2.06 SEAMS

- A. Provide double-locked seams.
- B. Provide rectangular ducts with longer than a 12-inch dimension with full-perimeter standing seams not less than one inch high.
- C. Seams shall be lock-formed and mastic-filled.
- D. Provide reinforcements at intervals not greater than 30 inches along the duct.

- E. No "S" seams will be accepted.

2.07 HANGERS AND SUPPORTS

- A. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2021 IBC Section 1613/ASCE 7-10 Chapter 13
- B. Ductwork shall be firmly anchored or connected to supporting members.
- C. Provide necessary hangers, supports, concrete inserts, and anchors for material and equipment to be installed.
- D. No perforated strap hangers nor wire supports will be accepted.
- E. Construct the anchors and inserts of 304 stainless steel.
- F. Carefully support the ductwork in horizontal runs, with rod and angle supports at no greater than 8-foot intervals.
- G. Locate hangers and supports not greater than 10 feet from each expansion loop or joint.
- H. Provide hangers and supports for ductwork and equipment in accordance with SMACNA standards.
- I. Supports shall be spaced to prevent visible duct deflection and loss of system integrity.
- J. Aluminum ductwork shall be constructed with strength and dimensional stability comparable to conventional steel duct. In the absence of other criteria, aluminum sheet and reinforcing shall have a moment of inertia three times greater than that recommended for steel ductwork.
- K. Supports shall be designed in accordance with the International Building Code.
- L. Provide aluminum angles with 304 stainless steel threaded hanger rods as supports for horizontal ducts and plenums.
- M. Supports for vertical ducts shall be aluminum of the angle bracket type.
- N. Sufficiently brace inlet ducts to withstand the maximum negative pressure.
- O. Design the duct supports and seismic restraints for static, dynamic, and seismic loads to comply with Section 01 73 00 and in accordance with the International Building Code.
- P. Seismic restraints shall not induce stresses in the ductwork caused by thermal expansion and contraction.

2.08 ACCESS DOORS

- A. Provide access doors in the ductwork at all dampers and filters, and as indicated on drawings.
- B. Provide doors with the following features:
 - 1. continuously hinged;
 - 2. double-skinned;
 - 3. constructed of either 22-gauge galvanized steel or 20-gauge aluminum to match the ductwork material;
 - 4. one cam lock for sizes up to 16 inches square or 2 cam locks for sizes over 16 inches square;
 - 5. foam sealing gaskets on all four sides.

- C. Access doors shall be rigid and shall not vibrate or cause noise under service.
- D. Doors shall be continuous hinged type with ventlock latch on outside.

2.09 FLEXIBLE CONNECTIONS

- A. Flexible connection joints shall be airtight and have a minimum allowance of 1-inch slack all around.
- B. Flexible connections shall be designed to be removed from the line and be reinstalled without disassembling adjacent ductwork.
- C. Connections shall be installed with a minimum 4-inch clearance between metal parts for distribution devices.

2.10 TURNING VANES

- A. Turning vanes shall be 2-inch blades for ducts up to 18 inches in either dimension and shall be 4 1/2-inch blades for larger ducts.
- B. Turning vanes material shall match to duct material. Galvanized ducts turning vane assemblies shall be finished with an air-dried phenolic corrosion resistant coating prior to installation.
- C. All turning vanes shall be constructed of double thickness vanes.

PART 3 EXECUTION

3.01 GENERAL

- A. Floor, Wall and Roof Openings for Existing Construction
 1. Provide openings for piping and equipment as required in the existing construction, whether or not they are specifically indicated.
 2. Cut the openings in a neat and orderly manner without damaging existing structures. Do not overcut corners.
 3. Patch openings to match the existing construction.
 4. Provide and assume responsibility for hangers and supporting members in the existing masonry or structural steel as required for proper completion of the Work.

3.02 INSTALLATION

- A. General
 1. Field Measurements
 - a. Duct lengths shall be determined from measurements taken at the Site.
 - b. The indicated dimensions are approximate and shall not be used for fabrication.
 2. Install ducts as indicated.
 3. Necessary provisions shall be taken into consideration during fabrication and installation of ductwork to provide for expansion and contraction.
 4. Ductwork shall be free from vibration when in operation.
 5. Provide necessary vibration isolation devices.
 6. Apply antiseize compound to bolt threads.
 7. Provide smooth bends or internal turning vanes at elbows, tees, and other points where the air flow changes direction.
 8. The inside of duct, specials, and fittings shall be smooth, clean, and free from blisters, sand and dirt.
 9. Ductwork shall be airtight.

10. Joints shall be carefully and neatly constructed, as indicated and as recommended by the manufacturer.
11. Flanges
 - a. Tighten flange bolts sufficiently to slightly compress the gasket and make a seal, but not so tightly as to distort the flanges.
 - b. Provide a flat washer under each nut and bolt head.
12. Dampers
 - a. Position the dampers to fit into the connecting ductwork at the indicated locations.
 - b. Install axles in the horizontal position unless otherwise necessary for proper operation of the damper.
13. Supports and Hangers
 - a. Support the ductwork in accordance with the manufacturer's recommendations and as indicated.
 - b. Duct supports shall comply with SMACNA Standards and applicable code requirements.
 - c. Supports and hangers shall transmit loads into the building structural frame through a system of intermediate beams and struts as necessary to comply with the indicated requirements.
 - d. Supports or hangers employing clip angles or similar devices for attachment to the duct will not be accepted.
 - e. Design the supports to resist IBC seismic forces.
14. Alignment and Elevation
 - a. Provide ductwork to the indicated lines and elevations, and slope as indicated to facilitate water drainage.
 - b. Use laser beam equipment or surveying instruments to maintain alignment and elevation.
 - c. If laser beam equipment is used, perform periodic elevation measurements with surveying instruments in order to verify accuracy.

B. Control Dampers

1. General
 - a. Coordinate damper submittals for type, quantity, and size in order to ensure compatibility with sheet metal design.
 - b. Follow the manufacturer's instructions for field installation of control dampers.
 - c. Unless specifically designed for vertical blade application, mount the dampers with the blade axis horizontal.
2. Duct Openings
 - a. Duct openings shall be free of obstructions and irregularities that might interfere with blade or linkage rotation or actuator mounting.
 - b. Duct openings shall measure 3/4 inch larger than damper dimensions, and shall be square, straight, and level.
3. Damper Sections
 - a. Individual damper sections, as well as entire multiple section assemblies, shall be completely square and free of racking, twisting, and bending.
 - b. Measuring the damper sections diagonally from upper corners to opposite lower corners of each damper section, both dimensions shall be within 1/8 inch of each other.
4. Shafts
 - a. Install an extended shaft or jackshaft in accordance with the manufacturer's instructions.
 - b. If a sticker on the damper face shows recommended extended shaft location, attach the shaft on the labeled side of damper to that blade.
5. Operation
 - a. Damper blades, axels, and linkage shall operate without binding.
 - b. After installation but before system operation, cycle the damper in order to ensure proper operation.
 - c. On multiple section assemblies, sections shall open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support ductwork or damper actuator in areas of damper when required in order to prevent sagging due to damper or damper actuator weight.

- 8. After installing low-leakage dampers with seals, caulk between the frame and the duct or opening in order to prevent leakage around the perimeter of damper.
- C. Install ductwork in accordance with SMACNA and NFPA. All ductwork indicated on the Drawings is schematic; therefore, changes in duct size, duct configuration, and location may be necessary to conform to field conditions.
- D. Install ductwork and accessories to provide a system free from buckling, warping, breathing, and vibration. Ductwork installation shall permit installation of other required services without piercing, crimping, or reducing duct sizes. Where space conditions permit, use full radius turns at offsets.
- E. Make all ductwork airtight. Seal flanged joints with closed-cell neoprene gaskets compressed between mating flanges. Seal all other joints and seams with liquid or mastic type sealants. Taped joints are not permitted. All joints, both transverse and longitudinal, shall comply with the requirements of SMACNA Seal Class A.
- F. Fabricate all duct fittings with continuously welded seams and joints.
- G. All ductwork shall be fabricated in accordance SMACNA Standards requirements for medium pressure ductwork and shall conform to 6-inch w.c. positive and negative pressure regardless of actual working pressure of the HVAC systems.

3.03 DUCT CLEANING

- A. The ducts shall be blown clean of dust and debris using compressed air.
- B. Do not use system fans for duct cleaning.

3.04 TESTS

- A. Provide duct test holes with patches in ducts where directed or necessary for testing and balancing purposes.
- B. Leak-test the ductwork after installation, in accordance with the National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, a publication of the Associated Air Balance Council (AABC).
- C. The maximum allowable leakage criteria shall be in conformance with ASHRAE standards.

END OF SECTION

SECTION 23 33 13.13

DAMPERS

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies HVAC system balancing and control dampers that are installed in ducts or independently mounted.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
32" Diameter Manual Round Damper	705-DPR25BB011
East 16x10 Damper	705-DPR25BB021
West 16x10 Damper	705-DPR25BB022
East 10x10 Damper	705-DPR25BB031
40x16 Damper	705-DPR25BB041
East 16x12 Damper	705-DPR25BB051
West 16x12 Damper	705-DPR25BB052
20x18 Damper	705-DPR25BB061
22x12 Damper	705-DPR25BB071
20x14 Damper	705-DPR25BB081
20x12 Damper	705-DPR25BB072
West 10x10 Damper	705-DPR25BB032

1.02 REFERENCE STANDARDS:

- A. This Section incorporates by reference the latest revision of the following documents. These references are 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
AMCA Standard 500	Test Methods for Louvers, Dampers and Shutters
SMACNA	HVAC Duct Construction

1.03 OPERATING REQUIREMENTS

- A. Pressure drop shall not exceed 0.02-inches w.c. at the design air volume
- B. The dampers shall meet the size and flow rate requirements indicated on Contract Drawings H3001 and H5001.

1.04 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
 2. Dampers dimensions and installation shop drawings.

3. Dampers construction information including frame, blade and linkage material data. Type of blades, and air flow and friction loss performance curve.
4. Installation requirements, showing clearance required for maintenance purposes.
5. Applicable operating and maintenance data for damper and operators as specified.

1.05 QUALITY ASSURANCE

- A. Certification: dampers shall bear the AMCA Certified Rating Seal for both air leakage and performance.

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 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Airolite
 2. Ruskin.
 3. Construction Specialties.
 4. Approved Equal.

2.02 BACKDRAFT OR GRAVITY DAMPERS

- A. General
 1. Provide backdraft dampers on the exhaust fans and ventilators where indicated.
 2. Damper sizes and capacities shall be as indicated on the Drawings.
- B. Design and Construction
 1. The dampers shall be of the multi-blade type, with soft-seating gaskets for minimizing noise and air leakage when closed.
 2. Blades shall be constructed of 16-gauge aluminum and shall be of an air foil design.
 3. Frames shall be fabricated from 16-gauge extruded aluminum alloy.
 4. The frames shall be totally out of the air stream and arranged for flange mounting.
 5. The dampers shall be designed to operate at 0.05-inch w.g. S.P., or less.
 6. Blades shall be individually counterbalanced and shall be provided with non-ferrous pins turning in nylon bearings.
- C. Damper Manufacturers, or Equal
 1. Air Balance, Inc.
 2. Air Dynamic
 3. Ruskin, Model BD2A1

2.03 VOLUME, CONTROL DAMPERS (MANUAL)

- A. General
 1. Provide volume control dampers in accessible locations in branch supply ducts and at each exhaust air opening, in order to properly regulate the volume of air delivered or withdrawn from each inlet and outlet, and as indicated.
 2. Damper sizes and capacities shall be as indicated on the Drawings.

- B. Construction
 - 1. The volume dampers shall be of the opposed blade type.
 - 2. The dampers shall be constructed of aluminum, of B & S 14-gauge thickness.
 - 3. The dampers shall be suitably reinforced with sturdy control shafts.
 - 4. Ductwork shall be reinforced to double thickness at damper shaft openings.
 - 5. Opposed blade dampers shall be constructed with a maximum blade size of 12 inches by 72 inches.
 - 6. Dampers material shall match the ductwork material.
 - 7. Dampers shall be provided with seals for low leakage where indicated on drawings.
- C. Air Extractor Type
 - 1. The volume control dampers indicated on drawings to be of the air extractor type shall be constructed of stainless steel, of 20-gauge for frames and of 24-gauge thickness for blades.
- D. Single blade dampers or splitter dampers will not be accepted.
- E. Manual control dampers shall be provided with mechanisms for adjustment and locking into position after being set.
- F. Manual Positioner (for manual dampers):
 - 1. A 3/8-inch locking quadrant shall be provided at one end of the damper, external to the ductwork, on manually adjusted dampers.
 - 2. Positioner extensions shall be provided for dampers installed in ductwork located in ceilings, walls or floors that is not directly accessible.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Align and install dampers in accordance with SMACNA standards, manufacturer's recommendations, and as shown on the drawings.
- B. Locate the damper positioners for direct access at the duct or install extensions where necessary to accessibility.
- C. Balancing dampers shall be opposed blade type unless otherwise specified.

3.02 TEST AND ADJUSTMENT

- A. Multiple blade dampers shall be manually tested, prior to installation and following installation to assure operation through their full range of movement without binding or interference.
- B. Final damper adjustments and positioning shall be performed during system balancing.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies diffusers, grilles, and registers for air distribution in the heating, air conditioning, and ventilating systems.

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revision of the following documents. These references are 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
ADC 1062 GRD-84	Test Code for Grille, Register and Diffuser Performance
ASHRAE	Handbook - HVAC Systems and Equipment Chapter, Air Diffusing Equipment
SMACNA	HVAC Duct Construction Standards Metal and Flexible

1.03 TYPE

- A. All grilles, and registers shall be designated as shown in the following table. The designation, size, and capacity shall be as indicated on the Drawings.

ITEM	DESIGNATION
Surface Mounted Exhaust Register or Grilles	ER-1 or EG-1

1.04 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. An 8½-inch by 11-inch manual with detail sheets or catalog data for diffusers, grilles, and registers.
 2. Manufacturer's catalog and or other data confirming conformance to specified design, material and equipment requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
1. Agitair.
 2. Carnes.
 3. Krueger.
 4. Titus.
 5. Price.
 6. Approved Equal.

2.02 GENERAL

- A. Provide exhaust registers and grilles as indicated.

- B. The sizes, capacities, and deflection of each unit shall be as indicated on the Drawings.
- C. Submittal
 - 1. Data sheet: Indicate materials of construction, finish, and mounting details, performance data including throw and drop, static pressure drop and noise ratings.
- D. The following schedule shall be followed:

Air Terminal Type	Border Type	Manufacturer, Model and Material	Optional damper	Neck Type
Exhaust Registers/Grilles (ER/EG)	Surface mount	Titus Model 350FL; Tuttle and Bailey; or equal	yes	Rectangular

- E. Registers, grilles and diffusers shall be constructed of aluminum.
- F. The finish shall be a white baked-on enamel.
- G. Accessory equipment shall be constructed of aluminum, or steel if aluminum is not available, and provided with a white baked-on enamel.
- H. The proper border style shall be selected by the Contractor to suit the installation conditions.
- I. Registers, grilles, and diffusers located in corrosive atmospheres, as indicated, shall be painted with a special protective coating in accordance with the requirements of Section 09 90 00.

2.03 ACTION SUBMITTALS

- A. Product Data
 - 1. Data sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, noise ratings.

2.04 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate Diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air outlets and Inlets."

2.05 MATERIALS

- A. Unless otherwise indicated, the diffusers, grilles, and registers shall be constructed of the same material as the ductwork in which they are installed.

2.06 ACCESSORIES

- A. All ceiling diffusers and all registers shall be equipped with an opposed blade volume dampers as shown on drawings. Dampers shall meet the requirements of Section 23 33 13.13.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Align, connect and install diffusers, grilles, registers and extractors in accordance with the manufacturer's recommendations and with SMACNA.

- B. Coordinate ceiling diffuser, register, and grille layout with lighting fixtures.
- C. Each unit shall be set flat against the room surface finish and shall have a felt gasket or seal.
- D. Paint visible ductwork behind register and grill flat back. Touch up marks and abrasions to match original finish.
- E. Install diffusers, registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors and fire dampers.

3.02 TESTING AND BALANCING

- A. Perform testing, adjusting, and balancing per Section 23 05 93.

END OF SECTION

SECTION 23 82 39

HOT WATER UNIT HEATERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies hot water unit heaters for indoor space heating applications.
- B. Equipment List:

ASSET NO.	EQUIPMENT DESCRIPTION
705-UH2501013	Grit Unit Heater 1
705-UH2501023	Grit Unit Heater 2
705-UH2502013	Grit Unit Heater 3
705-UH2502023	Grit Unit Heater 4
705-UH2502033	Grit Unit Heater 5
705-UH2502043	Grit Unit Heater 6

1.02 REFERENCED STANDARDS

- A. This Section incorporates by reference the latest revision of the following documents. These references are 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
NFPA 70E	National Electrical Code (NEC)

1.03 OPERATING REQUIREMENTS

- A. The equipment shall meet the following requirements:

EQUIPMENT NO.	705-UH2501013 & 705-UH2501023
Type	STANDARD VERTICAL HEATER
Motor	
Volt / Hz / Ph	115 / 60 / 1
HP	1/30
Hot Water	
Water Flow, gpm	4.4
Heat, BTU/hr	42,600
Air Flow, CFM	1155
Thermostat set point	55 F (adjustable)

EQUIPMENT NO.	705-UH2502013, 705-UH2502023, 705-UH2502033, & 705-UH2502043
Type	STANDARD VERTICAL HEATER
Motor	
Volt / Hz / Ph	115 / 60 / 1
HP	1/15
Hot Water	
Water Flow, gpm	7.2
Heat, BTU/hr	69,300
CFM	1665
Thermostat set point	55 F (adjustable)

1.04 SUBMITTALS

- A. Procedure: Section 01 33 00
- B. Provide the following submittals:
 - 1. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
 - 2. Electrical and control diagrams.
 - 3. Applicable operating and maintenance information as specified in Section 01 78 23.
 - 4. Equipment support, anchor bolt and mounting requirement calculations specified in Section 05 05 19 and Section 01 73 00 and as defined in the drawings.
 - a. Manufacturer shall provide equipment support design (for each unit heater). Support and anchorage shall be from ceiling as shown on the drawings. Drawings shall be used as a guidance for minimum requirements, final design of support layout shall remain the responsibility of the manufacturer.
 - b. Equipment support systems shall be Type 316L Stainless Steel in accordance with Section 05 50 00. Fasteners shall be in accordance with Section 05 05 23.
 - c. Complete structural design calculations and details, signed and sealed by a Washington licensed Professional Civil or Structural Engineer.

1.05 QUALITY ASSURANCE

- A. Unit heaters shall bear the label of a rating agency recognized in the State of Washington and shall conform to NEC requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Modine, model V/VN
 - 2. Trane
 - 3. McQuay
 - 4. Approved Equal.

2.02 EQUIPMENT FEATURES

- A. Standard Unit Heater:
 - 1. Standard unit heater shall be installed in non-corrosive, non-hazardous locations.
 - 2. Unit heaters shall be of the horizontal or vertical type, as scheduled.
 - 3. Heaters shall be provided complete with motor, fan, wire guard, heating coil, casing, vibration isolators and support brackets.
- B. Fan Casings
 - 1. Fan casings shall be steel-reinforced in order to provide a suitable support for the heating element and for attachment of the support brackets.
 - 2. The casings shall be finished with a factory finish.
- C. Fans and Motors
 - 1. The fans shall be of the multi-blade propeller-type.
 - 2. Fans shall be directly connected to the motor shaft.
 - 3. The fan and motors shall be statically and dynamically balanced.
 - 4. The fan shall be keyed and locked to the fan shaft.
 - 5. The fan and motor unit shall be mounted on vibration isolators to prevent noise.
 - 6. Motors shall be specially designed for unit operation.
 - 7. Motors shall be TEFC.
- D. Fan shafts shall be equipped with self-aligning ball or roller bearings and shall extend a sufficient length to receive the fan hub.
- E. Heating Coil:
 - a. The heating coil shall be composed of non-ferrous tube and fins.
 - b. Elements shall be leak-proof and shall be factory tested to 150 psig.
 - c. Overheat protected.
- 2. Controls:
 - a. Unless otherwise specified, a remote wall mounted thermostat shall be provided for each unit heater as shown on the drawings.
 - b. Control box shall be NEMA 4X with built-in controls and terminals and overheat protected.
 - c. Manual over temperature reset.
 - d. Fused transformer for control circuit. The unit heater controls shall be 24V.
 - e. The unit heater shall be provided with ON/OFF/Fan Only selector switch.
- F. Support and anchorage: manufacturer shall provide support and anchorage design. Submit, as defined above.

PART 3 EXECUTION

3.01 GENERAL

- A. Install unit heaters as shown and in accordance with the manufacturer's recommendations and recommended clearances from combustibles.
- B. The unit heater control system shall be coordinated with HVAC system control strategy as specified and shown on the drawings.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies general requirements for electrical work. Detailed requirements for specific electrical items specified in other sections are subject to the requirements of this Section. The Electrical Drawings and Schedules included in the specification are functional in nature and do not specify exact locations of equipment or equipment terminations.
- B. All electrical Work included in this Contract including pre-fabricated assemblies shall conform to 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
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures
NEMA	National Electrical Manufacturers Association
ICEA	Insulated Cable Engineers Association
IBC / IBO	International Building Code
UL	Underwriters Laboratories
NFPA 70	National Electric Code (NEC)
ASTM A123	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Provide the following submittals:
 - 1. Catalog cuts of equipment, devices, and materials requested by the specification sections.
 - a. Catalog information includes technical specifications and application information, including ratings, range, weight, accuracy, etc.
 - b. Catalog cuts shall be edited to show only the items, model numbers, and information which apply to the submittal requirements.
 - c. Catalog cuts shall be assembled in a folder. Each folder shall contain a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
 - 2. Applicable operation and maintenance information on an item-by-item basis in accordance with Section 01 78 23. Operation and maintenance information shall be provided at the time of equipment, device, or material site delivery, or at a certain stage of project completion as required by Section 01 78 23, whichever is the earlier. Full-size drawings shall be reduced to 11 x 17 inches.
 - 3. Test results for motors and electrical systems on the forms specified in Section 26 08 00 and found in Section 01 33 10. Maintain a file of the original test results and submit to the Project Representative prior to Final Acceptance.
 - 4. Description of functional checkout procedures, specified in this specification, 30 days prior to performing functional checkout tests.
 - 5. Interconnection diagrams depicting all cable requirements together with their actual terminations.

6. Electrical room plan and elevation drawings showing conformance with electrical working clearances and installation clearances required by selected manufacturer.

1.04 QUALITY ASSURANCE

- A. Identification of Listed Products:
 1. Electrical equipment and materials shall be listed and labeled for the purpose for which they are to be used, by UL or equivalent NRTL agency approved lab as the independent testing laboratory. Independent testing laboratory shall meet the requirements of the local or state inspection authority having jurisdiction.
 2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection. All costs and expenses incurred for such inspections shall be included in the original contract price.
 3. When the product is an assemblage of individual parts, whether the individual parts are listed or not, the entire assemblage shall be listed and labeled as a complete unit for the purpose for which it is to be used.
- B. Factory Tests: Where specified in the specification section, perform factory tests at the place of fabrication. Perform on completion of manufacture or assembly.

1.05 DEFINITIONS

- A. Elementary or Schematic Diagram: A schematic (elementary) diagram shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
- A. One-Line Diagram: Shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices, or parts used therein. Physical relationships are usually disregarded.
- B. Block Diagram: A diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
- C. Wiring Diagram or Connection System: A wiring or connection diagram includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.
- D. Interconnection Diagram:
 1. Show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices.
 2. References shall be shown to all connection diagrams which interface to the interconnection diagrams.
 3. Interconnection diagrams shall be of the continuous line type.
 4. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable.
 5. Each wire identification as actually installed shall be shown.
 6. The wire identification for each end of the same wire shall be identical.
 7. All devices and equipment shall be identified.
 8. Terminal blocks shall be shown as actually installed and identified in the equipment complete with individual terminal identification.
 9. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams shall be shown on the interconnection diagrams.
 10. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram.
 11. Signal and DC circuit polarities and wire pairs shall be shown.

12. Spare wires and cables shall be shown.

- E. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.
- 1.

1.06 DRAWINGS

- A. Prepare drawings specified as part of the work per Section 01 78 39 and submit per Section 01 33 00.
- B. Drawings shall be complete with borders and title blocks clearly identifying Contract name, equipment, and the scope of the drawing.
- C. Drawing standard requirements will be supplied by King County.

1.07 SITE CONDITIONS

- A. General: Unless otherwise indicated, size and derate equipment and materials for the ambient conditions, but not less than an ambient maximum temperature of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.
- B. Classified Areas:
 1. The following areas are designated as Class I Division 1:
 - a. None.
 2. The following areas are classified as Class I Division 2:
 - a. None.
- C. Corrosive Areas
 2. Grit Classifier Room.
- D. Seismic:
 1. Electrical equipment and supports: Braced per IBC requirements and Section 01 73 00.
 2. Provide calculations for overturning moment and design of the embedded anchors for securing free-standing equipment to the building structure.
 3. Fasten equipment that is front-accessible only to the wall or ceiling as well as the floor.

1.08 STORAGE OF MATERIALS AND EQUIPMENT

- A. Store materials and equipment per Section 01 67 00.
- B. Store indoor equipment and materials to be permanently located indoors and seal with plastic film wrap.

1.09 INDICATING LAMP COLORS

- A. Unless otherwise specified, equipment to follow with colored lenses in accordance with the following schedule:

Color	Function	Example
Red	Run, open valve	Equipment operating, motor running
Green	Ready, closed valve	Equipment ready, end of cycle
White/Clear	Normal condition	Control power on, status OK or clear
Amber/Yellow	Abnormal condition	Failure of equipment or status (yellow) abnormal, fault condition

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. General:
 - 1. Equipment and materials shall be new and free from defects.
 - 2. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work.
 - 3. Standard production materials shall be used wherever possible.
- B. Equipment Finish: Unless otherwise indicated, electrical equipment and materials shall be painted by the manufacturer as specified per Section 09 90 00.
- C. Galvanizing: Per ASTM A123.

2.02 CONDUCTOR / WIRE MARKERS

- A. Identify each power and control conductor at each end of each terminal to which it is connected.
- B. Conductors size No. 10 AWG or smaller shall have identification sleeves.
- C. Conductors:
 - 1. Identify each end as shown on the Drawings.
 - 2. If not shown on the Drawings, identify conductor ends with the Equipment number, followed by -Cxx, where xx is a unique number for that wire.
- D. Machine print on sleeves with permanent black ink the letters and numbers that identify each wire.
- E. Figures: 1/8-inch high.
- F. Sleeves: Yellow or white tubing, sized to fit the conductor insulation.
- G. Acceptable Manufacturer:
 - 1. TMS Thermofit Marker System by Raychem Co.
 - 2. Sleeve style wire marking system by W. H. Brady Co.
 - 3. Or Approved Equal.
- H. Adhesive strips are not acceptable.
- I. Use cable markers of the locking tab type for conductors No. 8 AWG and larger.
- J. Tabs: white plastic with conductor identification number permanently embossed.

2.03 NAMEPLATES

- A. Laminated phenolic plastic.
- B. Nominal Size: 3/4 inch high by 2 inches long.
- C. Black backgrounds with 3/16-inch white letters.
- D. If abbreviations are required because of space limitations, submit to the Project Representative prior to manufacture.
- E. Fastened using self-tapping stainless steel screws. The use of adhesives will not be permitted on the outside of enclosures.

2.04 TERMINAL BLOCKS

- A. Unless otherwise indicated, panhead strap screw type.
- B. Terminals shall be provided with integral marking strips which shall be permanently identified with the connecting wire numbers as shown on the Drawings.
- C. Terminal blocks for P-circuits (power 208-600 volts): Rated not less than the conductor current rating and less than 600 VAC.
- D. Terminal blocks for C-circuits (control and/or power 120 volts or less power) and S-circuits (signal): Rated not less than 20 amperes and less than 600 VAC.
- E. Terminals: Tin-plated.
- F. Insulating material: Nylon.

2.05 PROGRAMMING AND SOFTWARE FOR SUPPLIED EQUIPMENT

- A. For any device that requires programming, the Contractor shall provide licensed programming software and documentation. License shall include updates for duration of contract and warranty period.
- B. Contractor shall provide final documented application program and software for each programmable device.
- C. Contractor shall provide any special hardware programming interfacing (i.e., cable, dongles, etc.) required for programming devices.
- D. Submit in accordance with paragraph 1.03

PART 3 EXECUTION

3.01 GENERAL

- A. Construction:
 - 1. Unless otherwise indicated, electrical layout drawings are diagrammatic.
 - 2. Coordinate the location of electrical material or equipment with other equipment and work.
 - 3. Make necessary minor changes in location of electrical material or equipment to avoid interferences with other work prior to installation.
- B. Housekeeping:
 - 1. Protect electrical equipment from dust, water and damage.
 - 2. Wipe motor control centers, switchgear, and buses free of dust and dirt on the outside keep dry and vacuumed on the inside within 30 days of Substantial Completion.
 - 3. Touch up any scratches on equipment as specified in Section 09 90 00.
 - 4. During construction, allow no electrical equipment to be temporarily exposed to weather, debris, liquids, or damage.
- C. Dust Free Areas:
 - 1. Protect electrical, instrumentation and control equipment from dust by wrapping the equipment in plastic film wrap until installed to prevent dust from entering the equipment.
 - 2. Once electrical, instrumentation and control equipment is installed, protect from dust. Rewrap the equipment if necessary to keep the equipment dust free.

3.02 RECORD DOCUMENTS

- A. Provide record drawings in accordance with Section 01 78 39. Include the following schedules, lists, and drawings:
 - 1. Interconnection diagrams (Section 26 05 00).
 - 2. Original submittal drawings (Section 26 05 00).

END OF SECTION

SECTION 26 05 19
600 VOLT CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies conductors and cables rated 600 volts used for power, lighting, receptacle, signal, and control circuits.

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 B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B189	Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NEMA WC57/ICEA S-73-532	Standard for Control Cables
NEMA WC70/ICEA S-95-658	Non-Shielded Power Cables Rated 2000 V or less
NEC 310-12	General Conductors Color Code
NFPA 70	National Electric Code (NEC)
NFPA 820	Fire Protection in Wastewater Treatment and Collection Facilities
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables
UL 1277	Type TC Power and Control Tray Cable
UL 1581	Reference Standards for Electrical Wires, Cables, and Flexible Cords

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts showing general information of the conductors and cable.

PART 2 PRODUCTS

2.01 GENERAL

- A. **Unscheduled Conductors and Cables:**
1. With the exception of lighting, communication, and receptacle circuits, the type, size and number of conductors shall be as specified on the Drawings.

2. Lighting and receptacle circuit conductors are not shown on the Drawings and shall be sized by the Contractor in accordance with the NEC to limit voltage drop to 3 percent.
3. Minimum size of lighting and receptacle circuits shall be 12 AWG.
4. Number and types of communication, paging, and security cables shall be as required for the particular equipment provided.
5. Unless otherwise indicated, provide lighting and receptacle circuit conductors in accordance with CABLESPEC "XHHW-2".

- B. Cable Specification Sheets (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in this Section.

2.02 COLOR CODING

- A. General:
1. Multiconductor power and control cable colors shall be manufacturer's standard.
 2. Single conductor control conductor color shall be yellow, except for the grounded conductor which shall be white.
- B. Power Conductors:
1. Single-conductor power conductors shall be color coded in accordance with the following:

Use	Cable	Color
Three-phase, 480-volt power or 480/277	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
	Ground	Green
	Neutral	Gray
Three-phase, 120/208-volt power	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
	Ground	Green
Single-phase, 120/240-volt power	Line 1	Red
	Line 2	Black
	Neutral	White
	Ground	Green

2. Cables sized No. 4 AWG and larger may be black with colored 3/4-inch vinyl plastic tape applied in 3-inch lengths around the cable at each end.
3. Tag the cables at terminations and in pull boxes, handholes, and manholes.

- C. Signal Conductors: Unless otherwise indicated, cables shall be color coded black and white for pairs or black, red, and white for triads.

- D. Control Conductors: Control conductors color coding shall be manufacturer's standard.

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

- A. Single Conductor:
1. Stranded and used in conduits for power and control circuits.
 2. Unless otherwise indicated, provide in accordance with CABLESPEC "XHHW-2".

- B. Multiconductor Cable:

1. Used for power and control circuits routed in cable tray.
1. Cables shall be UL labeled, Type TC, designed for cable tray installation in accordance with NEC 340.
2. The type of insulation, number of conductors, and size of conductor shall be as specified.
3. Unless otherwise indicated, provide multiconductor power and control cable in accordance with CABLESPEC "MC".
4. Power Cable: Containing three or four conductors, as specified, plus an equipment grounding conductor.
5. Control Cable: Unless otherwise indicated, shall be size 14 AWG.
6. VFD Cables: Unless otherwise indicated, shall not be sized smaller than 12 AWG.

2.04 SIGNAL CABLES

- A. General:
 1. Provide signal cable for instrument signal transmission, alarm, communication and other circuits as specified. Circuit shielding shall be provided in addition to cable shielding.
 2. Provide circuits for Type A and B signals specified in Section 40 61 13 in compliance with the instrument manufacturer's recommendations.
 3. Unless otherwise indicated, provide single circuit signal cable in accordance with CABLESPEC "SIC".
 4. Unless otherwise indicated, provide multi-circuit signal in accordance with CABLESPEC "MIC".
- B. Communication System Cables: Communication, system cables shall be as specified in Division 40.

2.05 PORTABLE CORD

- A. Unless otherwise indicated, provide portable cord in accordance with CABLESPEC "CORD".
- B. Cords shall contain an equipment grounding conductor.

2.06 SPLICING AND TERMINATING MATERIALS

- A. Connectors:
 1. Tool applied compression type of correct size and UL listed for the specific application.
 2. Tin-plated high conductivity copper.
 3. For wire sizes No. 10 AWG and smaller: Nylon self-insulated, ring tongue or locking-spade terminals.
 4. For wire sizes No. 8 AWG and larger: One-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger.
 5. Mechanical clamp, dimple, screw-type connectors are not acceptable.
- B. Motor Connection Kits:
 1. Shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination.
 2. Shall accommodate a range of cable sizes for both in-line and stub-type configurations.
 3. Shall be independent of cable manufacturer's tolerances.
- C. Splicing is not allowed without prior approval from the Project Representative.

PART 3 EXECUTION

3.01 GENERAL

- A. Identify each power and control conductor at each terminal to which it is connected. The marking system shall comply with Section 26 05 00.
- B. Wire Pulling:

1. Complete the pulling of wire and cable into conduit without damaging or putting undue stress on the cable insulation.
 2. Soapstone, talc or UL listed pulling compounds are acceptable lubricants for pulling wire and cable.
 3. Grease is not acceptable.
 4. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.
- C. Whenever a cable leaves a raceway, provide a cable support.
- D. When flat bus bar connections are made with unplated bar scratch-brush the contact areas. Torque bolts to the bus manufacturer's recommendations.
- E. Provide and install yellow three-strand copolymer polyolefin pull string in all new conduits. String shall extend at least 1 foot beyond each end of the conduit and be tied off on bushing or in other manner acceptable to the Project Representative
- F. Splicing is not allowed without prior approval from the Project Representative.

3.02 600 VOLT CONDUCTOR AND CABLE

- A. Lacing and Bundling:
1. Lace and bundle conductors in panels and electrical equipment, No. 6 AWG and smaller, at intervals not greater than 6 inches, spread into trees and connected to their respective terminals.
 2. Lacing shall be made up with plastic cable ties.
 3. Lacing is not necessary in plastic panel wiring duct.
 4. Bundle conductors crossing hinges into groups not exceeding 12 and arrange so that they will be protected from chafing when the hinged member is moved.
- B. Slack:
1. Provide slack in junction and pull boxes, handholes and manholes.
 2. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box.
 3. Amount of slack shall be equal to largest dimension of the box.
 4. Where plastic panel wiring duct is provided for wire runs, lacing is not required.
 5. Do not use plastic panel wiring duct in manholes and handholes.
- C. Stranded Conductors:
1. Terminate as described in this Section, except where terminals will not accept such terminations.
 2. In these cases, terminate the conductors directly on the terminal block.
 3. Install compression lugs and connectors using manufacturer's recommended tools.
- D. Raceway fill limitations shall be as defined by NEC and the following:
1. Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC.
 2. However, lighting and receptacle circuits shall not be in conduits with power or control conductors.
- E. Make terminations at solenoid valves, 120 volt motors, and other devices provided with pigtail leads using self-insulating tubular compression connectors.

3.03 SIGNAL CABLE

- A. Circuits:
1. Run as individually shielded twisted pairs or triads.
 2. Do not, in any case, make up a circuit using conductors from different pairs or triads.
 3. Use triads wherever 3-wire circuits are required.
 4. Unless otherwise indicated, provide terminal blocks at instrument cable junctions, and identify circuits at such junctions.

- 5. Run signal circuits without splices between instruments, terminal boxes, or panels.
- B. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables.
- C. Common grounded return conductors for two or more circuits are not acceptable.
- D. Unless otherwise indicated, bond shields to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Provide terminals for running signal leads and shield drain wires through junction boxes.
- E. Shield Drain Wire:
 - 1. Terminate spare circuits and the shield drain wire on terminal blocks at both ends of the cable run and cause to be electrically continuous through terminal boxes.
 - 2. Do not ground shield drain wires for spare circuits at either end of the cable run.
- F. Terminal Boxes:
 - 1. Provide at instrument cable splices.
 - 2. If cable is buried or in raceway below grade at splice, provide an instrument stand as specified with terminal box mounted approximately 3 feet above grade.
- G. Install and terminate cable for telephone systems in compliance with the manufacturer's recommendations.

3.04 PORTABLE CORD

- A. Portable cord feeding permanent equipment, such as pendant cords, pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination.
- B. Connect portable cords to permanent wiring with the use of terminals.
- C. Use in-line taps and splices only where specified.

3.05 TESTING

- A. General: Test conductors and cable in accordance with Section 26 05 00 and Section 26 08 00.
- B. Signal Cable:
 - 1. Test each signal pair or triad for electrical continuity.
 - 2. Test each shield drain conductor for continuity. Shield drain conductor resistance shall not exceed the loop resistance of the pair or triad.
 - 3. Test each conductor (signal and shield drain) for insulation resistance with all other conductors in the cable grounded.
 - 4. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. Use a 500 volt megohmmeter for insulation resistance measurements.

3.06 SCHEDULES

- A. Cables are scheduled on the Drawings.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

- A. General:

1. Conductor and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets (CABLESPECS).
2. Install scheduled and unscheduled conductors and cables in accordance with the CABLESPECS.

B. CABLESPEC SHEETS:

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:**MC**

Description:

Multiconductor power and control cable, No. 1/0 AWG and larger, approved for tray installation and in accordance with UL 1569.

Voltage:

600 volts.

Conductor Material:

Bare annealed copper; stranded in accordance with ASTM B8.

Insulation:

XHHW-2, 90 degree C dry, 75 degree C wet, crosslinked polyethylene in accordance with NEMA WC57 / ICEA S-73-532 (control cable), NEMA WC70 / ICEA S-95-658 (Power Cable), and UL 44.

Assembly:

Individual conductors cabled together with nonhydroscopic fillers and binding tape.

Sheath:

Impervious, continuous, corrugated aluminum welded over cable core. Sheath shall meet the grounding conductor requirements of NEC table 250-95.

Jacket:

50 mil minimum, polyvinylchloride (PVC) in accordance with UL 1277.

Flame Resistance:

IEEE 383.

Manufacturer(s):

Okonite, Houston Wire & Cable, or approved equal.

Uses Permitted:

Cable tray, direct burial, encased in concrete in normal or Class I, Division 2 atmospheres.

Execution:

Installation:

Install in accordance with this Section.

Testing:

Test in accordance with Section 26 05 00 and Section 26 08 00.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

CABLE SYSTEM IDENTIFICATION:	TC
Description:	Multiconductor power and control cable, No. 14 AWG minimum through No. 1 AWG, approved for tray installation and in accordance with UL 1581
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	XHHW-2, 90 degree C dry, 75 degree C wet, crosslinked polyethylene in accordance with NEMA WC57 / ICEA S-73-532 (control cable), NEMA WC70 / ICEA S-95-658 (Power Cable), and UL 44.
Assembly:	Individual conductors cabled together with nonhydroscopic fillers and binding tape.
Jacket:	50 mil minimum, polyvinylchloride (PVC) in accordance with UL 1581.
Flame Resistance:	IEEE 383.
Manufacturer(s):	Okonite, Houston Wire & Cable, or approved equal.
Uses Permitted:	Cable tray, direct burial, encased in concrete in normal or Class 1, Division 2 atmospheres.
Execution:	
	Installation: Install in accordance with this Section.
	Testing: Test in accordance with Section 26 05 00 and Section 26 08 00.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:**XHHW-2**

Description:

Single conductor Cross-linked polyethylene power and control cable for sizes No. 14 AWG through No. 600 kCMIL.

Voltage:

600 volts.

Conductor Material:

Bare annealed copper; stranded in accordance with ASTM B8.

Insulation:

XHHW-2, 90 degree C dry, 75 degree C wet, cross-linked polyethylene in accordance with NEMA WC57/ ICEA S-73-532 (control cable), NEMA WC70/ ICEA S-95-658 (power cable).

Jacket:

None.

Flame Resistance:

N/A.

Manufacturer(s):

Okonite, X-Olene; Cablec, Durasheath XLP; or Approved Equal.

Execution:

Installation:

Install in accordance with this Section.

Testing:

Test in accordance with Section 26 05 00 and Section 26 08 00.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	SIC
Description:	Single twisted, shielded pair or triad, 16 AWG, instrumentation cable, UL listed. NEC type TC.
Voltage:	600 volts.
Conductor Material:	Bare annealed copper; stranded in accordance with ASTM B8.
Insulation:	15 mil, 90°C Dry / 75°C Wet, Polyvinyl chloride (PVC) with 4 mil nylon conduit or jacket.
Lay:	Twisted on a 2-inch lay.
Shield:	100 percent, 1.35 mil aluminum-Mylar tape with 18 AWG 7-strand tinned copper drain wire.
Jacket:	45 mil polyvinylchloride (PVC).
Flame Resistance:	UL 1277.
Manufacturer(s):	Okonite, Okoseal-N type P-OS; or Approved Equal.
Execution:	
Installation:	Install in accordance with this Section.
Testing:	Test in accordance with this Section.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:

MIC

Description:

Multiple twisted, shielded pairs or triads, 16 AWG, instrumentation cable, UL listed.

Voltage:

600 volts.

Conductor Material:

Bare annealed copper; stranded in accordance with ASTM B8.

Insulation:

15 mil, 90°C Dry / 75°C Wet, Polyvinyl chloride (PVC) with 4 mil nylon conduit or jacket.

Lay:

Twisted on a 2-inch lay.

Shield:

100 percent, 1.35 mil aluminum-Mylar tape with 18 AWG 7-strand tinned copper drain wire.

Overall Shield:

2.35 mil aluminum-Mylar tape with a No. 20 AWG 7-strand tinned copper drain wire.

Jacket:

45 mil polyvinylchloride (PVC).

Flame Resistance:

UL 1277.

Manufacturer(s):

Okonite, Okoseal-N type SP-OS; or Approved Equal.

Execution:

Installation:

Install in accordance with this Section.

Testing:

Test in accordance with this Section.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	CORD
Description:	Portable Cord, 10 AWG and smaller, UL listed, type SO; larger than 10 AWG, UL listed type G.
Voltage:	600 volts
Conductor Material:	Flexible rope stranded per ASTM B189 and B33. Conductors shall be coated except ground conductors may be uncoated.
Insulation:	Bare annealed copper; stranded in accordance with ASTM B8. Insulation shall be ethylene propylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
Jacket:	Heavy-duty neoprene as per ICEA S-68-516.
Manufacturer(s):	Okonite, Okocord; or Approved Equal.
Execution:	
Installation:	Install in accordance with this Section 26 05 19.
Testing:	Test in accordance with Section 26 05 00 and Section 26 08 00.

3.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

Cable System Identification:	ENET
Description:	Ethernet, CAT 6+ cable, CMR or CMP jacket, 4 pair count.
AWG (MM)	23 (0.57).
Conductor Material:	Solid annealed copper.
Insulation Colors:	Pair 1: ColorTip Light Blue, Blue. Pair 2: ColorTip Light Orange, Orange. Pair 3: ColorTip Light Green, Green. Pair 4: ColorTip Light Brown, Brown.
Separator:	Tape.
Jacket:	CMR: Flame retardant (FR) PVC. CMP: FR, low smoke PVC.
Characteristic Impedance (Ohms):	100 +/- 15.
Nominal Velocity of Propagation (%):	CMR: 70. CMP: 73.
Performance Compliance:	UL 444, CSA C22.2 No. 214-08, UL 1666, NFPA 262, ANSI/TIA 568-C.2, Article 800 NEC (NFPA 70), and RoHS-compliant.
Acceptable Manufacturers:	Superior Essex DataGain cable, Approved Equal.
Execution:	
NRTL Programs:	UL Verified CAT 6. UL c(UL) Listed CMR. UL c(UL) Listed CMP.
Installation:	Install in accordance with this Section and associated equipment per manufacturer's instruction.
Testing:	Test in accordance with this Section.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the system for grounding electrical equipment, exposed non-energized metal surfaces of equipment, and metal structures.

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 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth
NEC	National Electrical Code Article 250 Grounding and Bonding
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Product Data.
 - 2. Grounding System Test Results.

1.04 QUALITY ASSURANCE

- A. Comply with requirements of NEC Article 250.

PART 2 PRODUCTS

2.01 GROUND CABLE

- A. Annealed bare copper, concentric stranded as specified. If cable sizes are not indicated, the minimum sizes shall be as follows:
 - 1. 480V MCC and switchboards: 2/0 AWG.
 - 2. Exposed metal: 2 AWG.
 - 3. Grounding electrode conductor: 1/0 AWG

2.02 COMPRESSION CONNECTORS

- A. Cast copper.
- B. Acceptable Manufacturer:
 - 1. Thomas and Betts.
 - 2. Burndy.
 - 3. Approved Equal.

2.03 BOLTED CONNECTORS

- A. Acceptable Manufacturer:
 - 1. Burndy.
 - 2. O. Z. Gedney.
 - 3. Approved Equal.

2.04 EXOTHERMIC CONNECTORS

- A. Acceptable Manufacturer:
 - 1. Thermoweld.
 - 2. Cadweld.
 - 3. Approved Equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Make embedded and buried ground connections by compression connectors utilizing diamond or hexagon dies. Use a hand compression tool for wire sizes 2/0 AWG and smaller and a hydraulic pump and compression head for wire sizes larger than 2/0 AWG.
- B. Tools and dies:
 - 1. Approved for purpose used.
 - 2. Dimple compressions are not acceptable.
- C. Prepare compression connections in accordance with the manufacturer's instructions.
- D. Unless otherwise indicated, make exposed ground connections to equipment by bolted clamps.
- E. Do not use solder in any part of the ground circuits.
- F. Cables:
 - 1. Securely attach embedded ground cables and fittings to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement.
 - 2. As each part of the grounding system below finished grade is completed, notify the Project Representative a minimum of four hours prior to backfilling.
- G. Extensions:
 - 1. Extend grounding conductors that are extended beyond concrete surfaces for equipment connection a sufficient length to reach the final connection point without splicing.
 - 2. Minimum extensions: 3 feet.
- H. Conductors:
 - 1. Locate grounding conductors that project from a concrete surface as close as possible to a corner of the equipment pad, protected by conduit, or terminated in a flush grounding plate.
 - 2. Terminate grounding conductors for future equipment using a two-hole copper flush mounted grounding plate.
 - 3. Support exposed grounding conductors by non-corrosive metallic hardware at 4-foot intervals or less.
 - 4. Ground conductors, except signal conductor shields entering enclosures:
 - a. Bonded together to the enclosure if it is metallic and to metallic raceways within or terminating at the enclosure.
 - 5. Grounding conductor shall not be used as a system neutral.
- I. Use compression-type lugs in accordance with manufacturer's recommendations.

- J. Directly connect lightning arresters to the ground system using copper conductors, sized as specified.
- K. Metallic sheaths or shields of shielded power cable:
 - 1. Terminated by a copper grounding strip provided with cable connection for connection to the grounding system.
- L. Prior to making ground connections or bonds, clean metal surface at the point of connection.
- M. For all control devices with sealed cable connection, include a ground conductor in the control cable.
- N. Prior to burying of the ground conductors, record location for Record Drawings.

3.02 RACEWAY GROUND

- A. Metallic conduits:
 - 1. Assembled to provide a continuous ground path and bonded using insulated grounding bushings.
 - 2. Bond using insulated grounding bushings.
- B. Non-metallic conduits: Insulated ground conductor sized in compliance with the NEC.
- C. Grounding bushings: Connected to the grounding system using conductors sized in compliance with NFPA 70.
- D. Cable trays:
 - 1. No. 2/0 AWG bare copper ground conductor run on the outside of each tray.
 - 2. Conductor to be connected to each section or fitting using a carriage bolt and clamp.
- E. Every conduit shall contain an insulated green ground conductor sized in compliance with NEC.
- F. Duct Banks:
 - 1. Run along the duct bank a continuous No. 2/0 AWG minimum bare copper conductor.
 - 2. Bond using insulated grounding bushings.

3.03 EQUIPMENT AND ENCLOSURE GROUND

- A. Connect electrical and distribution equipment to the grounding system. Cables sized as indicated.
- B. Connect non-electrical equipment with metallic enclosures to the grounding system.
- C. Securely bond transformer yard fences and gates as specified.

3.04 ISOLATED GROUNDING

- A. Where the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, provide an additional isolated ground conductor from the equipment through the instrument power panel for connection to a single point ground bus in the automatic transfer switch enclosure.
- B. Conductor: Green insulation with a yellow stripe and run in the same raceway as the power and neutral conductors.
- C. Neutral conductor from the ultra-isolation transformers:
 - 1. Grounded only at the single point ground bus in the automatic transfer switch.

3.05 GROUNDING SYSTEM TESTS

- A. Test per IEEE 81 each grounding connection to determine the ground resistance.
- B. Submit a plot of ground resistance readings for each isolated ground rod or ground mat on 8-1/2 by 11 inch size graph paper.
- C. Current reference rod: At least 100 feet from the ground rod or grid under test.
- D. Make measurements at 10-foot intervals beginning 25 feet from the test electrode, and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.
- E. Consider a grounding system that shows greater than 2-ohm resistance for the flat portion of the plotted data inadequately grounded. Add additional parallel-connected ground rods and deeper driven rods until the ground resistance measurements meet the 2-ohm or less requirement.
- F. Use of salts, water, or compounds to attain the indicated ground resistance is not acceptable.

END OF SECTION

SECTION 26 05 33

RACEWAYS, BOXES, AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the electrical conduits, wireways, pull boxes, cable vault, cable trays, fittings, and supports.

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 C80.1	Rigid Steel Conduit-Zinc Coated
ANSI C80.3	Electrical Metallic Tubing-Zinc Coated
ASTM A 48 REV A	Gray Iron Castings
ASTM A193 REV C	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM F512	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC WW-C-581E	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC W-C-1094A	Conduit and Conduit Fitting Plastic, Rigid
NEC 500	Classified Locations, Classes I, II, and III, Divisions 1 and 2
NEMA ICS 6	Industrial Control and Systems Enclosures
NEMA RN1	Polyvinyl Chloride (PVC) externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA TC6	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA VE-1	Metal Cable Tray Systems
NEMA 250	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 79	Electrical Standards for Industrial Machinery
UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 360	Liquid Tight Flexible Electrical Conduit
UL 651	Rigid Nonmetal Electrical Conduit
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Include manufacturer's catalog cuts as specified by Section 26 05 00. Include general information and detailed specifications for the products specified in this Section.
 2. Certifications and calculations that raceway supports meet the seismic requirements specified in Sections 26 05 00, 01 73 00, and this Section.

PART 2 PRODUCTS

2.01 RACEWAY

- A. General requirements for raceway materials specified in this Section are listed in the RACESPECS sheets at the end of this Section. The type of raceway to be used for any given area and application shall conform to the requirements of Table A in this Section.

2.02 BOXES AND FITTINGS

- A. Pull Boxes and Wiring Gutters:
 - 1. Device and junction boxes less than 6 inches square shall be Type FD galvanized cast ferrous. Boxes larger than FD boxes shall be constructed of sheet steel, galvanized after fabrication, or NEMA 4X stainless steel or nonmetallic.
 - 2. Outdoor boxes and enclosures shall be provided with neoprene gaskets on the hinged doors or removable covers.
 - 3. Conduit bodies shall be ferrous alloy with screw taps for fastening covers. Gaskets shall be made of neoprene.
 - 4. Boxes and enclosures in corrosive areas shall be NEMA 4X stainless steel or nonmetallic.
 - 5. Boxes in classified areas shall be NEMA Class 7 galvanized cast ferrous.
 - 6. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code.
 - 7. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle.
 - 8. Covers larger than 3 by 4 feet shall be split.
- B. Terminal Cabinets:
 - 1. Terminal cabinets located indoors shall be NEMA 4.
 - 2. Cabinets located outdoors and in corrosive areas shall be NEMA 4X.
 - 3. Cabinets shall be provided with hinged doors.
 - 4. Adjustable terminal strip mounting accessories shall be provided.
 - 5. Cabinets shall be provided with channel mounted terminal blocks rated 30 A, 600 Vac.
 - 6. Terminals shall be No. 8 minimum strap-screw type, suitable for ring tongue or locking spade terminals.
- C. Conduit Seals:
 - 1. Install conduit seals in classified areas in conduit runs leaving the space. They shall be of the EYS or EZS type with male and female hubs.
 - 2. Use PVC-coated fittings with urethane interior coating for PVC-coated GRS; use copper free cast aluminum for rigid aluminum.
 - 3. The sealing compound shall be as prescribed by the manufacturer of the sealing conduit body.
 - 4. Use the sealant, such as Chico, in areas that are defined as classified and meet the NEC requirements for Article 500.

2.03 RACEWAY SUPPORTS

- A. Conduit Supports:
 - 1. Provide hot-dip galvanized framing channel with end caps to support groups of conduit.
 - 2. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required.
 - 3. Conduit supports for PVC-coated rigid steel and PVC conduit systems shall be one-hole PVC-coated rigid steel or clamps conduit wall hangers.
- B. Ceiling Hangers:
 - 1. Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable.

2. Unless otherwise indicated, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193.
 3. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.
- C. Suspended Raceway Supports (Racks):
1. Suspended raceway supports shall consist of concrete inserts, galvanized carbon steel rod hangers, and jamb nuts supporting hot-dip galvanized framing channel or lay-in pipe hangers as required.
 2. Unless otherwise indicated, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193.
 3. Brace all suspended raceway supports at 30-foot intervals (alternating from one side to the other) to meet specified seismic requirements.
- D. Design by Professional Engineer:
1. Raceway supporting systems, structures, and elements shall be designed to meet seismic and other building structural requirements and to support the static and dynamic load of the wiring and raceways that they will carry. Systems to be installed shall be prepared by a Professional Structural Engineer registered in the state of Washington to ensure conformance with IBC seismic, building, and load requirements.

2.04 NAMEPLATES

- A. Provide nameplates for all boxes in accordance with the requirements of Section 26 05 00. Nameplate wording shall be as indicated on the Drawings.
- B. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate.

2.05 FIRESTOPS

- A. Apply in accordance with manufacturer's recommendations.
- B. Acceptable Manufacturers:
 1. 3M CP25WB+
 2. Vimasco WC-5 FR
 3. Flamemastic 77
 4. Or Approved Equal.
- C. Products which are affected by water are not acceptable.

PART 3 EXECUTION

3.01 GENERAL

- A. Specific raceway types and applications are indicated on the drawings and/or in the raceway schedule. When not indicated on the Drawings and/or in the schedule Table A specifies the type of raceway required for each location and application by RACESPEC sheet. Use fittings, hubs and boxes as specified by the raceway type in RACESPEC. Unless otherwise indicated, in Table A, unscheduled conduit shall be galvanized rigid steel, RACESPEC type GRS.

LOCATION	APPLICATION/CONDITION	RACESPEC
Indoor noncorrosive	Exposed	GRS
Indoor corrosive	Exposed	PGRS
Outdoor	Exposed	PGRS
Non-Classified	Final connection to equipment and light fixtures	LFS

3.02 RACEWAY NUMBERING SYSTEM

- A. General:
 - 1. Identify each conduit; rack shall be identified by a unique number shown in the Drawings.
- B. Conduit Identification:
 - 1. Pressure stamp conduit numbers into a non-corrosive metal tag. Fix a tag with number to each end of each conduit and at each manhole, pullbox and handhole with Type 304 Stainless Steel wire.

3.03 CONDUIT

- A. General
 - 1. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.
 - 2. Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.
 - 3. Raceways shall be provided for lighting, receptacles, power, control, fire alarm, instrumentation, signaling, and grounding systems.
- B. Indoor and Outdoor Conduit Systems:
 - 1. Unless otherwise indicated, in general, conduit inside structures shall be exposed.
 - 2. Unless otherwise indicated, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.
 - 3. Install conduit to conform to the requirements of the RACESPEC sheets and the following:
 - a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.
 - b. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.
 - c. Exposed conduit shall be run on supports spaced not more than 8 feet apart.
 - d. Where three or more conduits are located in parallel run, space them out from the wall using framing channel.
 - e. Where conduits are suspended from the ceiling, support systems shall comply with the requirements of this Section.
 - f. Secure conduit rack supports to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.
 - g. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.
 - h. Install conduits between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, place conduits under the reinforcement.
 - i. Route conduit clear of structural openings and indicate future openings.
 - j. Flash and seal watertight those conduits which pass through roofs or metal walls.
 - k. Neatly group conduit into any openings cut into concrete and masonry structures, and grout using non-shrink type grout.
 - l. During construction, cap conduits to prevent entrance of dirt, trash, and water.
 - m. Terminate exposed conduit stubs for future use with galvanized pipe caps.
 - n. Determine concealed conduit stubup locations from the manufacturer's shop drawings.
 - o. Terminate concealed conduit for future use in equipment or by galvanized couplings plugged flush with structural surfaces.
 - p. Where the Drawings indicate future duplication of equipment wired hereunder, provide concealed portions of conduits for future equipment.
 - q. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.
 - r. Terminate all conduits that enter enclosures by fittings that ensure that the NEMA rating of the enclosure is not affected or changed.
 - s. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.

- t. Transitions from concealed or underground or embedded locations to exposed or aboveground or above-grade locations shall be made using type PGRS conduit for a distance of at least 12 inches on either side of transition.
- u. Conduit across structural joints where structural movement is allowed shall have an OZ-Gedney "Type DX" or Crouse-Hinds "Type XD," bonded, weathertight expansion and deflection fitting of that conduit size.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

A. The following RACESPECS are included in this Section:

RACESPEC SYMBOL	RACEWAY DESCRIPTION
GRS	Galvanized rigid steel conduit
LFS	Liquid tight flexible steel conduit
PGRS	PVC coated rigid steel conduit

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

RACEWAY IDENTIFICATION:	GRS
Description:	Galvanized rigid steel conduit.
Compliance:	ANSI C80.1, UL 6.
Finish:	Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.
Manufacturers:	Allied Tube and Conduit Corp., Wheatland Tube Co., or Approved Equal.
Minimum Size:	Unless otherwise specified, 3/4 inch for exposed, 1 inch for embedded, encased, or otherwise inaccessible.
Fittings:	Hubs: Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or Approved Equal.
Unions:	Electrogalvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.
Boxes:	
Indoor:	Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA 12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA 4 watertight.
	Conduit Bodies: Ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
Outdoor and Wet Areas:	Type FD cast ferrous for all devices and for junction boxes less than 6 inches square. NEMA 4X stainless steel or nonmetallic for 6 inches square and larger.
Corrosive:	NEMA 4X stainless steel or nonmetallic.
Classified:	NEMA Class 7 cast ferrous.
Elbows:	
3/4" through 1-1/2":	Factory fabricated or field bent.
2" through 6":	Factory fabricated only.
Conduit Bodies:	
3/4" through 4":	Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
5" and 6":	Electrogalvanized iron or cast iron box.
Expansion Fittings:	Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.
Manufacturers:	Appleton, Crouse-Hinds, Hubbel, O.Z. Gedney, Or Approved Equal.
Installation:	Galvanized rigid steel conduit shall be made up tight and with conductive "coppershield" thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.
	Conduit entering boxes shall be terminated with a threaded hub with a grounding bushing.
	Exposed male threads on galvanized rigid steel conduit shall be coated with zinc-rich paint.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

RACEWAY IDENTIFICATION:	LFS
Description:	Liquidtight flexible steel conduit.
Application:	Final connection to equipment subject to vibration or adjustment.
Compliance:	UL 360.
Construction:	Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquidtight plastic cover.
Minimum Size:	3/4 inch.
Fittings:	Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.
Installation:	The length of flexible liquidtight conduit shall not exceed 15 times the trade diameter of the conduit. The length of liquidtight conduit shall not exceed 36 inches.
	Liquid-tight flexible steel conduit shall be made up tight and with conductive "coppershield" thread compound.

3.04 RACEWAY SPECIFICATION (RACESPEC) SHEETS

RACEWAY IDENTIFICATION:	PGRS
Description:	Galvanized rigid steel conduit, corrosion-resistant, polyvinyl chloride (PVC) coated.
Compliance:	ANSI C80.1, UL 6, NEMA RN1.
Finish:	PGRS shall be hot dipped galvanized rigid steel conduit. The inside and outside, as well as the threads shall be galvanized. A minimum 40-mil thick PVC coating shall be bonded to the outside of the conduit and the inside shall be coated with 2-mil urethane. Coating shall be free of pinholes. Bending of conduit shall not damage either the interior or exterior coating. Bond strength shall exceed the tensile strength of the PVC coat. Elbows shall be factory made and coated.
Minimum Size:	3/4 inch.
Fittings:	Similarly coated to the same thickness as the conduit and provided with Type 304 stainless steel hardware. A 2-mil urethane coating shall be applied to the interior, and the threads of all fittings and couplings. Conduit and fittings shall be manufactured by the same company.
Hubs:	Hubs for connection of conduit to junction, device, pull or terminal boxes shall be threaded and made of cast ferrous alloy. Hubs shall be galvanized steel and have insulating bushings with bonding locknuts. The hubs shall utilize a neoprene O-ring and shall provide a watertight connection.
Boxes:	
Non-Classified:	NEMA 250, Type 4X stainless steel or nonmetallic.
Classified:	NEMA 250, Type 7D cast ferrous.
Installation:	PVC-coated conduit shall be supported away from the structure using PVC-coated conduit wall hangers. All conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Plastic coated conduit shall be made tight with special wrenches and fittings designed for tightening PVC-coated conduit. All threads shall be protected against corrosion per NEC 300.6 (a) by liberally applying an approved electrically conductive, corrosion-resistant compound – "coppershield." Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material. The area to be patched shall be built up to the full thickness of the coating. Painted fittings are not acceptable.

END OF SECTION

SECTION 26 05 73.19

ARC-FLASH HAZARD ANALYSIS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the arc flash study and report for all voltage levels of the electrical power system. The "electrical power system" for this project only includes equipment provided or installed under this contract. Arc flash study shall include the method and recommendation in determining proper Personal Protective Equipment (PPE) and providing proper labeling of equipment as specified in 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
IEEE 1584	IEEE Guide for Performing Arc-Flash Hazard Calculations
NFPA 70E	Standard for Electrical Safety Requirements for Employee Workplaces
OSHA 29 CFR, Part 1910 Subchapter S	Occupational Safety and Health Standards: Electrical
OSHA 29 CFR, Part 1926 V	Electrical Power Transmission and Distribution
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Certified Arc Flash Report.
 2. Arc flash warning labels.
 3. Electronic data files of arc flash calculations and report.
 4. 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 QUALITY ASSURANCE

- A. Qualifications: Study and Report shall be prepared by a Washington State registered professional electrical engineer.
- B. Preparation:
1. By the manufacturer of the switchboard, service entrance circuit breaker, motor control center; by an electrical testing service which is regularly engaged in power system studies; or by an electrical engineering firm which is regularly engaged to perform power system studies.

1.05 ARC FLASH REPORT

- A. Prepare a report summarizing the arc flash study and conclusions and recommendations which may affect the integrity of the electric power distribution system.

- B. Calculations shall be prepared, stamped, dated and signed by a Professional Engineer licensed in the state of Washington.
- C. Perform arc flash calculations to determine the incident energy, arc flash boundary, and minimum PPE requirements for locations throughout the power system.
- D. Arc flash warning labels:
 - 1. Produced and attached to the electrical equipment.
 - 2. Indicate approach boundaries, incident energy level, and the minimum PPE that is required when servicing the equipment within the arc flash boundary.
- E. As a minimum, include the following in the report:
 - 1. Equipment manufacturer's information used to prepare the study.
 - 2. Assumptions made during the study.
 - 3. Reduced copy of the one line drawing.
 - 4. Arc flash evaluations summary spreadsheet as specified below in this Section.
 - 5. Bus detail sheets as specified in this Section.
 - 6. Arc flash warning labels printed in color on adhesive backed labels.
 - 7. Printed copy of installed labels.
- F. Submit report a minimum of 60 days before energizing electrical equipment.

1.06 ARC FLASH STUDY

- A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed. In addition to the study requirements by NFPA 70E, the study shall include 120 VAC power distribution panels and all DC systems.
- B. Coordinate with Authority Having Jurisdiction (AHJ) for site-specific requirements.
- C. For each major part of the electrical power system, determine the following:
 - 1. Flash hazard protection boundary.
 - 2. Limited approach boundary.
 - 3. Restricted approach boundary.
 - 4. Prohibited approach boundary.
 - 5. Incident energy level.
 - 6. PPE hazard/risk category.
 - 7. Type of PPE required.
- D. Produce arc flash warning labels as indicated in PART 3.
- E. Produce bus detail sheets that list the items in Paragraph 1.05B and 1.05C.1 through 7 and the following additional items:
 - 1. Bus name.
 - 2. Upstream protective device name, type, and settings.
 - 3. Bus line to line voltage.
- F. Produce an arc flash evaluation summary sheet listing the following additional items:
 - 1. Bus name.
 - 2. Upstream protective device name, type, settings.
 - 3. Bus line to line voltage.
 - 4. Bus bolted fault.
 - 5. Protective device bolted fault current.
 - 6. Arcing fault current.
 - 7. Protective device trip/delay time.
 - 8. Breaker opening time.

9. Solidly grounded column.
 10. Equipment type.
 11. Gap.
 12. Arc flash boundary.
 13. Working distance.
 14. Incident energy.
 15. Required protective fire rated clothing type and class.
- G. Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Provide a current up-to-date short circuit and protective device coordination study. If one does not exist, then perform a short circuit and protective device coordination study as specified in Section 26 05 73.
- B. Perform the arc flash study in accordance with NFPA 70E, OSHA 29 CFR Part 1910 Subpart S, and IEEE 1584 Standards.
- C. Perform the studies using actual equipment data and the data from the same manufacturer of protective relay devices as being provided by the switchgear equipment manufacturers.
- D. Provide arc flash warning labels on equipment meeting standard ANSI Standard Z535.4 and as approved by the Project Representative and the Local Authority Having Jurisdiction.
- E. Labels: durable for location and in color with adhesive backs. Labels to include all of the following:
 1. WARNING - ARC FLASH HAZARD.
 2. Date of Analysis.
 3. Flash Hazard Category.
 4. Incident Energy Level at 18 inches in cal per cm. sq.
 5. Flash Hazard Boundary.
 6. Personal Protection Equipment requirement within the Flash Hazard Boundary.
- F. Provide a list of lockout and tagout devices that are compatible with the equipment.
- G. Provide arc flash labels for all equipment identified in NEC Article 110. Additional labels shall be provided for all enclosed feeder circuit breakers located at the generator, automatic transfer switch, and load bank breaker panel.

END OF SECTION

SECTION 26 05 73

POWER SYSTEM STUDY: SHORT CIRCUIT AND COORDINATION REPORT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the short circuit and protective device coordination study for all voltage levels of the electrical power system. The "electrical power system" starts at the line side of the Service Entrance circuit breaker and generator. Refer to single-line diagram of this Contract for details of the substation.

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 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Certified short circuit report and coordination study.
 2. Qualifications of firm preparing Short Circuit and Coordination Report.
 3. Electronic files of short circuit report and coordination study.
 4. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format. .

1.04 QUALITY ASSURANCE

- A. Qualifications: Study and Report shall be prepared by a Washington State registered professional electrical engineer.
- B. Preparation:
1. by an electrical engineering firm which is regularly engaged to perform power system studies.

1.05 SHORT CIRCUIT REPORT

- A. Prepare a report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system.
- B. As a minimum, include the following in the report:
1. Equipment manufacturer's information used to prepare the study.
 2. Assumptions made during the study.
 3. Short circuit calculations listing short circuit levels at each bus.
 4. Evaluation of the electrical power system and the model numbers and settings of the protective devices associated with the system.

5. Time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.
6. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment connected to that bus.
7. Calculations prepared, stamped, dated and signed by a Professional Engineer licensed in the state of Washington.

1.06 SHORT CIRCUIT STUDY

- A. One-line Diagram:
 1. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
 2. Type designation, current rating, range or adjustment manufacturer's style and catalog transformers.
 3. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
 4. Nameplate ratings of all motors and generator with their subtransient reactances.
 5. Transient reactances of generator and synchronous reactances of generator.
 6. Sources of short circuit elements such as utility ties, generators, and induction motors.
 7. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
 8. Standby as well as normal switching conditions.
- B. Calculations:
 1. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
 2. Calculate the maximum and minimum ground-fault currents.

1.07 COORDINATION STUDY

- A. Provide an evaluation of the electrical power system and the model numbers and settings of the protective devices associated with the system.
- B. As a minimum, include the following on 5-cycle, log-log graph paper:
 1. Time-current curve for each protective relay or fuse showing graphically that the settings will allow protection and selectivity within Industry standards. Identify each curve and specify the tap and time dial setting.
 2. Time-current curves for each device to be positioned for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, notify the Project Representative as to the cause.
 3. Time-current curves and points for cable and equipment damage.
 4. Circuit interrupting, device operating, and interrupting times.
 5. Indicate maximum fault values on the graph.
 6. Sketch of bus and breaker arrangement.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Perform the studies in accordance with IEEE Standards 141 and 242.
- B. Perform the studies using actual equipment data and the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the acceptance testing of electrical materials, equipment, and 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
ANSI	American National Standards Institute
ICEA	Insulated Cable Engineers Association
NEMA	National Electrical Manufacturer's Association
NETA	International Electrical Testing Association [NETA]

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Draft Test Plan and Procedures in accordance with the latest NETA requirements, 90 days prior to initial functional checkout. Contractor shall use NETA Acceptance Testing Specifications for all new equipment installed under this contract and NETA Maintenance Testing Specifications for all existing equipment reused under this contract unless otherwise requested by the Project Representative.
 2. Completed test report Forms 26 05 00-A, 26 05 00-B, 26 05 00-C, 26 05 00-D, and 26 05 00-K contained in Section 01 33 10.
 3. Functional checkout procedures 45 days prior to performing initial functional checkout tests.
 4. Final Test Report documenting test results and equipment and device settings.
 5. NETA certification of Testing Contractor provided as part of test plan submittal.

1.04 QUALITY ASSURANCE

- A. Qualifications: Testing Contractor shall be NETA certified.

1.05 APPLICATION

- A. Requirements for testing in accordance with this Section are specified in this and other sections of Divisions 26, 28, and 40. Where testing in accordance with this Section is required, the required tests, including correction of defects and retesting, shall be completed prior to energization of material, equipment, or systems.

1.06 TEST EQUIPMENT AND MATERIALS

- A. Test instruments shall be calibrated to references traceable to the National Institute of Standards and Testing Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date of recalibration.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 TESTING

- A. General:
 - 1. Prior to energizing the electrical circuits, perform the following tests. Unless otherwise indicated, a 1,000 volt megohmmeter shall be used for resistance measurements.
 - 2. Record test measurements on the Forms 26 05 00-A and 26 05 00-B.
 - 3. Submit a description of the proposed functional test procedures 45 days prior to the performance of functional checkout.
- B. Insulation Resistance Measurements:
 - 1. General:
 - a. Make general insulation resistance measurements on conductors and energized parts of electrical equipment.
 - b. Unless otherwise indicated, minimum acceptable values of insulation resistance shall be in accordance with the applicable ANSI, ICEA, NEMA, or NETA standards for the equipment or material being tested.
 - c. Record the ambient temperature at which insulation resistance is measured on the test form.
 - d. Record insulation resistance measurements on Form 26 05 00-A.
 - e. Insulation with resistance of less than 100 megohms is not acceptable.
 - f. Document checks and measurements.
- C. Conductor and cable tests:
 - 1. Measure phase-to-ground insulation resistance for all circuits 120 volts and above, except lighting circuits. Make measurements with motors and other equipment disconnected, except that solid state equipment shall be disconnected unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.
- D. Motor Tests:
 - 1. Complete Form 26 05 00-B for each motor after installation.
 - 2. Measure insulation resistance for all motors before being connected.
 - 3. Motors 50 HP and larger: Make insulation resistance measurements at the time of delivery and when connected.
 - 4. Insulation resistance values less than 100 megohms are not acceptable.
 - 5. Verify motor phase rotation.
 - 6. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
 - 7. Measure current on each phase with motor running at full load.
- E. Distribution Equipment: Measure insulation resistance for transformers, panelboards, and other distribution equipment phase-to-phase and phase-to-ground.
 - 1. Functional Checkout:
 - a. Perform functional testing in accordance with the manufacturer's requirements and the procedure provided in test plan and procedures.
 - b. Prior to functional testing, adjust and make operational all protective devices.
 - c. Have Project Representative witness the testing.
 - d. Check that circuit breakers, meters and monitors are installed and function properly.
 - e. Check functional operation of switchboards, motor control centers, control panels, automatic transfer switches and other electrical equipment.
 - f. Prior to energization of equipment, perform a functional checkout of the control circuit. Checkout shall consist of energizing each control circuit and operating each control, alarm, or malfunction device and each interlock in turn to verify that the specified action occurs.
 - g. Document all test results and device settings in the final test report.

2. Prepare a Test Report summarizing the final test procedures and test results.

END OF SECTION

SECTION 26 09 16

MISCELLANEOUS ELECTRICAL DEVICES

PART 1 GENERAL

1.0 SUMMARY

- A. This Section specifies miscellaneous electrical control and power devices, relays, magnetic contactors, disconnect switches, manual starters, and overcurrent protection.

1.1 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 (1,000 volts maximum)
NEMA ICS 1	Industrial Controls and Systems: General Requirements
NEMA ICS 2	Industrial Controls and Systems: Controllers, Contactors, and Overload Relays, Rated 600 Volts AC
NEMA KS 1	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

1.2 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Manufacturer's catalog data for products to be provided in the Work.
 2. Applicable operation and maintenance information: Section 01 78 23.

PART 2 PRODUCTS

2.0 CONTROL DEVICES

- A. Pushbuttons / Selector Switches, Oil tight:
1. Flush head, heavy-duty, with NEMA rating to match enclosure type.
 2. Operators: Red for stop functions and black for all other functions.
 3. Provide pushbuttons designated "Lock-Out-Stop" (LOS) with a padlockable attachment to maintain the device in a depressed (stop or open) position.
 4. Escutcheon legend as specified on the Drawings.
 5. Unless otherwise specified, use momentary contact type.
 6. Contact blocks:
 - a. NEMA ICS 2 designation A600 except when switching circuits monitored by programmable controllers or other solid state circuits.
 - b. Hermetically sealed, logic-read type.
 - c. Acceptable manufacturer:
 - 1) Allen-Bradley Series 800 T/H.
 - 2) Square D Class 9001 Type K.
 - 3) Approved Equal.
- B. Indicating Lights:

1. Indicating lights: 5 to 6 VDC light emitting diodes (LEDs) with push-to-test feature.
 2. Testing: As a group using a common lamp test button.
 3. Indicating light colors: Per Section 26 05 00.
 4. Heavy-duty, with NEMA rated socket/wiring to match enclosure type.
 5. Acceptable Manufacturers:
 - a. Allen-Bradley 800 T/H
 - b. Square D Class 9001 Type K
 - c. Approved Equal
- C. Control Stations:
1. Classification, unless otherwise specified:
 - a. Indoor locations: NEMA 12.
 - b. Outdoor locations: NEMA 3R or 4.
 - c. Corrosive areas: Nonmetallic NEMA 4X.
 - d. Hazardous areas: NEMA 7.
 2. Pushbuttons: Protective Hypalon boots.
 3. When indicating lights are specified, size to accommodate the transformer type lights.
 4. Acceptable Manufacturer:
 - a. Allen-Bradley, 800 H series.
 - b. Crouse-Hinds, NCS series.
 - c. Approved Equal.
- D. Coordinated Manual Control (CMC) Switch
1. Customizable combination of operator controls and indicating lights.
 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 indicated in 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. Acceptable Manufacturer:
 - a. Senasys Inc., Series CMC.
 - b. Approved Equal

2.1 CONTROL RELAYS

- A. Load-switching Control Relays:
1. When used for switching loads (solenoids, actuators, contactors, motor starter coils, etc.): Heavy-duty machine tool type.
 2. Relays that have contacts used for remote interlocking or when the switching load is not shown: Heavy-duty machine tool type.
 3. Contacts: As a minimum, 4-pole and field interchangeable to either normally open or normally closed. Relay shall be capable of accepting a 4-pole adder.
 4. AC relays: NEMA A600 contact ratings and electrical clearances for up to 600 volts.
 5. DC relays: NEMA P300 contact ratings and electrical clearances for up to 250 volts.
 6. Acceptable Manufacturer:
 - a. Allen Bradley Bulletin 700.
 - b. Square D Class 8501.
 - c. Approved Equal.

- B. Logic Level Switching Control Relays:
 - 1. Four Form C (4PDT), gold-silver-nickel contacts rated 2 amps resistive at 120V AC or 28V DC.
 - 2. Plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener.
 - 3. AC models: Neon lamp indicator wired in parallel with coil.
 - 4. Acceptable manufacturer (Control relays used for switching solid-state logic and signal circuits):
 - a. Potter Brumfield series KHA.
 - b. Allen Bradley Bulletin 700-HC14
 - c. Approved Equal.
- C. Latching Relay:
 - 1. Electrically actuated latching relay or an industrial relay with an electrically operated latching attachment.
 - 2. Latching mechanism: One SET coil and one RESET coil rated for continuous duty on 120 VAC.
 - 3. Maintain the last state upon a power failure.
 - 4. Contacts: 3A 120VAC minimum.
 - 5. Normally open and normally closed as shown on the Drawings.
 - 6. Acceptable manufacturer:
 - a. Allen-Bradley 700 HTA.
 - b. Idec RY2KS-UAC120.
 - c. Approved Equal.
- D. Timers:
 - 1. Timing relays:
 - a. Solid-state, pulse count type using a high frequency RC oscillator and integrated circuit counter for timing.
 - b. Do not use electrolytic capacitors in the timing circuits.
 - c. Time delays from 0.1 seconds to 48 hours, adjustable over a 20:1 range.
 - d. Timing adjustment: Knob adjustment on the top of the unit.
 - e. On-delay, off-delay, and single-shot timing models.
 - f. Reset in 0.03 seconds or less.
 - g. Timer accuracy: Plus or minus 2.0 percent under normal conditions.
 - h. Two NEMA form-C timed contacts.
 - i. Acceptable manufacturer:
 - 1) Agastat, STA series.
 - 2) Agastat BTSALISC with locking bail STAOOI if equal socket.
 - 3) General Electric.
 - 4) Approved Equal.
 - 2. Logic level time delay control relay:
 - a. General:
 - 1) Power supply: as indicated in drawings or as required.
 - b. Type 1 - Time delay "on" relay.
 - 1) DPDT contacts rated 3 A at 120 VAC.
 - 2) Repeatability: + 0.2% maximum.
 - 3) Setting error: + 10% maximum.
 - 4) Temperature error: + 3% maximum.
 - 5) Range: As specified, 0.1 - 3600 seconds.
 - 6) Lifetime - electrical: 200,000 operations mechanical: 50,000,000 operations.
 - 7) Coil voltage: As specified.
 - 8) Acceptable Manufacturers:
 - a) Allen-Bradley 700-HR series.
 - b) Omron H3CR-A series.
 - c) Approved Equal.
 - c. Type 2 - Time delay "off" relay.
 - 1) "True off" delay: timed contact remains energized after power is removed from coil terminals up to 600 seconds.
 - 2) DPDT contacts rated 3 A at 120 VAC.

- 3) Repeatability: + 0.4% maximum.
 - 4) Setting error: + 10% maximum.
 - 5) Temperature error: + 0.2% maximum.
 - 6) Range: As specified, 0.1 - 600 seconds.
 - 7) Lifetime - electrical: 100,000 operations mechanical: 20,000,000 operations.
 - 8) Coil voltage: As specified.
 - 9) Acceptable Manufacturers:
 - a) Allen-Bradley 700-HRQ series.
 - b) Omron H3CR-H series.
 - c) Approved Equal.
3. Motor-driven timers:
- a. Mounted in a one-piece molded case, permanently mounted and wired.
 - b. Driven by a synchronous motor which starts timing when initiated by an external signal.
 - c. Time settings: Made by turning a knob on the front of the dial.
 - d. Neon pilot light visible from the front of the timer shall glow red when the timer motor is energized.
 - e. Visual indication by a cycle progress pointer which advances to zero from the setting back to zero as time progresses.
 - f. Two sets of "instantaneous" NEMA form-C contacts which actuate when the timing is initiated.
 - g. One set of "delayed" NEMA form-C contacts which actuates when the unit has timed out.
 - h. Reset: Unless otherwise indicated, when the timing cycle is completed, timer automatically resets.
 - i. Acceptable manufacturer:
 - 1) Eagle Cycle-flex reset timer HP5 series.
 - 2) Automatic Timing Controls Series 305E.
 - 3) Approved Equal.

2.2 MAGNETIC CONTACTORS

- A. Motor contactors:
1. Designed for continuous operation of induction motors at 600 volts or less at 60 Hz and comply with NEMA ICS 2-321.
 2. Minimum contactor size: Unless otherwise indicated, NEMA size 1.
 3. Supply the contactor with a normally open auxiliary contact for use as a hold-in contact as a minimum. Provide additional contacts as indicated.
 4. Additional contacts as needed.
 5. The coil voltage, frequency, and number of poles to be as specified.

2.3 SAFETY DISCONNECT SWITCHES

- A. Heavy-duty, safety type rated 600 volts AC complete with or without current limiting fuses sized to match switch ampere rating as shown on the Drawings.
- B. Classification, unless otherwise specified:
1. Indoor enclosures: Unless otherwise indicated, NEMA 12. See section 26 05 33.
 2. Outdoor or corrosive areas: NEMA 4X, nonmetallic.
 3. Hazardous areas: NEMA 7.
 4. Classified areas: Suitable for the specified classification.
- C. Operating handle: Capable of being padlocked in the "off" position.
- D. Operator: Positive, quick-make, quick-break mechanism.
- E. Switch Mechanisms: One auxiliary contact rated B150, per NEMA ICS 2-125, that opens before the switch blades.
- F. Horsepower rated for motors and comply with NEMA KS 1.

- G. Defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position.
- H. Switches shall have line terminal shields.
- I. Acceptable Manufacturer:
 - 1. Westinghouse Type H-600.
 - 2. Cutler Hammer.
 - 3. General Electric.
 - 4. Siemens.
 - 5. Square D.
 - 6. Approved Equal.

2.4 OVERCURRENT PROTECTION

- A. Circuit Breakers:
 - 1. Thermal magnetic, molded-case type with the ampere rating as specified.
 - 2. Unless otherwise indicated, circuit breaker interrupting rating:
 - a. 25,000 amperes symmetrical minimum for service at 240 volts and below.
 - b. 65,000 amperes symmetrical minimum for 480-volt service.

2.5 ESELECTOR SWITCHES

- A. For Fans: 600V, heavy duty two-position, four-circuit, suitable for Class 1, Division 2 area.
- B. Indicating plate markings as follows: "Enable-Stop."
- C. Acceptable Manufacturer:
 - 1. Appleton.
 - 2. Crouse-Hinds EDS 21272.
 - 3. Approved Equal.

2.6 NAMEPLATES

- A. For all control stations, relays, timers, motor contactors and disconnect switches: Per Section 26 05 00.

PART 3 EXECUTION

3.0 GENERAL

- A. Mount control stations, contactors, and safety disconnect switches 48 inches above finished floor.

3.1 FIELD CHECKOUT AND TESTING

- A. Checkout each miscellaneous electrical device for:
 - 1. Proper mounting.
 - 2. Proper interconnections.
 - 3. Absence of shorts and grounds.
 - 4. Proper function of motor start and control equipment.
 - 5. Power supply.
 - 6. Field devices.
- B. Checkout systems:
 - 1. Proper interconnections.
 - 2. Absence of shorts and grounds.

C. Field Testing:

1. To be provided as part of the system and operational testing.
2. Test all products per Section 26 08 00.

END OF SECTION

SECTION 26 24 19

MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies existing 600-volt motor control centers (MCC) with new feeder branch circuit protection and motor controller units.

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/NEMA ICS 1	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2	Industrial Control Devices, Controllers and Assemblies
NEMA 1	National Electrical Manufacturer Association Enclosure 1
NFPA 79	Electrical Standard for Industrial Machinery
UL 845	Motor Control Centers

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Elementary connection and interconnection diagrams as required in this Section, in accordance with NFPA 79 and/or NEMA ICS standards.
 2. List of starters and feeder tap compartments indicating the size and type of circuit protection.
 3. Interrupting, withstand and continuous current rating of:
 - a. Starter units.
 4. Catalog and technical data indicating the equipment meets the specifications.
 5. Installation instruction, outline dimensions, front view drawing identifying control and monitoring devices, nameplate engravings, shipping section dimensions, weight, and foundation requirements assembly.
 6. External connection diagram showing function and identification of all terminals requiring field connections.
 7. Operations and Maintenance manuals as specified in Section 01 78 23.
 8. CAD files of the final MCC drawings
 9. Schematics and wiring diagrams.
 10. Plan drawings showing conduit entry locations.
 11. Recommended spare parts list.
 12. Certified copies of all material test reports.
 13. Training schedule and materials.
 14. Certification and calculations that the equipment complies with the seismic requirements of Section 01 73 00.
 15. Bill of Materials, including Form 01 78 45-A.
 16. Completed test report form 26 05 00-D.
 17. 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturer:
 - 1. Schneider Electric / Square D, to match existing
 - 2. All parts and accessories to existing equipment must be approved by the original equipment manufacturer to be compatible.
 - 3. All protective devices shall be fully rated. Series rating of protective devices is not allowed.
- B. The equipment in this section has been pre-selected by the County for system standardization. Contractor shall procure the items required in this section from a vendor authorized to supply products by the listed manufacturer. All protective devices shall be fully rated. Series rating of protective devices is not allowed.

2.02 SERVICE

- A. Motor control centers shall be rated 600 volts, 60 hertz, 3 phase, 4-wire as specified, and suitable for operation at the specified voltages and short circuit capacities.

2.03 STRUCTURE AND CONSTRUCTION

- A. Structure:
 - 1. Motor control centers shall be made of No. 14 gage steel minimum, and each section shall be as specified on the contract drawings. The individual unit compartments shall be a minimum of 12 inches high. There shall be 72 inches available for stacking starter units. Compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.
 - 2. A full height vertical wireway, 20-square-inch minimum, shall be provided for each vertical motor control center section. The wireway shall contain full height removable doors. Horizontal wireways shall be provided top and bottom, extending the length of motor control centers.
 - 3. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup. A removable lifting angle shall be mounted on top and shall extend the width of the motor control center lineup.
 - 4. Motor Control Centers and related equipment shall be braced for site seismic criteria listed in Section 01 73 00.
- B. Construction:
 - 1. Motor control centers located indoors shall have NEMA 1 rating.
 - 2. Starter units, size 5 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, plated copper free-floating stabs and steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed. Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.
 - 3. Fusible switch or circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.
 - 4. Hardware for mounting future starter and feeder tap units shall be provided at compartments specified as "FUTURE."

2.04 WIRING

- A. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller. Motor control centers shall be provided with all necessary interconnecting wiring and interlocking. When a control section, as described in this Section, is specified on the drawings or schedules, wire directly to the relays or programmable controller's input/output modules as part of the interconnecting wiring. Provide elementary and connection

diagrams for each starter unit and an interconnection diagram for the entire motor control center. Attach polyester plastic protected connection diagram to inside of each unit door.

- B. Power Wire: Power wire shall be copper 90 degrees C "MTW" insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.
- C. Control Wire: Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C and UL listed for panel wiring.
- D. Terminations and Cable Connections:
 - 1. Terminals: Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.
 - 2. Cable Connectors: Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 MCM, shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M, Burndy, or approved equal.
- E. Conductor Markers: Markers used for identification shall meet the requirements of Section 26 05 00.

2.05 MAIN AND FEEDER BRANCH CIRCUIT PROTECTION

- A. Circuit Breakers (Thermal Magnetic): Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amperes RMS symmetrical. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker. The motor circuit protector shall be set at its lowest position at the factory.
- B. Circuit Breakers (Magnetic Only): Magnetic circuit breakers shall be molded-case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 65,000 amps symmetrical.

2.06 MOTOR CONTROLLER UNITS

- A. General: Motor controller units shall be combination type with contactor and motor circuit protector as specified on the drawings. The starter units shall have a minimum UL listing of 65,000 amps RMS, symmetrical or as specified in the schedule.
- B. Motor Circuit Protectors: The molded case motor circuit protector shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection.
- C. Control Transformers:
 - 1. Each control transformer shall be rated 480/240-120V, single phase, 2 wire, 60 Hz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA STARTER SIZE	VOLT-AMPERE RATING
1	100
2	150

2. Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two UL Class CC time-delay primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all control transformers. Fuses shall be sized in accordance with NEC. Primary fuse shall have a time/current characteristic specifically designed for control circuit transformer protection.
 3. Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.
- D. Contactors:
1. Full-Voltage Non-Reversing (FVNR): Unless otherwise specified, contactors shall be full voltage, 3-pole, 600-volt AC, NEMA size 1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools.
 2. Full-Voltage Reversing (FVR): Reversing starters shall have mechanically interlocked contactor coils to prevent simultaneous engagement and shall have an additional contactor and auxiliary relays as required.
 3. Two-Speed, Two-Winding (2S2W): Two speed starters shall have two mechanically and electrically interlocked contactors. Separate running over-current protection shall be provided for each speed.
- E. Surge Protection: A surge protection device shall be provided in each starter. The device shall be encapsulated in a small module suitable for mounting directly to the starter coil. Additional panel space for the surge protection device shall not be required. Surge protection devices shall be rated 120V AC.
- F. Auxiliary Contacts: Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Each contactor shall be equipped with interlocks as shown on the drawings, but not less than two normally open and two normally closed electrically isolated auxiliary contacts. Auxiliary contacts shall be wired out to terminal blocks.
- G. Overload Relay: TeSys T Motor Management System with current module shall protect the power wiring and motor from excessive over currents. The relay shall be ambient compensated. The sensing element shall conform to ANSI/NEMA ICS 2-222.06, Class 20 tripping time. The management system shall incorporate Ethernet TCP/IP communications protocol. Each TeSys T Motor managements system shall integrate a Human Machine Interface (HMI) module on the front of the MCC. The Overload Relays shall include the LTM-E expansion unit.
- H. Terminal Blocks: Terminal blocks shall be screw type rated 600 volts, 20 amperes for control wiring and 30 amperes power wiring (starters size 3 and larger shall terminate the power leads directly to the contactor). The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.07 MISCELLANEOUS

- A. For motor starter units the control devices such as pushbuttons, selector switches, indicating lights, and overload reset pushbuttons shall be mounted on the unit compartment door via the HMI module.
- B. Elapsed time indicator shall be incorporated into the HMI module.
- C. Nameplates: Nameplates shall be provided in accordance with the requirements of Section 26 05 00. Nameplates shall be provided for all cubicles and compartments. A nameplate shall be provided identifying the motor control center.
- D. Provide phase fail relays which shall comply with the requirements of the control circuits.

PART 3 EXECUTION

3.01 GENERAL

- A. The motor control centers shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.
- B. Field wiring shall meet the requirements of Section 26 05 19. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.
- C. The TeSys T overload unit shall be provided and sized based on the actual full load amperes of the motor.
- D. The motor circuit protectors shall be adjusted to the lowest setting not causing false tripping.

3.02 FIELD TESTS

- A. Motor control centers shall be tested in accordance with Section 26 08 00.
- B. Complete test report Form 26 05 00-D.

END OF SECTION

SECTION 26 27 16

LOCAL CONTROL PANELS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies local control panels for controlling process equipment, consisting of enclosures, wiring, and electrical control devices. This section also applies to vendor packaged systems.
- B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Grit Washer Control Panel 1	705-FP1207
Grit Washer Control Panel 2	705-FP1208

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-310-C	Racks, Panels, and Associated Equipment
ANSI/NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies
ANSI/NEMA ICS 6	Enclosures for Industrial Controls and Systems
NEMA 4X	National Electrical Manufacturer Association Enclosure 4X
NEMA 12	National Electrical Manufacturer Association Enclosure 12
UL 508	Industrial Equipment
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
- Shop drawings and equipment data: Section 26 05 00.
 - Layout drawings of the local control panel enclosures indicating the front door and rear panel equipment arrangement and dimensions. Provide a list of materials and components with the layout drawings.
 - Instrumentation systems' manufacturer design.
 - Elementary and internal connection diagrams: Section 26 05 00.
 - A written description of the elementary diagram sequence of operation.
 - Operating and maintenance information: Section 01 78 23.
 - Completed test report form 26 05 00-K.
 - Bill of Materials, including Form 01 78 45-A.

1.04 QUALITY ASSURANCE

- A. Listing and labeling: See Section 26 05 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 1. Hoffmann Engineering Company.
 - 2. Schneider Electric - Square D.
 - 3. Approved Equal.

2.02 GENERAL

- A. Manufacture control panels in accordance with the general layouts, schedules, and details to suit the locations shown.
- B. The instrumentation systems' manufacturer to completely design the panel structures, internal and external devices, equipment arrangement, wiring, and piping.
- C. Provide control devices, control transformers, fuses, blown-fuse indicators, timing relays, control relays, selector switches, indicating lights, nameplates, terminal blocks, conductor markers, and miscellaneous materials as specified.
- D. Flush mount all instruments, control devices, and similar equipment shown or required to be located on the face of the panels with no mounting screws or bolts protruding through the panel face beyond the covering area of the escutcheon.
- E. Cleanly make cutouts for instruments in the manufacturer's shop. If a cutout is required for the fixed-mounted instruments, neatly work the cutout and trim in a flat black finish molded plastic material similar to the normal instrument escutcheons.

2.03 ENCLOSURES

- A. General:
 - 1. Comply with the requirements of ANSI/NEMA ICS-6.
 - 2. Panel doors:
 - a. Conceal hinges or piano hinges as applicable.
 - b. Open at least 110 degrees.
 - c. Provide each main door with a 3-point latching mechanism having roller latching at top and bottom and a vault-type-operating handle.
 - d. Provide steel doors with turned edges and brace for rigidity.
 - 3. Provide a 1/8-inch thick neoprene gasket on the panel frame to give the door a firm closure against the panel.
 - 4. Provide mounting pans on the rear inner wall of the panel and also on the inner sides if any devices are to be located there.
- B. Panel Classification: Unless otherwise indicated:
 - 1. Indoor enclosures: NEMA 12.
 - 2. Outdoor enclosures or in corrosive areas: NEMA 4X, nonmetallic.
 - 3. Outdoor enclosures in non-corrosive and non-classified areas: NEMA 3R.
- C. Size:
 - 1. Minimum enclosure area: Unless otherwise indicated, height by width, twice the sum of the area of the individual components mounted on the back panel.
 - 2. Enclosure depth: Depends on the type of components used, but not less than 6 inches.
- D. Finish and Color: In accordance with Section 26 05 00.

- E. Mounting:
1. Unless otherwise indicated, provide the enclosures with provisions for wall mounting.

2.04 PANEL WIRING

- A. Internal Wiring:
1. Single conductor 90 degree C "XHHW-2" wire with wire size in accordance with NFPA 70.
 2. Wireways:
 - a. Interconnect major groups of devices mounted within the panel with wireways.
 - b. The wireways may be EMT, flexible metal conduit for runs less than 3 feet or 2-1/2 by 2-1/2-inch or 4-inch by 4-inch steel wireways.
 - c. Provide PVC slotted-side panel wiring duct adjacent to relays.
 - d. PVC slotted side panel wiring duct may also be used for control wire.
 - e. Arrange the duct in horizontal configurations to pass near all relays and devices being fed from the duct.
 - f. Header ducts: In general, steel wireways as specified above.
 3. Provide panel wiring with stranded cross-linked polyethylene fire-resistant insulation and fit with pressure-type connectors at all terminations.
 4. Provide milliamperes and millivolt control and instrument signal wiring with stranded, pair-shielded polyvinylchloride insulated conductors as specified in Section 26 05 19.
 5. Run control and instrument signal wiring separately from the alternating current circuits, unless otherwise indicated on the drawings.
 6. Neatly tie all wiring in position with nylon cable ties.
 7. Feed instruments with portable cord connections through the instrument panel plug strip located near the top of the panel directly above the instruments. Use only the specified type of miniature locking plugs and receptacles for this purpose. These instrument supply cords are the only panel wiring which may hang free.
 8. Color code internal wiring as follows:

TYPE	COLOR
Power (120V AC)	Black
Neutral	White
Control	Red
Foreign voltage	Yellow
DC	Blue
Ground	Green

- B. Wire Markers:
1. Provide in accordance with Section 26 05 00.
- C. Wiring Methods:
1. Comply with UL 508.
 2. Provide plastic wireway with covers to route groups of wires.
 3. Provide plastic spiral wrap for exposed wires.
 4. Enclose wires that cross door hinge in plastic spiral wrap.

2.05 INSTRUMENT TUBING

- A. Bundle all instrument tubing neatly with plastic cable ties or in tubing clips at intervals not exceeding 18 inches.
- B. Neatly lay tubing taken out of bundles along the panel to the point where it bends out to feed the instrument connection.
- C. Lay out tubing in parallel, rather than twisted, runs prior to bundling.

- D. Color coded tubing is required.

2.06 CONTROL DEVICES

- A. Provide in accordance with Section 26 09 16.

2.07 INDICATING LIGHTS (LIGHT EMITTING DIODES)

- A. Indicating lights per Section 26 09 16.
- B. Indicating lights shall be Push to Test type.
- C. Color and associated function:

COLOR	FUNCTION	EXAMPLE
Red	Run, open valve	Equipment operating, motor running
Green	Ready, closed valve	Equipment ready, end of cycle
White or clear	Normal condition	Control power on, status
Amber (yellow)	Automatic	Equipment control in automatic position

- D. Additional colors for other operation indications shall be as noted on the Drawings.

2.08 ALARM AND MALFUNCTION DETECTION

- A. Provide devices which are used to directly detect or signal alarm or malfunction conditions with an external manual reset.
- B. Provide all devices or relays that are required to provide an external indication of malfunction, or status to a remote system, with an isolated dry NEMA Form C contact in addition to any contacts required for use by the internal control system.
- C. If the device contact is required for internal equipment control as well as to signal alarm or malfunction conditions, then the manufacturer may make the reset function a part of the manufacturer's equipment master shutdown system. However, show each source of shutdown by local trouble lights which are manually reset at the equipment control panel.
- D. Alarm or malfunction output contacts to open and remain open until manually reset when equipment is shut down due to malfunction.
- E. Trouble contacts not to indicate abnormal conditions when the equipment has been manually shut down.
- F. Initiate alarm and malfunction signals by a contact opening.

2.09 DEVICES WITH MOTOR STARTERS AND CONTACTORS

- A. Equipment provided with control devices having motor starters or contactors, shall comply with the following additional requirements:
 - 1. Disconnect switches:
 - a. Provide equipment with a disconnect switch and switch padlock hasp in accordance with WAC 296-24.
 - b. Disconnect: Horsepower rated disconnect switch or molded case circuit breaker, except that a manual motor starter may be used for drives less than 2 kVA.
 - c. Provide horsepower rated disconnect switches for equipment 2 kVA or greater with UL Class RK1 fuses.

- d. Circuit breaker interrupting ratings-minimum: Unless otherwise indicated or as a result of electrical power study provided for as part of this contract, - 22,000 symmetrical amperes for service at 240V or below and 32,000 symmetrical amperes for service above 240V.
 - e. When the disconnecting device is not a circuit breaker or fused disconnect, provide adequate overcurrent and short circuit protection for the circuit feeding the disconnecting device.
- 2. Overload protection: Provide protection for full motor running overload in ungrounded conductors for motors.
- 3. Overload relay contacts:
 - a. Do not connect overload relay contacts in the line having provision for grounding.
 - b. Provide grounding connections in the unfused side of control circuits and connect.
- 4. Power:
 - a. Supply power at one voltage as shown or specified.
 - b. Derive additional voltage requirements, such as 120V control power, from transformers provided internal to the control device as required.
 - c. Rate each control power transformer at least 150 percent of the calculated maximum load it serves.

2.10 ANALOG INSTRUMENTATION

- A. Equipment required to provide analog signals to the process control system specified in Divisions 33 and 40 to provide such signals as an isolated (ungrounded), 4-20 mA DC signal, linearly proportioned to the value of the measured variable.
- B. Equipment required to accept analog command signals from the process control system specified in Divisions 33 and 40 to accept externally powered 4-20 mA DC signals. The equipment's input terminals for command signals to be ungrounded and present not more than 250 ohms of resistance to the command signal.

2.11 TERMINAL BLOCKS

- A. Rated 20 amperes.
- B. Channel-mounted tubular screw type with pressure plate.
- C. Mount assembly on channel standoffs.

2.12 SPACE HEATER AND THERMOSTAT

- A. Provide a space heater and thermostat near the bottom of each panel section and for each 3 feet of length on large panels.
- B. Space Heater:
 - 1. Rated 240 volts, 200 watts, but operated at 120 volts (50 watts).
 - 2. Mount on porcelain standoff insulators at least 1/2 inch from the supporting surface.
 - 3. Connect the heater to a control transformer furnished with the panel.
 - 4. Provide an expanded metal guard to completely cover the heater and to allow free air movement.
 - 5. Acceptable manufacturer:
 - a. Chromalox Type PT-AC-1.
 - b. Electromode.
 - c. Approved Equal.
- C. Thermostat:
 - 1. Mount at mid panel height.
 - 2. Standoff and Type 62 mounting bracket.
 - 3. Acceptable manufacturers:
 - a. Fenwall Cat. No. 30,000-0.

- b. Honeywell.
- c. Approved Equal.

2.13 LABELING AND NAMEPLATES

- A. Labeling:
 - 1. Label local control panel components to match the description on the elementary diagram. Label internal components of the local control panel on the back side of the door with the same description used on the front side.
 - 2. Permanently mark label on or near each component. Machine embossed, adhesive backed nameplates shall identify the tag number of equipment inside cabinets.
- B. Nameplates:
 - 1. Identify external door-mounted components and the local control panel description with plastic nameplates in accordance with Section 26 05 00.

2.14 GROUNDING

- A. Ground all neutrals to the mounting plate using a copper bus or grounding lug. Use a grounding lug for a size No. 2 AWG bare copper conductor to ground the panel to the plant's grounding system.

PART 3 EXECUTION

3.01 GENERAL

- A. Alternating Current Control Circuits:
 - 1. 120 volts or less and grounded.
 - 2. Connect one terminal of each load device to the grounded conductor.
 - 3. Place control contacts, including overload device contacts, in the ungrounded side of the circuit.
- B. Use thermal overload relays in ungrounded conductors supplying a motor.
- C. Ground the panel to the plant grounding system shown on the Drawings.
- D. Provide conduit, wiring or mounting of devices not shown on the electrical or instrumentation Drawings, but required for a complete and operable system.

3.02 ASSEMBLY

- A. Conform to the requirements of UL 508.
- B. Test the functional operation of the local control panel prior to shipment.

3.03 INSTALLATION

- A. Install all wiring and tubing crossing hinges in a manner that will prevent chafing.
- B. Securely clamp bundles of similar conductors to the door and to the panel, and run the bundles parallel to the hinge for at least 12 inches.
- C. Use spiral nylon cable wrap in the hinge section of the bundle to fully protect the conductors or tubing against chafing.

3.04 GROUNDING

- A. Bond hinged or sliding pans, racks, and drawers to a ground bus by means of tinned-copper woven flat braid having a rating of at least 50 amperes.
- B. Copper Ground Bus: 1/4 inch by 1 inch minimum of suitable length for all conductor terminations and connected to the motor control center or station ground bus with No. 2 AWG copper, green insulated cable for all freestanding panels.
- C. The ground connection to the central ground bus may be run with other cables in an appropriate conduit in the case of small wall-mounted panels.
- D. Ground Connection: Not less than No. 10 AWG or as shown.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies wiring devices consisting of receptacles, plugs, switches, and appurtenances.

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 (1,000 volts maximum)
NEMA 5	
NEMA WD-1	General Purpose Wiring Devices
NFPA 70	National Electric Code (NEC)

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts for all materials.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. UL-list wiring devices for the current, voltage, and frequency specified and complying with NEMA WD-1.
- B. Use devices containing provisions for back wiring and side wiring with captively held metallic binding screws.
- C. Devices are to be brown, except those located in finished areas are to be ivory.
- D. All to be supplied by a single manufacturer.
- E. Enclosures shall meet or exceed requirements of NEMA 250.

2.02 RECEPTACLES AND PLUGS

- A. General: Grounding type.
1. Receptacles to be grounding type.
 2. Provide outdoor receptacles with weatherproof lift covers, while in use.
- B. 120 V Receptacles:
1. Indoor, clean areas:
 - a. Duplex 20 amp NEMA 5-20R that accept NEMA 5-15P or 5-20P plug caps.
 - b. Acceptable manufacturer:
 - 1) Hubbell 5362.
 - 2) Arrow Hart.
 - 3) Approved Equal.
 2. GFCI protected receptacles:

- a. Indoor and outdoor areas:
- b. Duplex 20 amp NEMA 5-20R that accept NEMA 5-15P or 5-20P plug caps.
- c. Tamper and weather resistant.
- d. Acceptable manufacturer:
 - 1) Hubbell GFR5362 series.
 - 2) Arrow Hart TWRVGF20 series.
 - 3) Approved Equal.
3. Where the manufacturer of cord connected equipment requires an isolated ground, provide a receptacle with isolated ground.
4. Isolated ground receptacles:
 - a. Acceptable manufacturers:
 - 1) Hubbell IG-5362.
 - 2) Arrow Hart 6766.
 - 3) Approved Equal.
- C. Male plug caps for 120 V and 250 V receptacles:
 1. Cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle.
 2. Rate plug caps at 15 amps.
 3. Provide one plug cap for every 4 receptacles, with a minimum of 2 plug caps.

2.03 SWITCHES

- A. General Purpose (Indoor, Clean Areas):
 1. General purpose switches: Quiet AC type, specification grade, with rated capacities as required.
 2. Match receptacles in color.
 3. Acceptable manufacturers:
 - a. Arrow Hart.
 - b. Hubbell.
 - c. Approved Equal, as follows:

	15A, 120-277 V		20A, 120-277 V	
	Arrow Hart	Hubbell	Arrow Hart	Hubbell
Single:	1891	1201	1991	1221
Three-way	1893	1203	1993	1223
Four-way	1894	1204	1994	1224
SPST momentary	1895		1995	

- B. Switches for outdoor areas:
 1. Maintained contact switches:
 - a. Press switch type with a weatherproof hypalon or neoprene cover.
 - b. Acceptable manufacturers:
 - 1) Arrow Hart.
 - 2) Hubbell.
 - 3) Approved Equal.
 2. Momentary contact switches: sealed contact pushbutton switches, rated NEMA 4X, mounted on a NEMA 4X control station.

2.04 DEVICE PLATES

- A. Provide with switches.
- B. Non-Corrosive Indoor areas:
 1. Type 302 stainless steel device plates on sheet metal boxes. Sheet steel, zinc electroplated with chrome finish in all other indoor areas.
 2. Acceptable Manufacturer:
 - a. Crouse-Hinds.
 - b. Appleton.

- c. Approved Equal.
- C. Corrosive or Outdoor areas: Impact resistant, marine grade fiberglass.
- D. Factory provided explosion-proof equipment.
- E. Provide device plates for instrumentation power supply disconnect switches with general purpose switches and a lockoff feature with provision for a single padlock.
- F. Nameplates:
 - 1. Provide with engraved laminated phenolic nameplates with 1/8-inch white characters on black background as specified in Section 26 05 00.
 - 2. Switches: Identify panel and circuit number and area served.
 - 3. Receptacles: Identify circuit and also voltage if other than 120 V, single phase.
 - 4. Indoor nameplates may be secured by epoxy glue.
 - 5. Secure outdoor or corrosive area nameplates with Type 316 stainless steel screws.

PART 3 EXECUTION

3.01 GENERAL

- A. Boxes:
 - 1. Independently support boxes by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate.
 - 2. Do not use wooden or plastic plugs inserted in masonry or concrete as a base to secure boxes. Do not use welding or brazing for attachment.
- B. Unless otherwise indicated, flush mount receptacles and switches installed in sheet steel boxes. Locate flush-mounted receptacles 18 inches above the finished floor.
- C. Mount switch boxes 48 inches above the floor. Locate receptacles installed in cast device boxes 48 inches above the finished floor.
- D. Wire all 480 V receptacles to suit the plant's standard phase rotation.
- E. Test wiring devices for correct connections.
- F. Perform all work in accordance with NFPA 70 and these specifications.

END OF SECTION

SECTION 28 46 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section establishes minimum standards and guidelines for providing a complete and operable and tested fire alarm system including final design, permitting, supervision, and installation by a qualified firm specializing in fire alarm design and installation.
- B. Work includes the design and installation of cable and raceway systems to support the fire alarm system which will monitor all heat detectors, smoke detectors, alarms, and pull stations.
- C. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Fire Alarm Panel	705-FAP705100

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
NFPA 72	National Fire Alarm and Signaling Code
NFPA 820	Standard for Fire Protection in Wastewater Treatment and Collection Facilities
FM	Factory Mutual Research Corporation Standards
NEC Article 760	Fire Alarm Systems
UL 268	Smoke Detectors for Fire Protective Signaling Systems
UL 268A	Smoke Detectors for Duct Applications
UL 521	Heat Detection for Fire Protective Signaling Systems
28 CFR Part 36, Appendix A	ADA Accessibility Guidelines for Buildings and Facilities
UL 38	Manual Signaling Boxes for Fire Alarm Systems
UL 497B	Protectors for Data Communications and Fire Alarm Circuits
<i>SFC</i>	<i>2018 Seattle Fire Code</i>

1.03 GENERAL REQUIREMENTS

- A. Provide fire alarm systems under the supervision of a single specialty contractor (fire alarm system contractor), which is regularly engaged in the design and installation of such systems of similar scope and complexity. Be responsible for performance of all systems as specified and as approved by the governing authority.
- B. All conduits and wiring among fire alarm sensors, boxes, and panels shall be supplied, installed, and tested by the fire alarm system contractor.

1.04 DESIGN REQUIREMENTS

- A. Provide a fire alarm system complete and operable in accordance with the following:
 - 1. Governing authority fire department standards.
 - 2. NFPA 70.
 - 3. NFPA 72.
 - 4. NFPA 820.
 - 5. Applicable provisions of 28 CFR Part 36, Appendix A.
- B. The design shall be prepared, stamped, dated, and signed by a Professional Engineer licensed in the state of Washington.
- C. The fire alarm system shall include:
 - 1. Smoke detectors.
 - 2. Heat detectors.
 - 3. Notification appliances.
 - 4. Manual fire alarm pull boxes.
 - 5. Fire alarm panel.
 - 6. Wire and cable.
 - 7. Appurtenances as required by the governing authority Fire Marshal, or local fire code.
- D. Provide independent self-contained fire alarm panels in each area as specified on the Drawings.
- E. Fire alarm panels shall monitor sensors, actuate alarm and signal devices, and retransmit alarm, supervisory, and trouble signals to the monitoring system.
- F. Contacts for transmission of data to the monitoring system shall be normally closed and open on alarm or malfunction. Contacts shall be rated not less than 2.0 amperes at 120 VAC.
- G. Fire alarm system shall retransmit alarm signals to the fire department in accordance with governing authority requirements. As a minimum, include sending individual zone address information of all alarm, trouble, and supervisory data through a UL Listed Fire Alarm Monitoring Service Provider (FAMSP).
- H. Fire alarm system shall be an addressable micro-processor based system with smart sensors.
- I. The fire alarm system shall provide automatic fire detection, retransmit alarm, supervisory and trouble signals by zone to an UL Listed FAMSP, retransmit alarm, supervisory and trouble signals to the PLC panel and Metrotel, monitor critical HVAC systems, and other functions normally attributed to fire alarm systems.
- J. Fire alarm system including automatic fire detection shall be provided as a complete and operable turn-key system in all areas protected by the zones assigned in this Section.
- K. Fire alarm Panel:
 - 1. 705-FAP705100
- L. Basic Performance:
 - 1. Signal Line circuits (SLC) shall be Class A (NFPA Style 6).
 - 2. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
 - 3. Each SLC shall be limited to only 80 percent of its total capacity at the time of initial installation.

1.05 SUBMITTALS

- A. Procedure: 01 33 00

- B. Provide the following submittals:
1. Shop drawings and equipment data per Section 26 05 00 requirements.
 - a. Product technical data:
 - 1) Battery calculations.
 - 2) Voltage drop calculations.
 - 3) Complete descriptive data indicating UL listing or FM approval for all system components.
 - 4) Sequence of operations of the system.
 - 5) Name of local service organization.
 - 6) Copy of point-to-point electrical schematic and wiring drawings submitted to governing authority and the approved drawings stamped by the governing authority.
 - b. Fabrication and/or layout drawings:
 - 1) Provide drawings in AutoCAD 2014, full size at 22 inches x 34 inches.
 - 2) Plan drawings showing type and locations of all fire alarm devices. Indicate salient features of each device (e.g., weatherproof, strobe candela rating).
 - 3) Complete system wiring diagrams for components capable of being connected to the system and interfaces to associated equipment.
 2. Qualifications of the fire protection engineer and fire protection installer.
 3. Catalog cuts showing general features of all products.
 4. Schematic diagrams showing the wiring of all modified systems.
 5. Plan drawings showing the locations of detectors and other related devices in each area.
 6. Acceptance test records and test certificates signed and approved by the governing authority.
 7. Operating and maintenance information per Section 01 78 23.
 8. System access keys.
 9. Project "as-built" record documents.
 10. 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.

1.06 QUALITY ASSURANCE

- A. Fire protection system designer:
1. Licensed Professional Fire Protection System Engineer in Washington State.
 2. Minimum of five years of experience with design of systems of similar scope.
- B. Fire protection system installer:
1. Licensed Fire Protection System installer in Washington State.
 2. Minimum of five years of experience installing systems of similar scope.
- C. UL Listing or FM approval.
- D. Governing Authority: City of Seattle Fire Marshall.

1.07 CONTRACTOR RESPONSIBILITY

- A. The Drawings annotate the areas required by this Contract to have a fire alarm system. This Section specifies the requirements for the fire alarm system.
- B. Using the Specification requirements and the general arrangement Drawing for the fire alarm system, be responsible for obtaining governing authority permits, approval, inspection, and certification of the entire fire alarm system and for meeting the requirements of this Section.
- C. Install the Fire Alarm System.

1.08 COUNTY RESPONSIBILITY

- A. Identify the Fire Alarm Monitoring Service Provider (FAMSP) for the Contractor.

- B. Provide the communications line between the monitored facility and the FAMSP. The Building 705 FACP will not be connected to the WPTP campus buildings. Only local alarming is required for Grit Building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire alarm panel:
 - 1. Notifier.
 - 2. Siemens Cerberus.
 - 3. Simplex.
 - 4. Approved Equal.

2.02 FIRE ALARM PANEL

- A. The fire alarm equipment shall comply with the requirements of NFPA 72.
- B. Sixteen-zone panel.
- C. Integral battery charger and sealed lead-calcium battery with sufficient capacity for 24 hours operation followed by five minutes sounding of audible alarms.
- D. Alarm Signal to UL Listed FAMSP or King County Security Division, as specified:
 - 1. For consistency throughout the system, King County's FAMSP is *Guardian Security*.
- E. Zone Assignments: annunciation required at minimum for the following zones:
 - 1. Building Area or Room:
 - a. Grit Classifier Room.
- F. Area Classifications:
 - 1. See Electrical Plans and Section 26 05 00 for area classification designations.
 - 2. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
 - a. Outdoor areas: Wet, Also, corrosive and/or classified when specifically designated on the Drawings or in the specifications.
 - b. Indoor areas: Dry. Also, wet corrosive and/or classified when specifically designated on the Drawings or in the specifications.
- G. System Description:
 - 1. Automatic and manual, analog addressable, general alarm and non-coded evacuation alarm, supervised, closed-circuit, 24 VDC microprocessor based fire detection and alarm system.
 - 2. Provide components including but not limited to the following:
 - a. Fire Alarm Panel.
 - b. Analog addressable heat sensors.
 - c. Analog addressable smoke detectors.
 - d. Addressable manual pull station.
 - e. Combination fire alarm horns with strobe.

2.03 AUTOMATIC FIRE DETECTORS

- A. Photoelectric Smoke Detectors per NFPA 72 with the following features:
 - 1. Sensitivity: Better than 3% per foot.
 - 2. Alarm indicator lamp.
 - 3. Capable of having sensitivity tested and adjusted as installed.

4. Nominal 24 VDC operation. Range: 17-26 VDC, standby current <1 mA, alarm current > 30 mA.
5. Terminal base connection.
6. Anti-tampering features.
7. Solid-state amplifier-switching circuitry.
8. UL 268 listed for 30-foot spacing.
9. FM approval.
10. Plug-in base with 2-wire terminal connection, compatible with other specified space detectors.
11. Notifier 2400 Series, Simplex 4098 Series, or equal.

2.04 MANUAL PULL STATIONS

- A. Addressable manual stations per NFPA 72 with the following features:
 1. Meets UL 38 Standard.
 2. Meets ADA Pull force requirements.
 3. Surface Mount indoor manual station.
 4. Single-action type not requiring part replacement to accomplish reset.
 5. Pull down lever locks in position, actuating alarm switch until manually reset.
 6. Switch contact: SPST N.O. rated 0.25A at 30V AC or DC.
- B. Notifier NBG-12S, Simplex 2099 Series, or equal.

2.05 NOTIFICATION APPLIANCES

- A. Interior Horn/Strobes:
 1. Solid state components.
 2. Audible signal: Field selected continuous or pulsed output. Field selected standard and high dbA sound output levels. Minimum output 75 dbA at 10 ft. (anechoic).
 3. Visible signal: Xenon flashtube, flashing at one flash per second with minimum 75 candela rating.
 4. Operating voltage: 21 to 30 VDC. Maximum current at nominal 24 VDC = 160 mA.
 5. Fully compliant with ADA 1990 requirements. Listed to UL 464 and UL 1971 and approved for fire protective service.
 6. Quantity and location of interior horn/strobes shall be as required by code and/or the Governing Authority.
 7. Notifier MASS12/24ADA, Simplex 4093 series, or equal.
- B. Exterior Horn/Strobes:
 1. Solid state components.
 2. Audible signal: Field selected continuous or pulsed output. Field selected standard and high dbA sound output levels. Minimum output 75 dbA at 10 ft. (anechoic).
 3. Visible signal: Xenon flashtube, flashing at one flash per second with minimum 75 candela rating.
 4. Operating voltage: 21 to 30 VDC. Maximum current at nominal 24 VDC = 160 mA.
 5. Fully compliant with ADA 1990 requirements. Listed to UL 464 and UL 1971 and approved for fire protective service.
 6. Quantity and location of interior horn/strobes shall be as required by code and/or the Governing Authority.
 7. Weather proof.
- C. Combination Audio/Visual Devices:
 1. Mount in an integral unit and have the same features as the individual units specified herein.

2.06 CABLE AND CONDUIT

- A. Conduit: See Section 26 05 33.
- B. Conductors:
 1. Insulation type per NEC 760.
 2. 120 VAC and power supply connections: 12 AWG, minimum.

3. Low-voltage general alarm circuits: 14 AWG, minimum.
 4. Low-voltage signaling circuits: 18 AWG, minimum.
 5. Annunciator and data communication circuits: As required by manufacturer, UL listed.
 6. Use larger wire sizes when recommended by equipment manufacturer and per voltage drop calculations.
 7. See Section 26 05 19
- C. Cable to interconnect the various components of the fire alarm system per NFPA 70.
- D. Locate the fire alarm panel in the electrical room. Route cables interconnecting the fire alarm panel with other components in a dedicated conduit.

PART 3 EXECUTION

3.01 GENERAL

- A. Install per NFPA 72, NEC Article 760, ADA 1990 requirements, and all applicable codes and manufacturer's recommendations.
- B. Install all wiring in raceways:
1. Provide raceways (conduits) per Section 26 05 33 for all interconnecting wiring between the Fire Alarm Panel and remote components.
- C. Make all fire alarm wiring continuous from terminal to terminal or from terminal to device pigtail lead.
1. Circuit splices not permitted.
 2. Color code all wiring by type of device.
 3. Coordinate color with County.
 4. Wiring joints, only when required at device pigtail leads shall utilize Scotchlok insulated conical spring connector.
- D. Provide sensors with electronics immune from false alarms caused by EMI and RFI.
- E. Installation of equipment and devices that pertain to other work in contract shall be closely coordinated with appropriate subcontractors.
1. Duct detector devices, conduit and wiring not included in the fire alarm system work to be brought to the Fire Alarm Panel.
 2. Connect conduit and wiring for the duct detectors, and alarms at the Fire Alarm Panel.
 3. Telephone dialer for Alarm Monitoring Agency.
- F. Mount fire alarm panel and devices located on architecturally finished surfaces flush or semi-flush.
- G. Surface mount alarm panel and devices located on wall surfaces.
- H. Supply manufacturer's authorized representative as on-site supervision.
- I. Clean all dirt and debris from inside and outside of equipment after completion of installation.
- J. Connect duct smoke detectors to the specified fire alarm panel for power supply, supervision, and alarm annunciation.
- K. Cover all smoke detectors with plastic bags immediately after installation to maintain cleanliness.
- L. Mark all duct sensor locations in red with "smoke/fire sensor location".
- M. Device Mounting Schedule:
1. Dimensions are to center of item unless otherwise indicated.

2. Mounting heights as indicated below unless otherwise indicated on Drawings:
 - a. Manual pull stations: 48 inches.
 - b. Notification appliances: 80 inches.
 - c. Control panels and remote annunciators: 72 inches to top.
 - d. Standalone duct detector annunciator: 54 inches.

3.02 TESTING

- A. Test the completed system per NFPA 72 in the presence of the Project Representative and the governing authority. Coordinate test scheduling with the governing authority. Provide a minimum of 1 week notice to Project Representative prior to testing.
- B. Upon successful testing, certify system in writing. Provide system certification and description in accordance with NFPA 72.

3.03 INSTRUCTION

- A. Provide an authorized representative to instruct and train Fire Department personnel and Owner's personnel in operation of system.

3.04 COMPLETION

- A. Prior to Final Acceptance:
 1. Turn all access keys over to the Project Representative.
 2. Turn in As-Built records.

END OF SECTION

SECTION 33 82 23
OPTICAL FIBER CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies optical fiber cables used for signal, and communications circuits.

1.02 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are 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
NFPA 70	National Electric Code (NEC)
UL 83	Thermoplastic-Insulated Wires and Cables

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Catalog cuts showing general information of the equipment furnished.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unscheduled optical fiber Cables:
1. The type, size and number of fibers shall be as specified on the drawings.
 2. Number and types of signal fibers and connectors shall be as required for the particular equipment provided.
- B. Optical fiber cables shall be marked and listed for the application required.
- C. Optical fiber cable Specification Sheets (FIBERSPEC): General requirements for fibers and cables specified.

2.02 COLOR CODING AND TAGGING

- A. Communication fibers: Communications fiber color coding shall be manufacturer's standard.
- B. Multi-fiber cable colors shall be manufacturer's standard.
- C. Tag at terminations and in pull boxes, handholes and manholes.

2.03 COMMUNICATION FIBERS AND CABLES

- A. Single Fiber cable:
1. For interconnections within panels and enclosures.

2. Terminated as required by utilization equipment.
3. Maximum length: 10 m (33 ft.)
4. Unless otherwise indicated, provide in accordance with FIBERSPEC "MM62.5".

B. Optical Multi-fiber Cable:

1. Used for communication between enclosures within a facility routed in cable tray.
2. Cables shall be UL labeled OFN, OFC, OFNR, or OFCR, as required, and shall be designed for cable tray installation in accordance with NEC 770.
3. The construction, type, number, and size of optical fibers shall be as specified.
4. Unless otherwise indicated, provide optical multifiber cable in accordance with CABLESPEC "MM62.5".

2.04 OPTICAL FIBER TRUNK CABLES

- A. Used for communication between buildings within a facility or between facilities.
- B. Unless otherwise indicated, optical fiber trunk cables shall be armored optical multifiber cables in accordance with CABLESPEC "MM62.5".

2.05 SPLICING AND TERMINATING MATERIALS

A. Connectors:

1. Type ST, SMA, or as specified.
2. Connectors shall be tool-affixed and listed for the specific application as recommended by the utilization equipment manufacturer.
3. Single fiber cables with factory installed connectors of suitable type are acceptable
4. Acceptable manufacturers: Amp, Amphenol, or approved equal.

B. Breakout Kits

1. Shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination.
2. Shall accommodate a range of cable sizes for both in-line and stub-type configurations.
3. Shall be independent of cable manufacturer's tolerances.
4. Acceptable manufacturers: Belden, Alpha, or approved equal

PART 3 EXECUTION

3.01 GENERAL

- A. Identify each optical fiber at each terminal to which it is connected. The marking system shall comply with Section 40 61 13.
- B. Cable Pulling:
 1. Complete the pulling of optical fiber cable into conduit or trays without damaging or putting undue stress on the cable insulation.
 2. Soapstone, talc or UL listed pulling compounds are acceptable lubricants for pulling optical fiber cable.
 3. Grease is not acceptable.
 4. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.
- C. Whenever a cable leaves a raceway, provide a cable support.

3.02 CABLE DRESSING

- A. Lacing and Bundling:

1. Lace and bundle individual optical fiber cables in panels and electrical equipment at intervals not greater than 6 inches, spread into trees and connected to their respective terminals.
2. Lacing shall be made up with plastic cable ties.
3. Lacing is not necessary in plastic panel wiring duct.
4. Bundle individual optical fiber cables crossing hinges into groups not exceeding eight fibers and arrange so that they will be protected from chafing when the hinged member is moved.

B. Slack:

1. Provide slack in junction and pull boxes, handholes and manholes.
2. Slack shall be sufficient to allow cables to be routed along the walls of the box.
3. Amount of slack shall be equal to largest dimension of the box.
4. Where plastic panel wiring duct is provided for wire runs, lacing is not required.
5. Do not use plastic panel wiring duct in manholes and handholes.

C. Individual Fibers:

1. Break out individual fibers from multi-fiber cables utilizing Breakout Kits as specified by cable manufacturer.
2. Terminate individual fibers with connectors as required by the utilization equipment
3. Install connectors using manufacturer's recommended tools.

D. Raceway fill limitations shall be as defined by NEC and the following:

1. Optical fiber cables may be run in the same raceway with electrical conductors provided derating requirements of the NEC are observed.

E. Unless otherwise indicated, bond armoring of multi-fiber cables to the chassis ground bus at the control panel or per NEC at other locations. Provide terminals for running grounding wires through junction boxes.

F. Terminal Boxes:

1. Provide at optical fiber cable splices.
2. If cable is buried or in raceway below grade at splice, provide an instrument stand as specified with terminal box mounted approximately 3 feet above grade.

G. Install and terminate cable in compliance with the manufacturer's recommendations.

3.03 TESTING

A. General: The Contractor shall test optical fibers and cable in accordance with Section 40 61 21.

B. Individual fibers:

1. Test each individual fiber for end-to-end attenuation at the wavelength specified. Verify that the utilization equipment attenuation budget is not exceeded.
2. Test armoring sheath for continuity and resistance to ground at each end. Resistance to ground grid shall not exceed one Ohm.

3.04 SCHEDULES

A. Optical fiber cables are shown on the drawings.

3.05 OPTICAL FIBER SPECIFICATION SHEETS (FIBERSPEC)

A. General:

1. Optical fiber cable types for different locations, service conditions and raceway systems are specified on individual specification sheets (FIBERSPECS).
2. Install scheduled and unscheduled optical fiber cables in accordance with the FIBERSPECS.

B. FIBERSPEC SHEETS: FIBERSPEC sheets follow.

3.06 OPTICAL FIBER SPECIFICATION SHEET-FIBERSPEC

Cable System Identification:	MM62.5
Description:	Multi-mode optical fiber cable, single or multiple fiber construction.
Optical Fiber Material:	Glass, graded index, 62.5 micron core with 125 micron cladding. Attenuation: 3.5 dB/km max. at 850 nm 1.5 dB/km max. at 1300 nm Bandwidth: 100 MHz-km min. Numerical aperture: 0.275
Buffer tubing:	Each fiber is enclosed in a hydrophobic gel-filled tube
Assembly:	Individual fibers cabled together with nonhygroscopic fillers and KevlarR yarn binding member.
Jacket:	Inner Jacket: 50 mil minimum, polyvinylchloride (PVC) in accordance with UL 1669. Outer Jacket: 50 mil minimum, polyethylene for water resistance
Flame Resistance:	IEEE 383
Manufacturer(s):	Belden 225712, Corning, or approved equal.
Uses Permitted:	Cable tray, direct burial, encased in concrete in normal or Class 1, Division 2 atmospheres.
Execution:	
Installation:	Install in accordance with 17804.
Testing:	Test in accordance with Section 40 61 13 and Section 40 61 21.

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 23 and 40. Use this Section in conjunction with those sections.

1.02 DEFINITIONS

- A. Pressure terms used in Section 40 05 01 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)

1.03 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
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 B16.4	Cast Iron Threaded Fittings, Class 125 and 250
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 B16.12	Cast Iron Threaded Drainage Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME Section IX	Boiler and Pressure Vessel Code
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

REFERENCE	TITLE
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 A774	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Stainless Steel Tubular Products
ASTM B88	Seamless Copper Water Tube
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C296	Asbestos-Cement Pressure Pipe
ASTM C443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
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
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 D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
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

REFERENCE	TITLE
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C301	Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303	Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
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
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
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

1.04 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, 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, supports, fittings, connections, penetrations, supports, valves, piping appurtenances, flexible couplings, thermal expansion, cathodic protection equipment, manholes, and clean-outs as applicable. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.
 4. Restrained joint anchorage calculations for buried pipe required by Section 40 05 01.
 5. Piping identification:
 - a. Pipe Markers
 - b. Warning Tape
 - c. Locate Wire and splice kits
 - d. Samples of all text and color coding.
 6. Locate wire electrical continuity test results.

1.05 BASIS OF BURIED PIPE DESIGN

- A. The specified minimum pressure and stiffness ratings and wall thicknesses of pipe materials indicated in the Contract Documents have been established based on design parameters and assumptions described in the Contract Documents. Design parameters include but are not limited to trench geometry and construction; native soil modulus and composite soil modulus of the trench; the materials used for pipe foundation, bedding, and backfill; and anticipated external and internal loads.

- B. If Contractor means and methods result in the Contractor to propose a variance from the design parameters in the Contract Documents provide:
1. Calculations verifying that the specified minimum pressure and stiffness ratings and wall thicknesses of pipe materials indicated in the Contract documents are adequate for the conditions resulting from the proposed variances in the design parameters. The submittal shall be stamped, signed and dated by a Professional Engineer registered in the state of Washington.
 2. Verification from the pipe manufacturer of the following:
 - a. Pipe manufacturer has reviewed the proposed design parameter variances.
 - b. Variance is acceptable for the specified minimum pressure and stiffness rating and wall thickness of their pipe material indicated in the Contract Documents.
 - c. Proposed design parameter variance is consistent with the pipe manufacturer's installation recommendations.

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 23 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. Plastic, steel, RCP, ductile iron, and polyethylene pipe may all be used at the Contractor's discretion in both buried and exposed service. 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.

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. 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.
- C. Pipe Support, Anchorage and Bracing:
 1. Support piping by anchor brackets, guides, saddles or hangers.
 2. Seismic anchorage and bracing: See Section 01 73 00 for seismic criteria.
 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.
- D. 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 must be maintained at all valves and other equipment.
- E. 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. 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 Standard Code for pressure piping including welding procedures, qualification of welders and testing. Follow applicable local safety codes.
 5. Provide gasket coated with recommended lubricant between contact faces of flanges.
- E. 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. Tighten fastener system to indicated torque.
- F. Pipe Hangers and Supports:
1. Provide piping systems with anchorages, sway braces, guides and supports as required by applicable portions of ASME B31.
 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.
8. Where testing existing chlorine and sulfur dioxide systems to the nearest isolation valve: first notify the Project Representative; the Contractor shall provide a tee in the new line adjacent to the valve. The branch outlet on the tee shall be valved and used for cleaning, pressure testing, draining, and drying the line. Unless otherwise indicated, the existing chlorine or sulfur dioxide system shall not be shut down during testing or connecting the tee and valve. Prior to placing the line in service, the valve on the branch outlet shall be plugged or sealed with a blind flange or threaded plug. Contractor shall be responsible for all damage to the existing system as a result of this work.
9. Testing of the ribbon anode and electrical isolation effectiveness should include the following. After installation of electrical isolation equipment, effectiveness shall be judged in accordance with NACE RP-0286. The magnesium ribbon anode installation shall be judged in accordance with NACE RP-0169. No practical testing of the zinc ribbon anode is possible because the anode is isolated from the environment until the polyethylene wrap is compromised.

B. Gas and Air Systems:

1. The allowable leakage rate for instrument air and odor control systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure.

C. Liquid Systems:

1. The allowable leakage rate for liquid systems shall be zero at the specified test pressure throughout the specified duration.

D. 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. Determine and select test equipment, temporary valves, bulkheads, and other water control equipment.
- E. Prior to hydrostatic testing, pipelines shall be flushed.
- F. Test pipelines in sections not to exceed one mile in length.
- G. Test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water.
- H. 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.
- I. 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.
- J. Remove or protect pipeline-mounted devices that may be damaged by the test pressure.
- K. Provide sufficient means to allow trapped air to exit. Air relief valves shall be open during pipeline filling.
- L. 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.
- M. Air within the pipeline shall be allowed to escape completely.
- N. Differential pressure across the orifices in the air release valves shall not be allowed to exceed five psi at any time during filling.
- O. 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.
- P. During this period, bulkheads, valves, and connections shall be examined for leaks.
- Q. If leaks are found, corrective measures satisfactory to the Project Representative shall be taken.
- R. Hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of four hours.
- S. Test pressure for piping shall be as specified in the PIPESPEC for the type and size of piping being tested.
- T. Test pressure shall be achieved for all elevations along the pipeline.
- U. No pressure test will be required for a reservoir overflow line.
- V. 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.

- W. Add water to restore the test pressure if the pressure decreases five psi below test pressure during the test period.
- X. 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. After connection to the equipment or structure, it shall then be blown out using the equipment.
3. Upon completion of cleaning, the piping shall be drained and dried with an air stream.
4. .

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. 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 paragraphs 3.08 and 3.09 (Table A and B). 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.

3.08 TABLE A: PROCESS AND FACILITY PIPING SYSTEMS

SYMBOL	SERVICE	SYSTEM	FLUID CATEGORY	PIPE MARKER
DR	Drain	5	Drain	Green
GT	Grit	4	Grit Slurry	Green
HRS	Heat Reservoir Supply	3	Water	Red
HRR	Heat Reservoir Return	3	Water	Red
IA	Instrument Air	1	Air	Orange
PDR	Process Drain	5	Drain	Green
OF	Overflow	5	Wastewater	Green

3.09 TABLE B: UTILITY WATER SYSTEMS

SYMBOL	SERVICE	SYSTEM	FLUID CATEGORY	PIPE MARKER
C3	No. 3 Water, Plant Effluent	2	Water	Green

3.10 PIPING SYSTEM 1

Piping Symbol / Service:	IA – Instrument Air
Test Requirements:	
Test Medium:	Water. Ref. Section 40 05 01
Test Pressure:	125 PSI
Duration:	120 minutes
Leakage:	Zero. Ref. Section 40 05 01
Gasket Requirements:	
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>(3/4" through 2")</u>	
Pipe:	Stainless Steel, Type 316L, ASTM A312, SCH 40S. Refer Section 40 05 23. Connections: weld type or flanged for valves. Fittings: Stainless Steel, Type 316L, Threaded, Welded Slip-On Flange ASME B16.3, or Socket Welded Fittings SCH 40S.
Valves:	Stainless Steel, Type 316 Ball, Flanged: Contromatics Series 2801 or Jamesbury Series 7150, or approved equal. Check: Ladish 5275 or Crane Fig 377, or approved equal.
<u>Buried and Encased Pipe and Valves:</u>	None
Remarks: <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. 	

3.11 PIPING SYSTEM 2

Piping Symbol / Service:	C3 – No. 3 Water, Plant Effluent
<u>Test Requirements:</u>	
Medium:	Water. 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:	<p>Stainless Steel, Type 316L, ASTM A312, SCH 40S. Refer Section 40 05 23.</p> <p>Connections: weld type or flanged for valves.</p> <p>Fittings: Stainless Steel, Type 316L, Threaded, Welded Slip-On Flange ASME B16.3, or Socket Welded Fittings SCH 40S.</p>
Valves:	<p>Stainless Steel, Type 316</p> <p>Ball, Flanged: Contromatics Series 2801 or Jamesbury Series 7150, or approved equal.</p> <p>Check: Ladish 5275 or Crane Fig 377, or approved equal.</p>
<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. Piping shall be insulated and heat traced, as shown on the drawings. 	

3.12 PIPING SYSTEM 3

Piping Symbol/Service:	HRR – Heat Reservoir Return HRS – Heat Reservoir Supply
<u>Test Requirements:</u>	
Medium:	Water. Ref. Section 40 05 01
Pressure:	150 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 drawing for pipe size and valve type)
<u>(2 1/2" or smaller)</u>	
Pipe:	Stainless Steel, Type 316L, ASTM A312, SCH 40S. Refer Section 40 05 23. Connections: weld type or flanged for valves. Fittings: Stainless Steel, Type 316L, Threaded, Welded Slip-On Flange ASME B16.3, or Socket Welded Fittings SCH 40S.
Valves:	Stainless Steel, Type 316 Ball, Flanged: Contromatics Series 2801 or Jamesbury Series 7150, or approved equal. Check: Ladish 5275 or Crane Fig 377, or approved equal.
<u>Buried and Encased Pipe and Valves:</u>	None
Remarks: <ol style="list-style-type: none"> 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. Refer to drawings for locations of expansion loops or joints. Refer to specification Section 40 05 44 for expansion joints. 3. Piping shall be insulated for heat loss control in accordance with Section 40 42 00. 	

3.13

3.14 PIPING SYSTEM 4

Piping Symbol/Service	GT - Grit
<u>Test Requirements:</u>	
Medium:	Water. Ref. Section 40 05 01.
Pressure:	50 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 drawing for pipe size and valve type)
<u>(2 1/2" and larger)</u>	
Pipe:	HDPE: 200 psi DR 11 HDPE piping. Ref. Sections 40 05 33 and 09 90 00. Connections: Butt Fusion and Flanged. Flanged for valves, pipe supports, and appurtances. Fittings: SST flanges, per Section 40 05 33; coating, ends and lining to match pipe.
Valves:	Eccentric Plug: Synthetic Rubber Faced; Dezurik Pec, Cast Iron or Milliken 601. Swing Type Check: Crane #383 or Powell Fig 559. BALL: Pratt or Apco-Willamette.
<u>Buried and Encased Pipe and Valves:</u>	None
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. Provide mechanical couplings at fittings and at 10-foot centers along straight pipe runs.	

3.15

3.15 PIPING SYSTEM 5

Piping Symbol/Service:	DR – Drain PDR -Process Drain OF- Overflow
<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 drawing for pipe size and valve type)
<u>(4" and smaller)</u>	
Pipe:	Polyvinyl Chloride (PVC), ASTM D1785, SCH 80, IPS Ref. Section 40 05 31. Connections: socket or taper threaded, ASME B1.20.1. Fittings: PVC, ASTM D2467, Sch. 80, socket. Or ASTM D2464 Sch 80, threaded.
Valves:	None
<u>(6" and larger)</u>	
Pipe:	Polyvinyl Chloride (PVC), Pressure Pipe, AWWA C900. Ref. Section 40 05 31. Connections: Flanged Fittings: ductile iron, AWWA C110,
Valves:	Gate: AWWA C500, O-Ring Seals, Mechanical Joint Ends, Clow F-5065. Butterfly: AWWA. Eccentric Plug: Dezurik PEC, Cast Iron or Milliken 603E. Ball: Pratt or Apco-Willamette.
<u>Buried and Encased Pipe and Valves:</u>	None
Remarks:	
1. HVAC system/equipment condensate drains shall be 316L SST; ASTMA312, Sch. 40. Fittings shall be wrought 316L SST, threaded, Sch. 40S. Connections shall be solder type with threaded adapters or flanged for equipment connections where required. Products and fabrication shall be as specified in Section 40 05 23.	

END OF SECTION

SECTION 40 05 19

DUCTILE IRON PIPE

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies ductile iron pipe, ductile fittings and gaskets for exposed pipe applications.
- B. Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe unless specifically stated otherwise.

1.02 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are 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
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 C150	Portland Cement
AWWA C104	Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast
AWWA C153	Ductile-Iron Compact Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints

1.03 SUBMITTALS

- A. Prior to delivering the product to the job site, the following submittals shall be provided in accordance with Section 01 33 00:
 - 1. Manufacturer's product data, catalog cuts, or shop drawings describing construction, dimensions, and materials including interior lining and exterior coatings. Indicate on the submittal each Piping System where the product will be used.
 - 2. Piping layout drawings.
 - 3. Certifications specified in the following documents:
 - a. AWWA C110.
 - b. AWWA C111.
 - c. AWWA C115.
 - d. AWWA C151
 - e. AWWA C153
 - f. AWWA C606

PART 2 PRODUCTS

2.01 GENERAL

- A. Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	
Water or other liquid	AWWA C110 / AWWA C153
Cement mortar lining	AWWA C104

2.02 PIPE

- A. Unless otherwise indicated, ductile iron pipe shall be Class 52 pipe having nominal laying lengths of 18 or 20 feet.
- B. For grooved-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

2.03 GASKETS

- A. Unless otherwise indicated, gasket stock shall be a synthetic rubber compound in which the elastomer is nitrile or neoprene. The compound shall contain not less than 50 percent by volume nitrile or neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.
- B. Gaskets shall comply with AWWA C111 for push-on and mechanical joints and with AWWA C606 for grooved end joints.

2.04 FITTINGS

- A. Unless otherwise indicated, fittings shall conform to AWWA C110.
- B. Unless otherwise indicated, the AWWA C153 compact ductile iron fittings are an acceptable substitute for standard fittings.
- C. All fittings shall be rated for a minimum working pressure of 250 psi.
- D. Ends: Flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified.
- E. Provide long-radius elbows where specified.
- F. Grooved End Fittings: In compliance with paragraph Section 40 05 01-1.02 B.

2.05 JOINTS

- A. Unrestrained Joints: Not used for exposed pipe

B. Restrained Joints:

1. General:

- a. Unless otherwise indicated, restrained joints are required for all exposed piping.
- b. Unless otherwise indicated, restrained joints shall be flanged or grooved end for exposed service.

2. Push-On Joints:

- a. As specified in paragraph Section 40 05 19-2.05 A.1., modified for restraint.
- b. Capable of being deflected after full assembly.
- c. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations.
- d. No field cuts of restrained pipe are permitted without prior approval of the Project Representative.
- e. Acceptable manufacturer:
 - 1) American Cast Iron Pipe Company, Flex-Ring or Lok-Ring Joint.
 - 2) U.S. Pipe, TR Flex Joint.
 - 3) Approved equal.

3. Flange Assemblies:

- a. Unless otherwise indicated, ductile iron, threaded-on flanges conforming to AWWA C115 or cast-on flanges conforming to AWWA C110.
- b. Flanges shall be adequate for 250 psi working pressure.
- c. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges.
- d. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.
- e. Unless otherwise indicated, bolts and nuts for flange assemblies shall conform with paragraph Section 40 05 40-2.02 C.
- f. Gaskets shall be as specified in paragraph Section 40 05 40-2.02 B.

4. Grooved End Joints:

- a. Couplings shall conform to AWWA C606.
- b. Unless otherwise indicated, grooved end couplings shall be rigid joint for exposed service and flexible joint for buried service.
- c. Unless otherwise indicated, bolts and nuts shall comply with paragraph 40 05 19-2.05 D.
- d. Acceptable manufacturers:
 - 1) Victaulic Style 31.
 - 2) Approved equal with flush seal type gasket designed for ductile iron pipe.

5. Mechanical Joints:

- a. Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.
- b. Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

C. Ball and Socket Flexible Joint Pipe:

- 1. Boltless type allowing a maximum joint deflection of 15 degrees.
- 2. Each joint shall be provided with a retainer lock to prevent rotation after assembly.
- 3. Acceptable manufacturer:
 - a. American Cast Iron Pipe Company, Flex-Lok Joint.
 - b. U.S. Pipe, USflex.
 - c. Approved equal.

D. Bolts and Nuts:

- 1. Corrosion-resistant, high-strength, low-alloy steel as specified in AWWA C111.
- 2. Corrosion-resistant, stainless steel bolts and nuts for use with ductile iron joints are an acceptable substitute for alloyed bolts and nuts. Galvanized or cadmium-plated steel bolts and nuts are not acceptable substitutes for stainless steel.

2.06 PIPE COATING

- A. Surface preparation: Clean and abrade ductile iron pipe to obtain a surface profile of 1.5 to 2.0 mils.
- B. Factory Coating: Where the final exterior topcoat on ductile iron pipe is not an asphaltic coating the application of an exterior asphaltic coating shall be prohibited to prevent topcoat compatibility problems. Provide a shop prime coat of moisture cured urethane (MCU) or epoxy.
- C. Final Base Coat: Apply one coat of moisture-cured urethane at 2-3 mil dry film thickness.
 - 1. Tenemic Series 1 Omnithane
 - 2. Sherwin William's B65S14 Corothane 1 mio-aluminum
 - 3. Approved equal.
- D. Final Top Coat: per Section 09 90 00 with System L-1a, B-1, or C-1 as specific for the service environment.

2.07 PIPE LINING

- A. Cement Mortar Lining:
 - 1. Unless otherwise indicated, interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104.
 - 2. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalies.
- B. Glass Lining:
 - 1. Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils, with minimum hardness of 5 Mohs and minimum density of 2.5 grams/cm3.
 - 2. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.
 - 3. Ductile or cast iron pipe shall be bored, machined, or grit blasted to remove any voids, protrusions or surface irregularities to obtain a smooth continuous surface for glass lining.
 - 4. Pipe shall be at least Class 53 on diameters of 6 inches or greater except for pipe to be bored or machined which shall be of a suitable wall thickness to assure boring or machining will not impair minimum wall thickness required for Class 53. Four-inch pipe shall be Class 56.
 - 5. Fittings shall be ground or grit blasted to remove any voids, protrusions or surface irregularities.
 - 6. For systems using glass lining, all gaskets shall be full-face and match the inside diameter of the piping to protect the entire flange from damage.
 - 7. Acceptable manufacturers:
 - a. Ferrock MEH-32.
 - b. Vitco SG-14.
 - c. Approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Follow piping runs specified on the Drawings as closely as possible. Submit proposed deviations in accordance with Section 01 33 00.
 - 2. Install pipe in accordance with AWWA C600.
- B. Insulating Sections: Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, provide an insulating section as specified in paragraph 40 05 40-3.05.

3.02 ACCEPTANCE TESTING

- A. Conduct hydrostatic pressure tests in accordance with AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.
- B. Conduct the tests in the presence of the Project Representative.

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 B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded.
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe
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 A240	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
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 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
ASTM A774	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
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 A774.
 - c. ASTM A778.
 - d. ASTM A409.
5. Test results specified in paragraph 1.04.
6. Names and qualification records of proposed welders.

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 weld procedures which have been qualified 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.

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: Type 316L, seamless, threaded joints conforming to ASTM A312. Minimum wall thickness: Schedule 40S.
- B. 3-Inches and Larger: Unless otherwise indicated, manufactured from ASTM A240 annealed and pickled sheets and plates, Type 316L, in accordance with ASTM A778 or ASTM A409 HT-0. Pipe shall be manufactured to nominal pipe sizes as listed in ANSI B36.19M.

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 B16.11.
- B. 3-Inches and Larger:

1. Unless otherwise indicated, butt-weld type manufactured in accordance with ASTM A774 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 ANSI 16.1, 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, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

PART 3 EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

- A. Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. 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 the TIG (GTAW) process.
 - 2. Heavier walls: Unless otherwise indicated, properly bevel and root pass using the TIG (GTAW) process, followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process.
 - 3. Filler wire: Add only ELC grades only to all welds to provide a cross section at the weld equal to or greater than the parent metal.

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. Butt welds: Have full penetration to the interior surface. Provide inert gas shielding to the interior and exterior of the joint.
 6. Remove excessive weld deposits, slag, spatter, and projections by grinding. Grind smooth welds on gasket surfaces.
- 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 an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.
 2. Remove all residue, oxide and heat stain from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Eucleen" or equal, followed by complete removal of the agent.
- 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.

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 31

PLASTIC PIPE

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 D1248	Polyethylene Plastics Extrusion Materials For Wire and Cable
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 D2657	Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Polypropylene Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

1.03 SUBMITTALS

- A. Procedure: 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:
 - 1. Material for pipes and fittings: AWWA C900, ASTM D1784, Class 12454-B.
 - 2. Pipe and fittings requirements: 235 psi – DR 18.
 - 3. Ductile Iron fittings: AWWA C110 Cement Mortar Lined. See Section 40 05 19.
 - 4. Restraints: All piping shall be restrained; restrained joints shall be made using bell restraint harness, ASTM A536 ductile iron with backup ring behind bell. Wedge assemblies, bolts, and nuts shall be 316L SST, B8 Class 1. EBAA Iron, Start Pipe Products, or equal.
- B. Non-pressure Pipe:
 - 1. Material for pipe and fittings: D1785, SCH 80.
 - 2. Schedule 80 PVC fittings: ASTM D2464.
 - 3. Pipe and fittings requirements: ASTM D3034 for SDR 35.
 - 4. 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

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.
 - 3. PVC pipe and fittings 4 inches in diameter and greater:
 - 4. Unless otherwise indicated, join by means of gasketed push-on joints or ductile iron push-on or mechanical joint fittings. Install restraints at joints.
- B. Line fittings: Line and coat as specified in Section 40 05 19.
 - 1. Unless otherwise indicated, paint PVC piping exposed to sunlight with UV resistant coating system as specified in Section 09 90 00.
- C. 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
 - Dimension Ration (DR): DR 11, 200 psi
 - Pressure Class: AWWA C906 - 125 psi or as otherwise specified
 - Maximum deflection in installed condition, buried pipes: 4.2% of the average inside diameter

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 must 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 (and at all pipe support locations) 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 must be properly supported, thermal expansion and contraction movement must be accommodated, and supports must be spaced to limit vertical deflection between supports.
3. Pipe supports must conform with the following additional requirements:
 - a. Supports must cradle the bottom 120 degrees of the pipe.
 - b. Supports must have a width at least one half of pipe diameter.
 - c. Edges of the supports must 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 – 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, pipe supports, and other appurtenances, and where specified.
 4. Victaulic Style 995 couplings shall be installed where specified on the Drawings for pipeline disassembly for maintenance.

3.02 FIELD TESTING

- A. System Test Phase: Following the preoperational, and component test phases, 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:
 - a. General: Deflection testing shall be performed on the entire length of installed pipe no sooner than 30 days after completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe and fittings in the installed pipeline under external loads shall not

exceed the maximum deflection as specified within this Section. Either of the following devices and procedures may be used to measure deflection.

- b. Pull-Through Deflection Testing: The Contractor shall determine whether the allowable deflection has been exceeded by use of a pull-through device.
- c. Pull-Through Device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this Section, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:
 - 1) A diameter, or minor diameter as applicable, equal to the average inside diameter of the pipe minus the dimension equivalent of the maximum installed deflection specified in this Section. A tolerance of plus 0.5 percent in the diameter of the test device will be permitted.
 - 2) A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.
 - 3) Center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of not less than 70,000 pounds per square inch, with eyes or loops at each end for attaching pulling cables.
 - 4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.
- d. Pull-Through Device Procedure: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.
- e. Deflection Device: The Contractor shall determine whether the allowable deflection has been exceeded by use of a deflection measuring device.
 - 1) Deflection Measuring Device: This device shall be sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. The deflection measuring device shall be approved by the Project Representative prior to use.
 - 2) Deflection Measuring Device Procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of the maximum allowable specified in this Section are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of the allowable, remove pipe which has excessive deflection, replace with new pipe, and completely retest in the same manner and under the same conditions.

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. Procedure: 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. A welder qualification certificate for each welder
 - 4. 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 requirements.
 - 3. Welders shall be qualified by the Contractor or Fabricator in accordance with ASME Section IX.
 - 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 must 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. Ductile Iron pipe: rigid type as specified in Section 40 05 19.
4. Cut grooves are not permitted on fabricated or light wall pipe. Note that Ductile Iron pipe must 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 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: 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. Unless otherwise specified, use model as recommended by the manufacturer for the application
8. Grooved end flexible-type couplings:
 - a. Gruvlok Fig 7001.
 - b. Approved Equal.
9. Grooved end rigid-type couplings:
 - a. Gruvlok Fig 7401.
 - b. Approved Equal.

2.04 GASKETS

- A. Materials:
 1. EPDM: Ethylene-propylene-diene-terpolymer.
 2. Neoprene: Neoprene.
 3. Nitrile: 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 aqual.

- 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 B31.1.

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. Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Provide welding certification for each welder working on piping fabrication.
- B. Make welds in accordance with the requirements of ASME B31.1 for piping Systems 8, 26, and 28 specified in Section 40 05 01. Make welds in accordance with the requirements of ASME B31.3 for piping System 20 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.

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. For piping 2 inches in diameter and larger passing from concrete to earth, provide two pipe couplings or flexible joints as specified. The first coupling or joint shall be within 2 feet of the structure. The second coupling or joint shall be located at a sufficient distance from the first coupling or joint to accommodate the maximum expected differential settlement, as specified in the geotechnical report, taking into account the maximum allowable deflection of each coupling or joint. If specific couplings or joints and a

separation distance are indicated on the drawings, Contractor shall provide these as shown on the drawings.

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

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

1.03 OPERATING CONDITIONS:

- A. The hangers and supports specified in this Section are provided to resist pipe vertical and horizontal gravity and seismic 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 Wetwells, Pump Rooms, Grit Classifier Building, Odor Control Spaces, Chemical storage, storage and handling, battery rooms

1.04 HANGER AND SUPPORT SELECTION

- A. Select pipe hangers and supports as specified. 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.

- B. 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.
- C. Insure hangers and supports are sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.
- D. Use rod hangers where negligible pipe movement occurs and for suspended lines, wherever practical. Use bases, brackets or structural cross for piping supported from below.
- E. Hangers for the suspension of 2½ inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.
- F. 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.
- G. 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.
- H. 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.
- I. Unless otherwise indicated, existing pipes and supports shall not be used to support new piping.
- J. Stock hanger and support components shall be used wherever practical and be compatible with any existing hanger hardware for system standardization.
- K. Anchorage and bracing for all suspended ductwork and other distribution systems shall be provided per 2018 Washington State Building Code Section 1613/ASCE 7-10 Chapter 13
- L. Provide all necessary hangers, supports, concrete inserts, anchors and guides for material and equipment to be installed.
- M. No perforated strap hangers and no wire supports will be accepted.
- N. Insulation Allowance
 - 1. Hangers supporting insulated pipe shall be sized to fit the pipe plus the insulation.
 - 2. The insulation at support points shall be provided with a metal shield in order to prevent damage to the insulation.
- O. Anchors and guides shall be constructed of steel, in accordance with approved Shop Drawings, and as indicated.
- P. Pipe hangers used to support uninsulated copper piping shall be copper plated.
- Q. Anchors
 - 1. Anchorages shall be obtained by welding lugs onto the pipe and providing abutting surfaces against the lugs to restrict longitudinal movement.
 - 2. Anchors shall be designed such that the pipe may be removed by removing bolts; no welding of pipe to the anchor will be accepted.
 - 3. bolting materials shall be cadmium plated.
- R. Guides shall be located not more than 20 ft from each expansion loop or joint.

- S. Horizontal runs of pipe shall be provided with supports spaced such that the sag of the unsupported length will not create any pockets in the piping (weight of fluid included).
- T. Vertical Piping
 - 1. Vertical piping shall be:
 - a. Supported at the base with fittings made for this purpose; or
 - b. Supported from the nearest horizontal member or floor with a riser extension pipe clamp.
 - 2. Provide a riser extension clamp on each floor.
- U. Hangers for ductwork and equipment shall be as indicated and in accordance with the guidelines of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- V. Inserts shall be galvanized.

1.05 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Manufacturer's catalog data on pipe supports and components, including data on load capacity.
 - 2. Hanger and support locations and components indicated on the piping layout drawings required by Section 40 05 01.
 - 3. Fabrication drawings for fabricated components.
 - 4. Shop Drawings: Submit certified drawings showing all details of pipe, electrical conduit, ductwork and miscellaneous support devices. Shop drawings shall include all details of construction, anchor size, hanger rod sizes, bar sizes, weld sizes, mounting dimensions and overall space requirements.
 - a. Submit manufacturer's literature to verify support of 5 times the weight or thrust of the piping without failure. Where standard tables are not available, provide calculations signed and stamped by a Civil or Structural Professional Engineer licensed to practice in the state where the project is located. All calculations shall be provided in English units.
 - b. All exposed and above grade piping shall be vibrationally isolated and restrained by a Seismic Restraint System. Provide calculations in accordance with specification sections 01 73 00.
 - 1) The Typical Details provided in the construction documents for supporting mechanical equipment, electrical equipment and distributed systems (i.e. piping, conduit, ducting, other) are to be used for general guidance, **minimum** requirements, and layout for support systems. Design for these support systems shall be provided in the submittal. The design shall include details and calculations stamped and signed by a Civil or Structural engineer registered in the State of Washington.
 - 2) Submit layout drawing(s) showing where submitted supports will be used. Layout drawings shall document how the pipe support will be used to resist lateral loads, perpendicular and parallel to the pipe, the specific height and spacing in that area, where the support will connect to flanges (e.g. pipe friction cannot be used to resist lateral loads)- to ensure the calculated maximum loads/spacing provided are appropriate (and to ensure contractor is installing correct detail in appropriate location).
 - 3) Submit documents supporting manufacturer's published values (load capacities, max design loads, deflection from stress, etc.) in terms of how the values were obtained (independent testing laboratory, testing agency, or government agency).

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. 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: 304 or 316 stainless steel.
- 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

- 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. Vertical pipe support applications shall be as specified above except that insulation shields shall not be used for insulated pipe.

13. 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.

14. 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. Embedded concrete insert framing channel shall be 1-5/8 inch wide by 1-3/8 inch deep.
 - d. 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.
- F. Fiberglass Framing Channel:
 - 1. Framing channel shall be 1-5/8 inches square, pultrusion formed, fiberglass reinforced plastic with 0.200-inch wall thickness.
 - 2. Channel shall have a continuous slot along one side with in-turned clamping ridges
 - 3. Acceptable manufacturers:
 - a. Aickin Corporation
 - b. Aickinstrut 2000 series
 - c. Approved Equal.

2.03 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.

2.04 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. 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.

- F. 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 items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.
- D. Use embedded anchor bolts instead of concrete inserts for support installations in areas below water surface or areas normally subject to submerging.
- E. 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.
- F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.
- G. Rollers shall roll freely without binding.
- H. 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.
- I. Cut and drill baseplates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.
- J. 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 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.

3.04 ANCHOR BOLTS

- A. Anchor bolt material and installation requirements shall conform to Specification Section 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
AISC 325	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 project 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: Section 01 73 00.

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 restraints may be omitted from the following installations:
 - 1. Gas piping less than 1-inch inside diameter.
 - 2. Piping in boiler and mechanical rooms less than 1¼-inch inside diameter.
 - 3. All other piping less than 2½-inch inside diameter.

- 4. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support for the hanger.
- 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. Procedure: 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. For each seismic restraint location, provide calculations substantiating the loads, in all directions, that the seismic restraint system must withstand. Calculations must be stamped, dated, and signed by a currently registered professional structural engineer in the State of Washington.
 - 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 - 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.

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 GENERAL

- A. Pipe restraints shall conform to the requirements of MSS SP-58 and MFMA.

2.04 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.

2.05 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.

2.06 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.

2.07 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 paragraph 2.02 E.
- 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.

2.08 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.

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: 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):

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Grit Classifier Replacement

- 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) Ductwork expansion joints: May be rated at less than 50 psig but must be rated equal to the design pressure and, in no case, less than 2 psig.
- 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 must 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.
- C. Other Constructions:
- 1. Polyvinylchloride:
 - a. Acceptable manufacturers:
 - 1) Celanese "Chemtrol" CPVC slip type having Teflon impregnated seal rings.
 - 2) Certain-teed Fluid Tite PVC.
 - 3) Johns-Manville PVC double bell expansion joint.
 - 4) Approved Equal.
 - 2. Teflon:
 - a. Molded TFE bellows.
 - b. Acceptable manufacturers:
 - 1) Metraflex T-2.

- 2) Garlock Style 215.
- 3) Resistoflex R-6905.
- 4) EGG Style M-150.
- 5) Approved Equal.

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

- A. Consist of molded Teflon bellows and 150-pound ductile iron flanges.
- B. Flanges: Completely isolated from the chemical by the molded Teflon bellows.
- C. Integral steel limit bolts and Monel reinforcing rings shall be provided on the connectors.
- D. Gaskets: Non-asbestos.
- E. The connectors shall allow for an axial transverse movement of at least ½-inch, and an offset of at least 3/8-inch.
- F. Rated for a pressure of 130 psi at a temperature of 70 degrees F.
- G. Acceptable manufacturers:
 1. Metraflex Teflon Expansion Joint.
 2. Garlock, modified as necessary to provide the specified features.
 3. Approved Equal.

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.
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.
Teflon Construction (2.01C2)	FRP containment 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.
Teflon Flexible Connector (2.03)	Connection of PVC piping to polyethylene chemical storage tanks.

END OF SECTION

SECTION 40 05 47

PIPING APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

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

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	National Electrical Manufacturers Association

1.03 SUBMITTALS

- A. Procedure: 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 or higher suitable for the electrical classification.
- 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

- A. General:
1. The operating temperature range for pipeline thermometers shall be suitable for the temperature range specified in the Piping System Specification Sheets, Section 40 05 01. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus 2 percent of thermometer full scale.
 2. Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

- B. Bimetallic Thermometers: Unless otherwise indicated, bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing.
 - 1. Case material: type 304 stainless steel.
 - 2. Thermometer dial: minimum 5-inch diameter; equipped with external adjustment mechanism for zero reset.
 - 3. Acceptable manufacturers:
 - a. Ashcroft Type EH.
 - b. Marsh Mastertherm.
 - c. Approved equal.
- C. Filled Thermometers: Unless otherwise indicated, filled type thermometers shall have minimum scale length of 9 inches and shall be of the adjustable angle type mounted for convenient viewing.
 - 1. Frame material: type 304 stainless steel.
 - 2. Thermometer tube: mercury-filled Pyrex tube, recessed into the frame.
 - 3. Acceptable manufacturer:
 - a. Weksler.
 - b. Taylor.
 - c. Approved Equal.

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: 0-100 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.
- 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. 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.
 - 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.
- C. Fuel Oil Strainers:
 - 1. Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens.
 - 2. Screen perforation shall be 3/64 inch.
 - 3. Acceptable manufacturers:
 - a. Bailey No. 1.
 - b. Mueller.
 - c. Approved Equal.
- D. Duplex Strainer:
 - 1. Duplex basket type strainers with manual three-way switching valve, without the necessity of external bypass piping.

2. The strainers shall have stainless steel bodies with removable flanged stainless steel covers, built-in floor stands, and flanged ends; removable perforated plate strainer baskets made from Type 316 stainless steel; and stainless steel three-way ball valve with PTFE seals.
3. Rated for 100 gallons per minute, working pressures up to 150 psi, and size as indicated on the drawings.
4. Strainers shall have 80 mesh (177 micron) perforations.
5. Cocks for air relief and valved connections for drains shall be provided. Strainers shall be furnished with provisions for manual backflushing. Position indicators shall show which basket is online. Provide pressure gauges on inlet and outlet side of strainers (to determine when cleaning is required).
6. Manufactured by SP Kinney Engineering, or 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 PIPELINE THERMOMETERS

- A. Unless otherwise indicated, use filled thermometers on all water based services, and use bimetallic thermometers for high temperature (300 degrees F or above) steam or gaseous services.
- B. Use filled thermometers where vibration or unstable mounting conditions exist.
- C. Provide thermometers for all water and process stream inlets and outlets at each heat exchanger, heat extractor, and chiller; where shown, and adjacent to process taps for temperature sensing or transmitting instrumentation.
- D. Provide thermometers for sludge service at elbows with the process sensor oriented in the direction of sludge flow.

3.02 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.

3.03 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. Procedure: 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. Tested in accordance with ASTM E814.
 2. Exposure to heat shall expand product 8 to 10 times its original volume into any cavities in wall opening (intumescence).
 3. Acceptable manufacturers:
 - a. 3M brand fire barrier strip FS195.
 - b. Hilti CS-2420, Intumescent Wrap.
 - c. Dow Corning Fire Stop Wrap Strip 2002.
 - d. Approved Equal.
- B. Firestop Sealant:
1. Tested in accordance with ASTM E814.
 2. Acceptable manufacturers:
 - a. 3M fire barrier caulk CP25WB.
 - b. CS-240 Firestop Sealant.
 - c. Dow Corning Firestop Sealant 2000.
 - d. Approved Equal.
- 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 manufacturers:
 - 1. Thunderline Link-Seal.
 - 2. National Pollution Control, Kor-N-Seal.
 - 3. 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 and powered actuator for valves and gates, and operator appurtenances.
- B. Types: For use in the control valve schedule in Section 40 06 21 and in this Section, powered actuators are defined as follows:

ACTUATOR TYPE	SERVICE TYPE	DEFINITION
1	Modulating	Electric actuator (Three phase/Solid state controls)
2	Isolating	Electric actuator (Three phase/Solid state controls)
3	Modulating	Pneumatic diaphragm actuator/Electropneumatic controls
4	Isolating	Pneumatic diaphragm actuator/Electromechanical controls
5	Modulating	Pneumatic cylinder actuator/ Electropneumatic controls
6	Isolating	Pneumatic cylinder actuator/Electromechanical controls
7	Isolating	Quarter turn actuator (single phase)
8	Isolating	Quarter-turn actuator for corrosive applications (single phase)
9	Isolating	Manual with limit 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
ASTM A519	Seamless Carbon and Alloy-Steel Mechanical Tubing
ASTM B584	Copper-Alloy Sand Castings for General Applications
AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C542	Standard for Electric Motor Actuators for Valves and Slide Gates
IP	International Protection Rating
NAMUR	User Association of Automation Technology in Process Industries

1.03 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
1. Affidavits of compliance, as required by AWWA C500.
 2. Materials of construction
 3. Wiring diagrams and other information noted in Section 43 05 01
 4. Operations and maintenance manuals as specified in Section 01 78 23.
 5. Product data for specified power actuators.
 6. Connection diagrams: In hard copy and electronic (preferably) AutoCAD format.
 7. Catalog cuts of all furnished components and equipment, including dimensions and weight.
 8. Field test schedule and procedure including test forms.

9. Test reports.
10. As-built actuator configuration parameters and communications settings in hard copy and electronic format.
11. 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. Factory-mounting by either the actuator or valve manufacturer.
 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. Actuator housing shall have a NEMA rating conforming to the area classification indicated in Section 40 06 21.
 4. 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.

2.03 LOCAL CONTROL STATIONS

- A. Remote-mounted control stations shall be mounted for ease of actuator access when required by the Instrument Schedule in Section 40 06 71 or when shown on the Drawings.
 1. Mount where shown in the Contract Drawings.
 2. Control station shall have an enclosure rated for the area classification shown on the Drawings and include the following:
 - a. LOCAL/STOP/REMOTE switch
 - b. OPEN and CLOSE pushbuttons
 - c. Position indication status lights, RED for OPEN and GREEN for CLOSE.

3. Interconnecting cable required between the actuator and the remote-mounted control station shall be as specified in Section 26 05 19 or manufacturer's special cable.

2.04 POWERED ACTUATORS

- A. Type 1 actuators: Electric Actuator (Modulating/Three Phase/Solid State Controls):
 1. General:
 - a. Power supply 480V, 3 phase, 60 Hz
 - b. Conform to AWWA C542
 - c. Rated for area classification shown on the Drawings.
 - d. All covers and entries are to have O-ring seals, and watertight to IP68, 7 m submergence for 72 hrs.
 - e. Anti-condensation heater
 - f. Torque-transmitting housings are to be cast iron, except motor housing.
 2. Motor:
 - a. Totally enclosed non-ventilated design (TENV)
 - b. Designed for modulating service.
 - c. Completely sealed from gear case to allow mounting in any position.
 - d. Valve actuators shall be sized for an operating torque equal to twice the maximum required valve operating torque under specified process control conditions. Torque sensor shall be configurable from 40 to 100% and set to disengage motor power at 75 percent of the shaft's design torque.
 - e. Class F insulated.
 - f. Motor Protection:
 - 1) Thermal switches embedded in motor windings to shut down motor at high temperatures.
 - 2) Motor to be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve.
 3. Integral Starter and Transformer:
 - a. Reversing Starter: The actuators motor controls shall have protection against excessive current surges due to instantaneous reversal of operation commands.
 - b. Control power shall be provided by an integral 120 VAC, single phase control transformer unless a separate power source is shown on the Drawings. The transformer shall be sized so that load is no more than 80 percent of its capacity. The control transformer shall incorporate overload protection and shall have the necessary taps and be adequately rated to provide power to energize the contactor coils, provide power for a remote instrument and control station (if required) and power all connected components.
 4. Bearings and Gearing:
 - a. Bearings to be antifriction or self-lubricating type.
 - b. Bearings shall not require any maintenance between overhauls
 - c. All drive gearing and components must incorporate a lost-motion hammerblow feature.
 - d. For quarter turn valves, the drive gearing shall be self-locking to prevent the valve from back-driving the actuator.
 - e. The gearing design shall permit inspection or disassembly without taking the valve out of service.
 5. Operating Speed:
 - a. Linear actuators: 12 inches per minute
 - b. Quarter turn actuators: 90 degrees per minute per 12-inches in valve diameter. For example a 6-inch diameter valve would require 30 seconds to open or close. A 24-inch valve would require two minutes to open or close.
 6. Handwheel
 - a. Declutch mechanism to engage and disengage handwheel.
 - b. Clearly marked with an arrow and the word CLOSE.
 - c. For linear valve types the handwheel is to be mechanically independent of the motor drive and should permit valve operation in a reasonable time with a manual force not exceeding 100 pounds for seating/unseating the valve.
 - d. The drive is to be automatically restored to electrical operation by starting the motor.

7. Torque and Limits
 - a. Direct torque measurement at the output of the actuator using the torque hall sensor principle.
 - b. Torque setting to be possible within 40% to 100% of the rated torque
 - c. Provide independently set programmable torque switch bypass for valve unseating and other short duration, high torque conditions.
 8. Local Controls
 - a. Integral switches and pushbuttons shall be provided with as a minimum, a LOCAL/STOP/REMOTE switch (lockable) and OPEN and CLOSE pushbuttons.
 - b. Position indication status lights, RED for OPEN and GREEN for CLOSE.
 9. Status Contacts: A minimum of 6 status contacts shall be supplied for remote status indication of the following: (2) N.O. contacts for the OPEN position, (2) N.O. contacts for the CLOSE position, (1) N.O. contact for the REMOTE position, and (1) N.O. contact Fault Trip for overtorque, phase error, and thermal overload.
 10. Modulating Controls:
 - a. Programming of the actuator shall be accomplished without the removal of the actuator cover.
 - b. Solid state positioner with control electronics capable of modulating valve or gate positions by accepting control system position input signals and providing position feedback as specified in the contract drawings and/or the Instrument Schedule Section 40 06 71.
 - 1) Accepts a 4 to 20 mA DC position command signal to proportionally position the valve/gate 0-100% travel. Controller has a maximum input impedance of 250 ohms and is galvanically isolated.
 - 2) A 4-20 mA feedback position transmitter shall be wired to the actuators terminal strip for remote position indication and shall support to a 600 ohm line resistance.
 - 3) Controller positioning accuracy shall be 1.0 percent of total travel or better at the valve operating speed specified.
 - 4) The LCD display to show valve position in normal operating mode.
 - 5) Valve is to remain in last position when main power is on or off.
 - c. Diagnostic software for modulating valves:
 - 1) Bluetooth interface for communication with a laptop or tablet computer with LCD graphic display clearly visible under all lighting conditions.
 - 2) Windows based software to allow download and upload of all actuator configuration parameters, diagnostics, and operations log.
 - 3) Automatic software updates upon connection of the laptop or tablet and opening of the internet application.
 11. Acceptable Manufacturers:
 - a. Rotork IQ Series
 - b. Auma SA or SQ Series with AC controls
 - c. Limitorque MX Series
 - d. Approved Equal.
- B. Type 2 actuators: Electric Actuator (Isolating/Three Phase/Solid State Controls):
1. The same as Type 1 actuators except as noted in this section.
 2. Local Controls:
 - a. Same as Type 1 except eliminate paragraph 2.04A10, Modulation Controls.
 3. Acceptable Manufacturers:
 - a. Rotork IQ Series
 - b. Auma SA or SQ Series with AM controls
 - c. Limitorque MX Series
 - d. Approved Equal.
- C. Type 3 actuators: Pneumatic Diaphragm Actuator (Modulating/Electropneumatic Controls):
1. Actuator Characteristics:
 - a. Diaphragm actuator with a sliding stem design.
 - b. Double-acting, unless spring return is needed. See the fail positions in Section 40 06 21.

- c. Shall have a cast-aluminum or pressed-steel body with polyester-reinforced neoprene or nitrile-rubber diaphragm.
 - d. Diaphragm size sufficient to operate the valve with a supply air pressure to the pilot valve or positioner not more than ____ psig.
 - e. Sized for an operating force equal to twice the maximum required force under specified flow conditions.
 - 2. Positioner
 - a. Positioner shall be microprocessor-based, and convert control signals to a pneumatic output to control pneumatic valve.
 - b. Compatible with HART
 - c. Signal input: 4-20 mA, isolated for equipment ground.
 - d. Positioner feedback signal: 4-20 mA into 600 ohms at 24 VDC.
 - e. Input impedance not to exceed 450 ohms.
 - f. Suitable for supply pressure from 18 to 150 psig and provided with a filter regulator assembly complete with gage.
 - g. For double-acting service, provided with integral shutoff/equalizing valve assembly.
 - 3. Approved Manufacturers:
 - a. Emerson Fisher Series 657/667 (choose direct acting or reverse acting)
 - b. Approved Equal
- D. Type 4 actuators: The same as Type 3 actuators except the unit is to be controlled electromechanically:
- 1. Provide with a pilot solenoid valve and position switches as specified in Section 2.05.
 - 2. Acceptable Manufacturers:
 - a. Emerson Fisher
 - b. Approved Equal.
- E. Type 5 actuators: Pneumatic Cylinder actuator/solid state controls:
- 1. Actuator sizing:
 - a. Cylinder size sufficient to operate the valve with a supply air pressure to the pilot valve or positioner not more than ____ psig.
 - b. Sized to provide not less than 2 times the peak torque required by the valves under specified flow conditions.
 - c. Double-acting, unless spring return is needed. See the fail positions in Section 40 06 21.
 - 2. Quarter Turn Actuator Characteristics:
 - a. Double-acting cylinders unless spring return is needed.
 - b. Actuators are equipped with two piston guide rods to bear the lateral rack-and-pinion thrust forces. Bearing surfaces including inside cylinder wall and guides coated with a permanent dry-film lubricant and corrosion inhibitor.
 - c. Single-acting actuators with multi-springs at each end to balance forces on the pistons.
 - d. Suitable for use with nonlubricated dry instrument quality air.
 - e. Cylinder: Anodized aluminum.
 - f. Piston: Aluminum.
 - g. Shaft: Stainless Steel
 - h. Seals: Nitrile rubber
 - i. Fasteners: Stainless Steel
 - 3. Positioner
 - a. Same as Type 3 actuator.
 - 4. Acceptable Manufacturers:
 - a. Flowserve (Worcester) Series F-39.
 - b. Emerson (Keystone) Series F-89.
 - c. Approved Equal.
 - 5. Linear Actuator Characteristics:
 - a. Double-acting cylinders unless spring return is needed.
 - b. Bearing surfaces including inside cylinder wall and guides coated with a permanent dry-film lubricant and corrosion inhibitor.
 - c. Suitable for use with nonlubricated dry instrument quality air.

- d. Cylinder: Steel, ASTM A519, Grade 1018.
 - e. Piston: Gray iron.
 - f. Bearings: Bronze, ASTM B584, Grade 88-10-2.
 - g. Seals: Lip- or cup-type of duro-nitrile elastomer.
 - h. Steel cylinder rod: Electro-plated with nickel.
 - i. Sized to provide not less than 2 times the peak force required by the valves with 60 psig air supply.
- 6. Positioner:
 - a. Same as Type 3 actuator.
 - 7. Acceptable Manufacturers:
 - a. Emerson Bettis.
 - b. Rotork.
 - c. Limitorque
 - d. Approved Equal.
- F. Type 6 actuators: Same as Type 5 actuators except the unit is to be controlled electromechanically:
- 1. Provide with a pilot solenoid valve and position switches as specified in paragraph 2.05.
 - 2. Acceptable Manufacturers:
 - a. Emerson Bettis
 - b. Rotork
 - c. Limitorque
 - d. Approved Equal.
- G. Type 7 actuator: Quarter-turn actuator, single phase:
- 1. Valve actuators sized for an operating torque equal to twice the maximum required under specified flow conditions.
 - 2. Power Supply: 115 VAC, 60 Hz
 - 3. Hardwire control, capacitor-run type motor:
 - a. Aluminum enclosure with visual position indication, polyester coating
 - b. Sealed, permanently lubricated gear train
 - c. Two SPDT adjustable limit switches for open and closed positions
 - d. Declutchable manual override
 - e. Heater/Thermostat
 - f. Thermal overload protection
 - g. Acceptable Manufacturers:
 - 1) Flowserve (Worcester) Series 75
 - 2) Emerson (Bettis) TorqPlus
 - 3) Rotork models Q, ROM, and RCEL
 - 4) Approved Equal.
- H. Type 8 actuator: Quarter-turn actuator for corrosive applications, single phase
- 1. Valve actuators sized for an operating torque equal to twice the maximum required under specified flow conditions.
 - 2. Power Supply: 115 VAC, 60 Hz
 - 3. NEMA rating as specified in Section 40 06 21.
 - 4. Electromechanical Control:
 - a. Sealed, permanently lubricated gear train
 - b. 50-100 percent duty cycle.
 - c. Thermally bonded powder coat finish and stainless steel hardware.
 - d. Two SPDT adjustable limit switches for open and closed positions
 - e. Declutchable manual override
 - f. Thermal overload protection
 - g. Visual position indicator
 - 5. Actuator to mount directly on the valve for chemical service without the use of any adapter plates or harnesses.
 - 6. Acceptable manufacturers:
 - a. Asahi Series 92

- b. Hayward ECP
 - c. Approved Equal.
- I. Type 9 actuators:
 - 1. Manual valves provided with two independent position switches for open/close indication as specified in paragraph 2.05.

2.05 ACTUATOR CONTROL DEVICES

- A. Position Switches:
 - 1. Visual position indication with two SPDT contacts with minimum rating of 2 amperes at 120V AC or 24V DC.
 - 2. Provide with mounting bracket
 - 3. Acceptable Manufacturers
 - a. Flowserve XCL
 - b. Topworx DXP
 - c. Rotork Soldo
 - d. Approved Equal.
- B. Solenoid Valves:
 - 1. Plug-in units (pneumatic and electric connections) with lapped spool in floating sleeve suitable for continuous service on dry, nonlubricated instrument quality air.
 - 2. 2,3,4-way, 3 or 5-port, double-solenoid, 2-position, with integral speed control needles and mufflers on each exhaust port, unless single solenoid with spring return is needed.
 - 3. Provide four-way solenoids for double acting pneumatic actuators and three-way solenoids for spring return pneumatic actuators.
 - 4. Shall Fail-Open, Fail-Closed, or Fail-in-Last Position as required to meet the requirements of the associated pneumatic valve. See the fail positions noted in the Control Valve Schedule, Section 40 06 21.
 - 5. For pneumatic actuators which are required to Fail-in-Last Position, dual solenoid valves shall be used.
 - 6. Valves with Cv less than or equal to 1.0: Direct solenoid actuated.
 - 7. Valves with Cv greater than 1.0: Solenoid pilot actuated and suitable for supply pressures between 25 and 125 psig.
 - 8. Provided with nonlocking recessed manual override and shall comply with NAMUR, except that NEMA 7 cases to be provided in classified areas. Solenoids shall have fully encapsulated Class H coils.
 - 9. Sized to provide full stroking of the control valve in 3 seconds with speed control needles fully open.
 - 10. Filter regulators with gage shall be provided with solenoid pilot valves except that a common filter regulator shall be used for manifolded pilot valves.
 - 11. Solenoid valves shall be rated for continuous duty at 120 VAC, 60 Hz. Maximum power consumption in energized state to be less than 2W and inrush less than 0.35A
 - 12. Acceptable manufacturer (general):
 - a. Numatics.
 - b. Ross series W70.
 - c. Asco
 - d. Parker-Skinner
 - e. Approved Equal.
 - 13. Acceptable manufacturer (where 3 or more valves are mounted at a common location):
 - a. Numatics.
 - b. Ross.
 - c. Asco
 - d. Parker-Skinner
 - e. Approved Equal.
 - 14. Manifolds shall be provided.

2.06 ACTUATOR APPURTENANCES

- A. Valve Boxes:
 - 1. Cast iron and having suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers.
- B. Floor Boxes:
 - 1. Hot-dip galvanized.
 - 2. Where operating nut is in the concrete slab: Floor box is bronze bushed.
 - 3. Where operating nut is below the slab: Opening in the bottom of the box to be sufficient for passage of the operating key.
- C. Adjustable Shaft Valve Boxes:
 - 1. Concrete or cast iron.
 - 2. Gas line covers: Impressed with the letter "G".
 - 3. Box covers on waterlines shall be impressed with the letter "IV".
 - 4. Acceptable manufacturer:
 - a. Brooks No. 3RT.
 - b. Christie G5.
 - c. Empire 7-1/2 valve extension box.
 - d. Approved Equal.

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:
 - 4. 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. Powered Actuators
 - 1. Powered actuators shall have their manual operating accessory, where specified, mounted and operable from the specified operating level.
- C. 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. Test each valve/actuator as a combined unit, 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.

3.03 ACTUATOR APPURTENANCES

- A. Valve Boxes:
 1. Provided for buried valves.
 2. Extending to finished surfaces.
- B. Floor Boxes:
 1. Provided for wrench operation of valves located below concrete slabs.
 2. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

SECTION 40 05 60

BONNETED KNIFE GATE VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies furnishing and installing bonneted knife gate valves. All knife gate valves on sewage shall be bonneted.
- B. Valve List:

VALVE	VALVE NO.	POWERED OPERATOR
West Grit Hopper Knife Gate Valve	705-KGV120129	Type 2 Power Actuator, Per Section 40 05 57
East Grit Hopper Knife Gate Valve	705-KGV120130	Type 2 Power Actuator, Per Section 40 05 57

- C. Powered Operators: Section 40 05 57 and 40 06 21.

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 B16.5	Pipe Flanges and Flange Fittings:
ASTM B98	Copper-Silicon Alloy Rod, Bars and Shapes
AWWA C520	Knife Gate Valves, Sizes 2 In. (50 mm) Through 96 In. (2,400 mm)

1.03 VALVE DESCRIPTION

- A. Pressure/Temperature Ratings:
- Valves 2 inches through 24 inches: W.O.G. non-shock working pressure ratings of 150 psi.
 - Valves greater than 24 inches: W.O.G. non-shock working pressure ratings of 50 psi
 - Designed for a temperature of 150 degrees F.

1.04 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
- Catalog cuts or shop drawings showing fabrication, dimensions and materials of the valves components.
 - Catalog cuts, data of powered operators and appurtenances. Provide related power and control wiring diagram of the powered operators.
 - Provide knife gate valves installation shop drawings and verify that the valves will match the condition for installation as shown on the drawings. For valves that must be installed at an angle, or horizontally, submit supporting information that show that the valves can operate in this configuration.
 - Operations and maintenance information per Section 01 78 23.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturer:
 - 1. Hilton Series H-200-B.
 - 2. Pratt LCV Figure 193.
 - 3. Fabri-Valve CF134.
 - 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
Wetted parts	Type 304 stainless
Stem	Type 304 stainless
Exterior flanges and stiffeners	Cast or fabricated carbon steel
Yoke	Cast or fabricated carbon steel
Stem nut	Bronze
Packing	Teflon impregnated synthetic fiber
Bolts, Fasteners	Type 304 stainless

2.03 BODY AND BONNET

- A. Body and Bonnet: same pressure rating.
- B. Packing gland at top or bonnet with leak tight seal around the stem. Packing shall be replaceable without disassembling the valve or removing the actuator.
- C. Flanges: Machined true. Bolt holes
 - 1. For 2 to 24-inch, per ASME B16.5 for 125 lb. class rating.
 - 2. For valves larger than 24-inch, ASME B16.47 Series A, Class 150.
 - a. Flange shall be custom fabricated to match bolt pattern of existing valves. See drawings for requirements.
 - b. Valve and operator shall require custom anchorage design, provided by the manufacturer. See drawings for additional requirements.
- D. Seat: Uni-directional with gate wedges and resilient seats

2.04 GATE AND STEM

- A. Rising stem design.
- B. Machined and polished to surface finish of 32 micro-inch RMS to prevent damage to valve seat.
- C. Acme threads.
- D. Designed to accommodate the thrust and torque from the specified actuator.
- E. Provide bonnet flush and drain ports.

2.05 FINISHES

- A. Exterior ferrous metal: Epoxy primer and top coat.

2.06 SOURCE QUALITY CONTROL

- A. Hydrostatic Test: per AWWA C520.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and as shown on the Drawings.
- B. Orientation:
 - 1. Install with valve stem in vertical position unless otherwise shown.
 - 2. If shown or required to be in non-vertical position, submit design showing the valve gate and guides are capable of operating in this position; provide additional support as required.
 - 3. The seat on uni-directional knife gate valves shall be oriented to allow system pressure to assist in sealing the knife gate valve when closed.
 - a. The seat shall face the pump or other mechanical equipment if the KGV is used for isolating this equipment.
 - b. The seat shall face a branch line that is to be isolated.

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 63.13

AWWA METAL-SEATED BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies metal seated ball valves 6-inches and larger

1.02 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revision of the following document. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ASME B16.1	Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
AWWA C507	Ball Valves 6 inches through 60 inches.
AWWA SP-72	Ball Valves with Flanged or Butt-Welding Ends for General Service
AWWA SP-110	Ball Valves; Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Valve: manufacturer's catalog data and shop drawings with dimensions showing plan view and elevations; cross sectional view showing internal components and materials of fabrication, and component weight.
- C. Operator: manufacturer's catalog data and shop drawings with dimensions showing plan view and elevations; cross sectional view showing internal components and materials of fabrication, and component weight.
- D. Open/close and holding torque calculations used in sizing the actuator.
- E. Factory test results.
- F. Field test results.
- G. Installation and start-up instructions.
- H. Operations and maintenance information per Section 01 78 23.

1.02 DESIGN AND PERFORMANCE REQUIREMENTS

- A. Valve to meet application the following application needs:
1. Each valve shall be in a pump stop-and-check service on the discharge side of a large sewage pump.

- B. Raw sewage contains rags and stringy material, tramp iron, industrial wastes, incidental quantities of petroleum products and considerable quantities of grit with particle sizes up to that of large cobblestones.
- C. The valves shall be hydraulic cylinder operated by a common fluid power system. The fluid power system shall be designed to provide the below-listed valve operating times at 1400 psi against an 80 psi differential across the valve. In order that these times not degraded,
 - 1. Normal operation: 60 seconds (fully open to fully closed and vice versa)
 - 2. Emergency closure: 10 seconds
- D. Maximum stroking force shall be computed by assuming the following:
 - 1. The valve is closed or opened against an 80 psi differential pressure with an empty downstream pipe or free discharge, whichever is worse.
 - 2. A bearing coefficient of friction of not less than 0.3.
 - 3. A seat coefficient of friction of not less than 0.5.
- E. Maximum anticipated line flow, with the valve in the fully open position is as follows:
 - 1. 20-inch valve: 20 MGD
 - 2. 24-inch valve: 34 MGD
- F. Each valve will be expected to be operated from fully opened to fully closed, and from fully closed to fully opened position several times each day.

1.03 FACTORY TESTS

- A. Test each valve.
- B. Per AWWA C507.
- C. Cycled six times from the fully open to the fully closed position and vice versa to demonstrate the valve is free from binding, vibration, and chatter. Cycled three times at each of the following full stroke times: 10 seconds and 60 seconds.
- D. With its ball in the open position and both ends bulkheaded, shall be subject to a test pressure of 300 psi. This pressure shall be maintained for period of at least 60 minutes during which time all valve parts shall show no evidence of distress, leaks, or weeping.
- E. With its ball in the closed position and the downstream flange bulkheaded, shall be subject to a test pressure of 150 psi. This pressure shall be maintained for period of at least 30 minutes during which time the valve shall maintain a drop tight seal. Leakage through the valve at 20 psi shall not exceed one half pint per minute.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Henry Pratt Co.
- B. APCO/Willamette
- C. Approved equal.

2.02 VALVES

- A. Full-ported metal-to-metal seated ball valves with flanged ends, rated at 150 psi and drilled to ANSI B16.1 Class 125.

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AWWA METAL-SEATED BALL VALVES

- B.** Body, ball, torque unit and cylinder operator.
- C.** Single-seated at the inlet opening. No seating surfaces shall be provided at the downstream opening.
- D.** Seating and unseating action shall be eccentric with two degrees of offset.
- E.** Clear waterways shall be provided between the ball and the body to permit and encourage flushing action as the ball is moved from the open to closed position and vice versa.
- F.** Fabrication per AWWA C507.
- G.** Drop tight and meet or exceed AWWA C507 inspections and testing standard.
- H.** Arrange to be installed with the shaft in the horizontal position and the actuating cylinder mounted vertically upward on the river-right side of the valve.

2.03 BODY

- A.** Cast iron, ductile iron, or cast steel.
- B.** Flanges: flat faced and machined parallel to each other within 0.005 inch.
- C.** Integrally cast bronze bushed trunnions for the operating shaft.
- D.** A rigid means for supporting the torque unit without the necessity of additional supports.

2.04 BALL

- A.** Cast iron, ductile iron, or cast steel.
- B.** Integrally cast bronze bushed trunnions for the operating shaft. One trunnion holds the operating shaft which passes through the packing seal area and connects to the actuator.

2.05 SEATS

- A.** Seating surfaces shall be located on the upstream opening of the body and on the upstream face of the ball.
- B.** Seats shall be of the flexible metal type. Ball and body seats shall be accurately machined and aligned on slightly offset centers to insure that the seating surfaces are in contact only when the ball is at the actual point of closing and do not drag against each other when the ball is cycled.
- C.** Body seats: 400 series monel rigidly attached to the base metal and accurately machined to form the seating seal.
- D.** Ball seats: stainless steel series 300 rigidly attached to the base metal and accurately machined to form the seating seal.

2.06 BEARINGS

- A.** Bronze for the ball and body trunnions.
- B.** Mating surfaces shall be of dissimilar hardness to prevent galling or binding.
- C.** Load shall not exceed 2000 psi at 250 psi differential pressure.

2.07 SHAFTS

- A. 18-8 Type 304 or 17-4 Type 630 stainless steel.
- B. Ball shaft shall be so designed that the factor of safety for all combined stresses shall be at least five to one.
- C. Maximum torsional deflection shall not exceed 1/6 degree per foot of unsupported length using a seat coefficient of friction of 0.5 and a bearing coefficient of friction of 0.3.

2.08 SHAFT SEAL

- A. Pass through a sealing area equipped with a field-replaceable packing or O-ring seal.
- B. The sealing device shall be capable of being removed and having the seal replaced with the line under pressure, without removing the valve from the line.

2.09 CYLINDER ACTUATORS

- A. Conform to the operating requirements of AWWA C507.
- B. Designed to hold the valve in any intermediate position between full open and full closed without creeping or fluttering.
- C. Move the valve from full open to full close and vice-versa when a minimum of 1400 psi or a maximum of 1800 psi is applied to the cylinder.
- D. Wetted parts of the hydraulic cylinders shall be stainless steel and cylinder rods shall be chromium plated stainless steel.
- E. Cylinders shall be cushioned at both ends and shall be fitted with air bleeds. Rod seals shall be of the non-adjustable wear compensating type.
- F. Rod wiper for removing deposits inside the cylinder.
- G. External dirt wiper.
- H. Materials shall be compatible and acceptable for use with hydraulic fluid.
- I. Manual override capability to allow for operation of the valve during loss of hydraulic system function.

2.10 TORQUE UNIT

- A. Traveling crosshead, necessary bearings and suitable linkage to impart positive rotary motion to the plug shaft. The crosshead shall be designed for direct connection to the hydraulic cylinder operator specified herein and the torque unit case shall be arranged for support of the cylinder.
- B. Designed so that during the first 50 percent of closing stroke, the flow shall be reduced by approximately 80 percent and the remaining flow shall be gradually reduced to complete shutoff during the last 50 percent of closing stroke.
- C. The unit shall be arranged so that when the ball is in the open position, the ball seats are in the upper half of the valve body.
- D. Torque units shall be designed to permit inspection, lubrication, and disassembly without removing the valve from the line.

- E. In addition, each unit shall be arranged to permit adjustment and replacement of the stub shaft seal without removal of the torque unit from the valve and while the valve is under pressure.
- F. A ball position indicator shall be provided on the torque unit cover.
- G. Submersible double-pole double-throw limit switches suitable for use with a 125 VDC control circuit shall be provided in each torque unit. Limit switches shall indicate OPEN and CLOSED valve positions.

2.11 FINISH

- A. All internal cast or ductile iron surfaces, except finished or bearing surfaces, shall be shop painted with corrosion resistant epoxy primer. Coal tar coating products are not acceptable.
- B. All exterior surfaces, except finished or bearing surfaces, shall be shop painted with manufacturer's standard corrosion resistant primer.

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.

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
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. Check valves shall be sized and selected to ensure each check valve is fully open under all flow conditions.
 2. 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. Procedure: 01 33 00
- B. Provide the following submittals:
1. Manufacturer's product data detailing materials, construction, and flow capacity.
 2. Provide submittal showing the flow requirement to fully open the valve. Contractor shall confirm that the check valve remains open under all flow conditions during testing.
 3. Manufacturer's product data detailing limit switch system, materials, and wiring diagram.
 4. 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
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 ACCESSORIES (NOT USED)

2.05 FINISHES

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

2.06 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. Tested to confirm that the check valve is fully open under the lowest flow condition.
 - 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. Procedure: 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 DIAPHRAGM VALVES

- A. The valve body and ends shall be 316 stainless steel. Valve diameter 2-inches and larger shall have flanged ends, valves smaller than 2-inches shall be screwed or flanged ends. Bolts and nuts shall be stainless steel and stem and bonnet seals shall be Viton O-rings. Valve shall have visible position indication.
- B. Diaphragm shall be Hypalon or equal.
- C. Manufactured by ITT Dia-Flow Weir, or 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 STOP AND DRAIN VALVES

- A. Quarter turn.
- B. Brass or Bronze body with threaded ends.
- C. Acceptable manufacturers:
 - 1. Mueller H-10284.
 - 2. 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. Procedure: 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 manufacturers:
 - 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 to be disconnectable under pressure.
- D. Acceptable manufacturers:
 - 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.
Grit Washer 1 Solenoid Valve	705-SV12BH011
Grit Washer 2 Solenoid Valve	705-SV12BH021
Grit Washer 3 Solenoid Valve	705-SV12BH031
Grit Washer 4 Solenoid Valve	705-SV12BH041

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
705-SV12BH011	C3	1	1	150	110	NC
705-SV12BH021	C3	1	1	150	110	NC
705-SV12BH031	C3	1	1	150	110	NC
705-SV12BH041	C3	1	1	150	110	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. Procedure: 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 manufacturers:
 - 1. Direct Acting Type:
 - a. Automatic Switch Company.
 - b. Honeywell-Skinner.
 - c. Approved Equal.
 - 2. Pilot Type:
 - a. Cla-Val Co.
 - b. Golden Anderson.
 - 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

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 combination NEMA 4X, 7C, and 7D enclosures.
 - 2. Solenoids shall have fully encapsulated Class H coils.
- C. Pilot Type:
 - 1. Valves shall have combination NEMA 7 and 9 enclosures.
 - 2. Solenoids shall have molded, Class F coils.
 - 3. Pilot control shall be adjustable to regulate the rate of opening and closing the main valve over a range of 5 to 230 seconds.

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, 50 horsepower or less. This Section does not specify specialty motors such as submersible motors, 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. Procedure: 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. Where a winding over-temperature device is specified for motors 100 horsepower or larger, provide a response curve for the temperature device.
 - 5. 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.

6. Motor Part Load Efficiency Curve or Table.
7. Bearing life estimate in years at the highest motor speed.
8. 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 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 be 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.
 6. Multiple belt drive motors shall use roller bearings rated for a service life of not less than 10 years while in continuous use at the highest rated motor speed and the maximum anticipated radial and thrust loadings both multiplied by a factor of 1.2.
- 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.
 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) Reliance Electric SXT-XT
 - 2) Westinghouse Mill and Chemical
 - 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

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
20	91.7	93.0	91.0
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
300	-	96.2	95.8
350	-	96.2	95.8
400	95.8	96.2	95.8
450	95.8	96.2	95.8
500	95.8	96.2	95.8

- b. The efficiency: as determined by the dynamometer test method, IEEE 112, Method B.
- c. Acceptable manufacturer:
 - 1) Reliance Electric Duty-Master XE
 - 2) Baldor Super-E
 - 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) Reliance Electric
 - 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 in Paragraph 2.03.C.4 of this Section.
8. Inverter Duty Motors:
 - a. The motors controlled by variable frequency drives (VFD): rated for inverter duty and must 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, Paragraph 31.4.4.2. 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 manufacturers:
 - 1) General Electric
 - 2) Reliance
 - 3) 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 must 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 must 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 06 21

MOTORIZED CONTROL VALVE SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies schedules for motorized control valves.
- B. Solenoid valves are not included in this section. Solenoid valves are specified in Section 40 05 82.

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. Procedure: 01 33 00
- B. If required, Cv documentation.

1.04 CONTROL VALVES

- A. Control valve information in the supplement is defined as follows:
 - 1. Control Valve Number: Assigned asset number as shown on the drawings and in the Asset Management system.
 - 2. Specification Section: Associated valve type specification section.
 - 3. Service: Identifies the process fluid designation (see Section 40 05 01) for the type of fluid the valve will be in contact with.
 - 4. Line Size and Cv: Open/close valves shall be sized for the line size shown and modulating valves shall be sized for the flows Cv value indicated. Valve size shall match line size except where Cv is listed. In those cases, a smaller valve may be supplied in order to meet the Cv requirement. Submit Cv documentation including effect of line size reductions. Document functional control range, 0 to 60 degrees, 0 to 90 degrees for disc style submitted with confirmation that actuator is compatibly adjusted.
 - a. Where the specific valve is smaller than the connected pipe, provide reducers/increasers.
 - b. Pressure drop across each valve for the purpose of actuator sizing shall be the test pressure for the service as listed on the PIPESPEC sheets in Section 40 05 01.
 - c. Cv values shall be as determined by ISI-SA 75.02.
 - 5. Actuator Type: Automatic actuator types (Type 1 through 8) are specified in Section 40 05 57.
 - 6. Shutoff Pressure (upstream): Is the maximum 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.
 - 7. Open/Close Time: Open/close time shall be adjustable and minimum stroke time in accordance with Section 40 05 57. Initial setting shall be as listed.
 - 8. Enclosure: Allowable rating shall be one of the following:
 - a. NEMA 4 – Weatherproof
 - b. NEMA 4X – Weatherproof and Corrosion Resistant

- c. NEMA 6 – Submersible
 - d. NEMA 7 – Explosion proof
9. Failure Position:
- a. FC = Fail Closed
 - b. FO = Fail Open
 - c. FLP = Fail Last Position
 - d. For Type 5 and 6 actuators failure position shall be either FC or FO.

1.05 CONTROL VALVE SCHEDULE

CONTROL VALVE NUMBER	SPEC	SERVICE	LINE SIZE (IN)	CV	ACTUATOR NUMBER	OPERATOR TYPE	SHUTOFF PRESSURE (PSI)	OPEN/CLOSE TIME (SEC)	ENCLOSURE	FAILURE POSITION
705-KGV12BI011	40 05 60	Dewatered Grit	36x36	N/A	705-KGV12BC011	2	N/A	60	NEMA 4X	CLOSED
705-KGV12BI021	40 05 60	Dewatered Grit	36x36	N/A	705-KGV12BC021	2	N/A	60	NEMA 4X	CLOSED

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION

SECTION 40 06 70

SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section describes the following schedules.
 - 1. Section 40 06 71: Instrument Schedule
 - 2. Section 40 06 73: PLC IO Schedule
 - 3. Section 40 06 76: SPCS IO 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.

PART 3 EXECUTION [NOT USED]

END OF SECTION

INSTRUMENT SCHEDULE

[illegible]

SECTION 40 06 73

PLC IO SCHEDULE

TAG NO	DESCRIPTION	SET:RESET	RANGE	ENG UNITS	PROCESS DWG	PLC DWG	MODULE TYPE	RACK:SLOT:POINT	NOTES
TBD	Washer/Stirrer 1 Control Power Fail	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 1 Call to Run	N/A	N/A	N/A	P6001	I7001	DO	TBD	Local - not to Ovation
TBD	Washer/Stirrer 1 Overcurrent	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Grit Screw 1 Control Power Fail	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Grit Screw 1 Call to Run	N/A	N/A	N/A	P6001	I7001	DO	TBD	Local - not to Ovation
TBD	Grit Screw 1 Overcurrent	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Organics Valve 1 Open Command	N/A	N/A	N/A	P6001	I7001	DO	TBD	Local - not to Ovation
TBD	Organics Valve 1 Close Command	N/A	N/A	N/A	P6001	I7001	DO	TBD	Local - not to Ovation
TBD	Grit Classifier 1 Emergency Stop	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Spray Wash Valve 1 Open Command	N/A	N/A	N/A	P6001	I7001	DO	TBD	Local - not to Ovation
TBD	Spray Wash 1 Flow Switch	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 1 Hi Level	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 1 Lid Open	N/A	N/A	N/A	P6001	I7001	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 Control Power Fail	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 Call to Run	N/A	N/A	N/A	P6001	I7002	DO	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 Overcurrent	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 On/Running	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Grit Screw 2 Control Power Fail	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Grit Screw 2 Call to Run	N/A	N/A	N/A	P6001	I7002	DO	TBD	Local - not to Ovation
TBD	Grit Screw 2 Overcurrent	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Grit Screw 2 On/Running	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Organics Valve 2 Open Command	N/A	N/A	N/A	P6001	I7002	DO	TBD	Local - not to Ovation
TBD	Organics Valve 2 Close Command	N/A	N/A	N/A	P6001	I7002	DO	TBD	Local - not to Ovation
TBD	Organics Valve 2 Closed	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Organics Valve 2 Open	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Grit Classifier 2 Emergency Stop	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Spray Wash Valve 2 Open Command	N/A	N/A	N/A	P6001	I7002	DO	TBD	Local - not to Ovation
TBD	Spray Wash 2 Flow Switch	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 Hi Level	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 Lid Open	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 2 Pressure	N/A	0-10	Feet	P6001	I7002	AI	TBD	Local - not to Ovation
TBD	Classifer 2 Ready (Interlock)	N/A	N/A	N/A	P6001	I7002	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 Control Power Fail	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 Call to Run	N/A	N/A	N/A	P6002	I7003	DO	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 Overcurrent	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 On/Running	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Grit Screw 3 Control Power Fail	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Grit Screw 3 Call to Run	N/A	N/A	N/A	P6002	I7003	DO	TBD	Local - not to Ovation
TBD	Grit Screw 3 Overcurrent	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Grit Screw 3 On/Running	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Organics Valve 3 Open Command	N/A	N/A	N/A	P6002	I7003	DO	TBD	Local - not to Ovation
TBD	Organics Valve 3 Close Command	N/A	N/A	N/A	P6002	I7003	DO	TBD	Local - not to Ovation
TBD	Organics Valve 3 Closed	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Organics Valve 3 Open	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Grit Classifier 3 Emergency Stop	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Spray Wash Valve 3 Open Command	N/A	N/A	N/A	P6002	I7003	DO	TBD	Local - not to Ovation
TBD	Spray Wash 3 Flow Switch	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 Hi Level	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 Lid Open	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 3 Pressure	N/A	0-10	Feet	P6002	I7003	AI	TBD	Local - not to Ovation
TBD	Classifer 3 Ready (Interlock)	N/A	N/A	N/A	P6002	I7003	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 Control Power Fail	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 Call to Run	N/A	N/A	N/A	P6002	I7004	DO	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 Overcurrent	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 On/Running	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Grit Screw 4 Control Power Fail	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Grit Screw 4 Call to Run	N/A	N/A	N/A	P6002	I7004	DO	TBD	Local - not to Ovation
TBD	Grit Screw 4 Overcurrent	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation

SECTION 40 06 73

PLC IO SCHEDULE

TAG NO	DESCRIPTION	SET:RESET	RANGE	ENG UNITS	PROCESS DWG	PLC DWG	MODULE TYPE	RACK:SLOT:POINT	NOTES
TBD	Grit Screw 4 On/Running	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Organics Valve 4 Open Command	N/A	N/A	N/A	P6002	I7004	DO	TBD	Local - not to Ovation
TBD	Organics Valve 4 Close Command	N/A	N/A	N/A	P6002	I7004	DO	TBD	Local - not to Ovation
TBD	Organics Valve 4 Closed	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Organics Valve 4 Open	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Grit Classifier 4 Emergency Stop	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Spray Wash Valve 4 Open Command	N/A	N/A	N/A	P6002	I7004	DO	TBD	Local - not to Ovation
TBD	Spray Wash 4 Flow Switch	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 Hi Level	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 Lid Open	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation
TBD	Washer/Stirrer 4 Pressure	N/A	0-10	Feet	P6002	I7004	AI	TBD	Local - not to Ovation
TBD	Classifer 4 Ready (Interlock)	N/A	N/A	N/A	P6002	I7004	DI	TBD	Local - not to Ovation

SPCS IO SCHEDULE

[illegible]

SECTION 40 41 00
HEAT TRACING FOR PROCESS PIPING

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 on a dedicated 20Amp circuit
- E. Maximum loading per heat trace controller shall not exceed 20A.
- F. Tracer tape shall be protected by a GFEPD (20 or 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 NEMA 4X 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: 20 amperes at 120V AC.
 2. Calibration tolerance: 2 degrees F.
 3. Sensor material: stainless steel.
 4. Exposure temperature: -65 to 140 degrees F.

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
C3 Water	2 in	O	5W/ft @ 50°F	15F -140F	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

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. Procedure: 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. Rigid insulation with aluminum jackets shall be used for outdoor piping.
- B. Insulation for 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 white kraft paper. 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. 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. Sheet metal screws shall be aluminum or stainless steel. Screws shall not be used for outdoor installations.
 - 3. 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.

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 need 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 insulation 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	140-200	1.5	1.5	2.0	2.0	2.0	2.0
C3	40-80	1.5	1.5	2.0	2.0	2.0	2.0

^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.

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 controls and monitoring automation within the existing Supervisory Process Control System (SPCS) Ovation Distributed Control System (DCS). The Emerson Ovation DCS are existing systems being modified with 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
UL 60947	Low Voltage Switchgear and Controlgear
King County	PLC and OIT Installation and Programming Requirements

1.03 SUBMITTALS

- A. Procedure: 01 33 00

- B. Provide the following submittals:
1. Catalog cuts of all furnished components and equipment.
 2. Fabrication drawings with keyed Bills of Materials. Furnish hard copy as well as electronic format.
 3. Seismic design information including a list of equipment weighing 400 pounds or more.
 4. Certifications.
 5. Factory test schedule and procedure including all test forms.
 6. Field test schedule and procedure including all test forms.
 7. Test Reports.
 8. 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.
 9. Elementary Drawings and Loop Diagrams: Electronic format.
 10. Connection Diagrams. Electronic format.
 11. Interconnection Diagrams. Electronic format.

1.04 QUALITY ASSURANCE

- A. Qualifications: The systems integration company which constructs and installs the process instrumentation and control system shall have the following minimum qualifications:
1. A single systems integration company regularly engaged in the design and installation of systems of similar scope and complexity.
 2. 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.
 3. A minimum of three years in the business of providing system integration.
 4. Completed the same type of work specified on at least five projects of equal or larger size.
 5. Has experience with working on plants with Ethernet (Modbus\TCP & Ethernet\IP) and DeviceNet.
 6. Local support within 50 miles of the work site.
 7. Has an electrical or controls engineer currently registered as a professional engineer in the state of Washington to supervise the work.
 8. The on-site Electrical or Control Systems engineer shall have a minimum of five years' experience installing wastewater control systems of similar scope and complexity.
- B. Labeling: New and modified electrical control panels shall be in conformance with UL 508A and shall bear the UL label.
- C. 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.
- D. Calibrate, configure, test, and start up the complete process instrumentation and control system.
- E. 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.
- F. 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: As defined in Section 01 75 20 and is represented in this Section as the "Factory Test" or "Factory Acceptance Testing".

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 valve actuators, instruments, motor control centers (MCCs) and equipment motor/drives. 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.

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 with King County.
 - b. King County 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 equipment/instrumentation provided Contractor.
 - c. 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. A Programmable Logic Controller, (PLC).
 - 7. Hardwired local control panels (LCP) including Operator Interface Terminal (OIT), conventional panel-mounted switches, controllers, recorders, and indicators; specific purpose panels, local control panels for individual equipment manual control. Manufactured and including the requirements of UL 508/UL 508A.
 - 8. Conventional field instrumentation including components such as primary elements, analyzers, indicating transmitters, level, flow, temperature, and pressure switches.
 - 9. Final control elements such as valve positioners and solenoids.
- B. The process control system interfaces with existing Emerson Ovation DCS drop panels, new 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 and as shown in the Contract Documents.
 - 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 a PLC used to control the process.
 - b. The second level is a backup automatic control system outside of the PLC.
 - c. The third level is the local control, sometimes automatic and sometimes manual.

4. In all cases, equipment shall have (as indicated on the Drawings), hand-off-remote or local/remove 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 "as-built" or record drawings of existing work 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 be updated to include 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. Procedure and submittals: per Section 01 73 00.
 2. Structures and equipment shall be braced to prevent damage from specified forces.
 3. Equipment shall not be required to function properly during periods of seismic disturbance, but shall be capable of manual restart without repair or modification following a disturbance.
- 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. 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.
- B. Location: Test within Washington State.
- C. The Project Representative may elect to witness the factory test. Provide a written test schedule and notify the Project Representative no less than seven days prior to the test.
- D. 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.
- E. 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.
- F. Correct deficiencies and retest prior to shipment of the equipment to the work site.
- G. Owner's programmers (Emerson Management Services) shall be responsible for Factory Acceptance Testing of the Emerson Ovation DCS software programming. Contractor shall Coordinate with the Owner's third-party SPCS Ovation programmer, Emerson Management Services, six months in advance of equipment startup.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
 - 1. Ship as a single unit to work site.
 - 2. Anchor and brace equipment weighing 400 pounds or more to resist seismic forces per UBC 1632. Seismic criteria for the work site are listed in Section 01 73 00.
 - 3. 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 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 tests beginning with the Factory Test, will be witnessed by the Project Representative or County-designated person unless a written exemption is provided.
3. Notify the Project Representative of the test date seven 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.

Test reports: Conform to the requirements of Forms below per Section 01 33 00 and ISA S20.

B. 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.

C. 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
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. 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. 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. Verify correct operation of the applicable annunciator window.
 - f. 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. Closed-loop test:

- a. Test shall demonstrate stable operation of the loop under actual Facility operating conditions. This test includes adjustment of loop tuning parameters and shall be witnessed by the Project Representative.
 - b. Unless otherwise specified, adjust tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop to provide $\frac{1}{4}$ -amplitude damping or better.
 - c. Prepare a chart recording showing loop response to a step disturbance for each loop.
 - d. Make two charts for cascade loops, one showing the secondary loop response with its set point on manual, and the second showing overall loop response.
 - e. Chart recordings shall be made at sufficient speed and amplitude to clearly show specified amplitude damping and shall be annotated to show loop number and title, and settings of parameters and set point.
8. SPCS system test:
- a. Coordinate with the Project Representative for the requirements of these tests.
 - b. Test both the PLC-to-Ovation connection and Ovation connection. Check both systems end-to-end from the field sensor location to the treatment plant control room.
 - c. Provide the services of a qualified technician for at least 24 labor-hours to assist in this test.
 - d. Check that the equipment is functioning correctly and as specified.
 - e. Check that all specified signals are telemetered and received at West Point Treatment Plant as required.
 - f. Check that all control signals are telemetered correctly from the treatment plant control room and the appropriate control action is observed on the field equipment.

END OF SECTION

SECTION 40 61 21

PLC AND HMI TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. All PLC and Human Machine Interface (HMI) installations shall be tested in accordance with the requirements of this Section.
- B. The Contractor shall demonstrate that each PLC system was fully tested during development and installation 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. The Contractor shall provide tests for all equipment and software. If equipment or software does not have specific tests defined in the contract, then the Contractor shall develop testing procedures. All software and all equipment related to the PLC shall be tested.

1.02 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Test Schedules: Per this Section and Section 01 75 20
 - 2. Test Plans: Per this Section and Section 01 75 20
 - 3. Test Results: Per this Section and Section 01 75 20

1.03 DOCUMENTATION

- A. Provide complete documentation of all test plans.

PART 2 PRODUCTS

2.01 TEST PLANS AND REPORTS

- A. Prepare and submit for review and approval:
 - 1. Factory Acceptance Test Plan and procedures
 - 2. Site Acceptance Test Plan and procedures
 - 3. Test Schedules
 - 4. Test Reports
 - 5. PLC and HMI program documentation
- B. Prepare and document a separate test plan for each of the Factory Acceptance Test and Site Acceptance Test. The test procedures shall be a formal submittal delivered to King County for review and approval before the start of the test.
- 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 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 TEST

- A. Factory Acceptance Test (FAT) and verification for all deliverable equipment, programs, and associated documentation shall be performed prior to shipment of the system to the site. The tests shall verify that the PLC equipment is manufactured and assembled correctly, is operating as designed, and is in compliance with the contractual requirements. The tests shall verify that the software and hardware meet the functional and performance requirements of the project.
- B. The Factory Acceptance Test shall include the following major test and verification activities:
 - 1. System Configuration Verification: Prior to beginning of the Factory Acceptance testing, the system shall be subjected to system deliverable configuration verification. A copy of the configuration and record of quantities of part numbers are to be included in the Factory Acceptance Test Report. No equipment replacement or substitutions are permitted without rigorous quality control accounting and retesting of affected equipment.
 - 2. Equipment Test and Verification: The FAT for the equipment consists of visual inspection and verification that the equipment is assembled in accordance with the approved drawings. All hardware enclosures shall be verified to determine the structural integrity. Inspect and verify the following at a minimum:
 - a. Mounting configuration
 - b. Paint work and finish
 - c. Dimensions
 - 3. Verify the following wiring and connections at a minimum:
 - a. Wire in terminal block, including correct connection and labeling, wiring installation and wire stripping.
 - b. Cable runs, including correct connection and labeling, supports, routing, shielding, wire-way design, and terminal security.
 - c. Fuse and breakers for correct rating and placement
 - d. Grounding strips, including layout, cables, connection security, and correct size.
 - 4. Perform the following inspection checks:
 - a. Card wiring support
 - b. I/O rack clearances
 - c. I/O and equipment labeling
 - d. I/O card type verification
 - e. I/O card layout
 - f. Power supply mounting
 - g. Power cable routing
 - h. Data cable routing.

5. Functional Test:

Exercise every specified system function and include the following at a minimum:

- a. Rigorously exercise all inputs and outputs both individually and collectively.
- b. Demonstrate analog input and analog output accuracy.
- c. Test all HMI functions.
- d. Verify all control operations to ensure they result in the correct sequence of operation at the PLC.
- e. Simulate PLC communication error conditions and demonstrate error detection and handling.
- f. Demonstrate PLC power supply failure and recovery.
- g. Provide certified test results for the deliverable equipment.
- h. Demonstrate correct calculation of totalized quantities.
- i. Demonstrate proper operation of application programs and control strategies using whatever simulations are necessary. The test shall include typical and worst case scenarios that would arise in the use of the system.

- C. The system may be shipped to the site only after the Factory Acceptance Test has been completed satisfactorily and approved by the Project Representative.

3.02 SYSTEM TEST PHASE - SITE ACCEPTANCE TESTING

A. Communications Test: Connect the PLC inputs to the facility.

1. Demonstrate the following:

- a. Proper communications to the SCADA system.
- b. Accurate bi-directional data transfer of all required analog and discrete signals between the PLC and the SCADA system.
- c. Test duration shall be a minimum of three 24-hour days.

B. Demonstrate the followings:

1. Conformance with 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 the PLC control outputs (valve, motor, etc.) and demonstrate PLC or manual control and correct status indication on the Operator Interface Terminal and SCADA system.
5. Status Inputs: Exercise each individual facility system component connected to the PLC (motors, valves, etc.) and demonstrate correct status indication on the Operator Interface Terminal and SCADA system.
6. Alarm Inputs: Exercise each alarm input to the PLC from the field device and demonstrate correct indication on the HMI and SCADA system.
7. Alarm Outputs: Exercise each alarm output from PLC and demonstrate correct indication on Annunciator, SCADA and/or Metrotel.
8. Computed Alarms: Demonstrate computed alarms in the PLC and correct indication on Operator Interface Terminal and SCADA system.

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. Procedure: 01 33 00
- B. Provide the following submittals:
1. Dimensional Drawings.
 2. Catalog Cuts including performance parameters.
 3. Installation Information.
 4. Wiring Diagrams.
 5. 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.
 - 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. Sola SDN-P Series.
 - b. PULS Q-Series.
 - c. 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. PULS YRM.
 - b. Delta CliQ DRR.
 - c. 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 1

PART 1 GENERAL

1.0 SUMMARY

1.1 REFERENCES

- A. P&ID's: P6001 & P6002
- B. Related Control Strategies: See Section 46 23 63
- C. Control Diagrams:
- D. Instrument Loop Diagrams:
 - 1. Grit Classifier #1: See drawing I7001
 - 2. Grit Classifier #2: See drawing I7002
 - 3. Grit Classifier #3: See drawing I7003
 - 4. Grit Classifier #4: See drawing I7004
 - 5. Grit Hopper Knife Gate Valves: See drawing I7005
- E. Instrument Index, Alarm Schedule, PLC I/O List.
- F. I/O Schedule: See Section 40 06 76

1.2 SYSTEM DESCRIPTION

- A. This control strategy describes the control of the grit classifier equipment. There are four grit classifiers that are controlled by a packaged vendor-supplied control system.
- B. Status and monitoring in the existing Supervisory Process Control System (SPCS) Emerson Ovation system, as well as interlocks with grit pumps, shall be programmed Emerson Process Management (under contract directly with the Owner).

1.3 EQUIPMENT

For full list of asset numbering see Specification Section 01 78 40 (including washer solenoid valves, pressure sensors, high level sensor).

EQUIPMENT NO.*	EQUIPMENT NAME/DESCRIPTION
705-ME12BH011	Grit Dewatering Screw No. 1
705-ME12BH021	Grit Dewatering Screw No. 2
705-ME12BH031	Grit Dewatering Screw No. 3
705-ME12BH041	Grit Dewatering Screw No. 4
705-ME12BH012	Grit Washer Stirrer No.1
705-ME12BH022	Grit Washer Stirrer No.2
705-ME12BH032	Grit Washer Stirrer No.3
705-ME12BH042	Grit Washer Stirrer No.4
705-ACT12BH011	Motor Operated Organics Drain Valve No. 1
705- ACT12BH021	Motor Operated Organics Drain Valve No. 2
705- ACT12BH031	Motor Operated Organics Drain Valve No. 3
705- ACT12BH041	Motor Operated Organics Drain Valve No. 4

1.4 ALARMS

A. Alarm Schedule

DESCRIPTION	ANNUNCIATOR ¹	PLC/SPCS
Classifier #1 Wash Water Fail		X
Classifier #1 Stirrer Fault		X
Classifier #1 Grit Screw Fault		X
Classifier #1 Organics Valve Fault		X
Classifier #2 Wash Water Fail		X
Classifier #2 Stirrer Fault		X
Classifier #2 Grit Screw Fault		X
Classifier #2 Organics Valve Fault		X
Classifier #3 Wash Water Fail		X
Classifier #3 Stirrer Fault		X
Classifier #3 Grit Screw Fault		X
Classifier #3 Organics Valve Fault		X
Classifier #4 Wash Water Fail		X
Classifier #4 Stirrer Fault		X
Classifier #4 Grit Screw Fault		X
Classifier #4 Organics Valve Fault		X

Note 1. Alarm indicator lights for all classifiers shall be displayed on vendor supplied control panel (as specified in 46 23 63 and shown on the drawings) and I/O fault signals shall be displayed through Ovation.

1.5 INTERLOCKS

A. Each Classifier will have the following interlocks:

1. The stirrer, grit screw, organics valve, and wash water selector switches must all be in the auto position for the grit washer to function in the auto mode.
2. If the stirrer, grit screw, or organics valve are faulted, the stirrer, grit screw, organics valve, and wash water will not function in the auto mode.
3. If the Grit Washing Equipment ready signal is not received, the five grit feed pumps (five per classifier) shall be stopped.
4. The organics valve will never be open while the grit screw is operating. If the grit screw is called to run while the organics valve is opened, the organics valve will close immediately.
5. The E-STOP push button will turn off the stirrer, grit screw, organics valve, and wash water.
6. The inspection door (open signal) will turn off the stirrer, grit screw, organics valve, and wash water.

B. Each classifier will have the following faults/interlocks:

1. Stirrer Motor Overload: when the stirrer motor overload is tripped the stirrer and grit screw will stop immediately, the organics valve will close, and the stirrer overload light will be energized.
2. Stirrer Overload Shutdown: if a high current is measured, the stirrer and grit screw will stop immediately, the organics valve will close, and the stirrer overload light will be energized.
3. Grit Screw Motor Overload: When the grit screw motor overload is tripped, the stirrer and grit screw will stop immediately, the organics valve will close, and the grit screw overload light will be energized.
4. Grit Screw Overload Shutdown: if high current is measured, the stirrer and grit screw will stop immediately, the organics valve will close, and the grit screw overload light will be energized.
5. Organics Valve Close: If the organics valve is called to close and does not reach the closed position within the time set in the organics valve fault timer, the stirrer and grit screw will stop immediately and the organics valve fault light will be energized.

6. Organics Valve Open: if the organics valve is called to open and does not reach the open position within the time set in the organics valve fault timer, the stirrer and grit screw will stop immediately and the organics valve fault light will be energized.
7. All above faults can be reset by pressing the system reset pushbutton.

1.6 CONTROL OPERATION

A. CONTROL POWER ON-DELAY:

1. Each time the power supply to the control panel is cycled, the PLC will allow all solid state devices to become fully energized.

B. MODES OF OPERATION:

1. Stirrer Modes of Operation:
 - a. HAND: When stirrer H-O-A selector is in the HAND position, the stirrer will run continuously.
 - b. AUTO: When stirrer H-O-A selector is in the AUTO position, the stirrer will operate per the Auto Sequence detailed below.
2. Grit Screw Modes of Operation:
 - a. HAND: When grit screw H-O-A selector is in the HAND position, the grit screw will cycle on and off with the grit screw FOR-OFF-REV selector.
 - b. FOR (Forward): When the grit screw selector is in the hand position and the forward direction is selected, the grit screw will cycle continuously in the forward direction.
 - c. REV (Reverse): When the grit screw selector is in the hand position and the reverse direction is selected, the grit screw will cycle in the reverse direction. This switch will spring return from REV to OFF.
 - d. AUTO: When grit screw H-O-A selector is in the AUTO position, the grit screw will operate per the Auto Sequence detailed below
3. Organics Valve Modes of Operation:
 - a. OPEN: When organics valve selector is in the OPEN position, the organics valve will remain open.
 - b. CLOSED: When organics valve selector is in the CLOSED position, the organics valve will remain closed.
 - c. AUTO: When organics valve selector is in the AUTO position, the organics valve will operate per the Auto Sequence detailed below.
4. Wash Water Solenoid Valve Modes of Operation:
 - a. HAND: When wash water selector is in the HAND position, the wash water will run continuously.
 - b. AUTO: When wash water selector is in the AUTO position, the wash water will operate per the Auto Sequence detailed below.

C. GRIT SYSTEM AUTOMATIC CYCLE

1. The grit washer will start in automatic cycle based on the following two conditions:
 - a. One or more of the grit feed pumps (five grit pumps per washer) has a sent a running contact signal.
 - b. A call to run has been received from Ovation.
2. The grit pump running and Ovation call to run contact must be maintained for a time set in the grit cycle on-delay timer before the grit system will start an automatic cycle.
3. WASH WATER:
 - a. The wash water will start to run once the automatic feeding cycle starts.
4. STIRRER:
 - a. When the automatic feeding cycle starts, the stirrer will start to run once the stirrer on-delay timer reaches its setpoint.
5. PRESSURE SENSOR:
 - a. The pressure sensor will be activated once the automatic feeding cycle starts and stays active through the entire feeding cycle.
6. GRIT SCREW:

- a. The grit screw will start to run once the grit level, as measured by the pressure sensor, rises and stays above the grit density start setpoint for the time set in the start level debounce timer.
 - b. Once the grit screw is called to run, the screw will cycle on and off, on time first, per the setting of the repeat cycle timers.
 - c. The on off cycles of the screw will continue after the grit density falls below the stop setpoint for the time set in the low level debounce timer.
7. ORGANICS VALVE:
- a. When the automatic feeding cycle starts, the organics valve will close if not already closed and the organics valve open-delay timer will begin timing.
 - b. Once the valve open-delay timer reaches its setpoint, the organics valve will open.
 - c. The organics valve will remain open for the time set in the duration timer.
 - d. Once the open duration timer has reached its setpoint, the organics valve will close.
 - e. This cycle may be repeated as required during the feeding cycle.
 - f. Note: organics valve will never be open while the grit screw is operating. If the grit screw is called to run while the organics valve is opened, the organics valve will close immediately.
- D. GRIT SYSTEM AUTOMATIC SHUTDOWN CYCLE
- 1. Once the grit feeding has stopped, the system will go into a shutdown cycle. During the shutdown cycle, the remote start signal will no longer be received.
 - a. Stirrer: the stirrer will continue to run after the organics valve completes its final cycle for the time in the stirrer off-delay timer.
 - b. Wash Water; the wash water will remain on until the stirrer motor shuts off.
 - c. Pressure Sensor: pressure sensor will remain active for the time set on the pressure sensor off-delay timer. Once the time has expired, the sensor will be de-activated.
 - d. Grit Screw: Screw will continue to operate per the feeding cycle sequence of operation, as long as the pressure sensor is active. Once the screw begins its cycle, the pressure switch will remain active until its cycle is complete.
 - e. Organics Valve: Valve will open once pressure sensor becomes de-activated. Valve will remain open for preset time. Once time has elapsed, valve will close.
- E. CONTINUOUS FEED MODE
- 1. Operators may change from normal to continuous feed mode from the HMI.
 - 2. During continuous feed mode, the wash water and stirrer will both cycle per repeat cycle on and off timers. Pressure sensor, grit screw, and organics valve will run as noted in the automatic feeding cycle.
 - 3. Once feed signal from pumps or Ovation has been removed, the system will operate as described in the grit system automatic shut down cycle.
- F. EMERGENCY STOP
- 1. The stirrer, grit screw, organics valve and wash water will stop immediately and the control power on light will be de-energized if any of the e-stop pushbuttons are pressed or the inspection door is opened.
 - 2. Once the reset button is pressed and the inspection door is closed, the system will cycle back to auto mode.
- G. HMI INFORMATION
- 1. The HMI will display all elapsed motor run times
 - 2. All adjustable setpoints can be accessed and adjusted through the HMI
 - 3. The present fault(s) will be displayed on the HMI
 - 4. The history of all past faults can be accessed through the HMI
 - 5. The present level of grit will be displayed on the HMI

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. Provide the following submittals:
1. Dimensioned front view drawings.
 2. Dimensioned internal equipment layout drawings.
 3. Panel assembly drawings shall include sections showing clearances between face and rear mounted equipment and keyed Bills of Materials.
 4. Nameplate engraving schedule showing engraving by line, character size, and nameplate size.
 5. Enclosure manufactures' drawings.
 6. Panel seismic calculations.
 7. Panel wiring diagram for each panel. The diagram shall meet the requirements as set forth in the NFPA 79 Electrical standards for industrial machinery.
 8. 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. 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. Ovation Modbus TCP Communication
1. Provide Cat 6 cabling and Ethernet communication from each local control panel controller to existing network switch in Ovation control panel.
 2. Configure controller/PLC for exchange of data with Ovation via Modbus TCP.
 3. Provide a list of each Modbus TCP point with point description and Modbus address for all points defined in drawings at a minimum.
- E. Panel Schedule. Refer to Divisions 11 through 16 for additional panels which may cross-reference Div. 17 for panel requirements.

PANEL NUMBER	DESCRIPTION	NEMA RATING
705-FP1207	Local Control Panel – Classifier #1 / #2	NEMA 4X
705-FP1208	Local Control Panel – Classifier #3 / #4	NEMA 4X
705-PNL12BC011	Local Control Panel – Knife Gate Valves	NEMA 4X

PART 2 PRODUCTS

2.01 MATERIALS AND QUALITY

- A. General:
1. Panel work shall be designed for seismic requirements per Section 01 73 00.
 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 paragraph 40 67 00-2.03.E.
 4. Nameplates shall identify face-mounted instruments per paragraph 40 67 00-2.03A.
 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.
- A. 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.
 - B. 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 or 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.
 - C. Fabrication of NEMA 7 Cabinets: NEMA 250, Type 7 suitable for Class I, Division 1, Group D classified area and assembled and installed to maintain this rating.

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. 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.
- C. Do not insulate outdoor or below grade enclosures and provide with thermostatically controlled space heaters.
- D. 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.
- E. If space heater surface temperature exceeds 122° F (50° C), provide an expanded metal guard.
- F. 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.
- G. 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 or 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.
- F. Programmable Logic Controller
1. CPU Module
 - a. 2 MB non-volatile memory, minimum
 - b. 1 USB client port
 - c. 2 Ethernet ports
 2. Power Supplies
 - a. Output power sufficient for module load plus 20%.
 3. Local I/O Modules
 - a. Installed to the right of controller module
 - b. Communication and power through backplane
 - c. Include removable terminal blocks
 - d. I/O types as required plus 10% spare
 4. Ovation Communication Interface
 - a. Modbus TCP
 - b. Dedicated interface module or utilize controller Ethernet port
 5. Manufacturer, Model
 - a. Allen-Bradley, CompactLogix 5380
 - b. or Approved Equal
- G. Human Machine Interface (HMI)
1. Touchscreen color display, minimum 10"
 2. Compatible with selected controller
 3. Ethernet communication
 4. Conformally coated
 5. Manufacturer, Model
 - a. Allen-Bradley, PanelView Plus 7 Performance
 - b. Or Approved Equal
- H. Fiber Media Converter
1. Converts Ethernet communication between multimode fiber optic and cat 6 cables
 2. SC or ST connector options
 3. DIP Switch configurable

4. Operating Temperature: 32 to 113°F
5. Control panel mounted
6. Manufacturer, Model
 - a. EtherWAN, EL100T
 - b. Or Approved Equal

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 70

PLC AND OIT PROGRAMMING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the requirements for programming the PLC and Human Machine Interface (HMI) units in the grit classifier control panels. Operations Interface Terminal (OIT) and HMI are equivalent terms in this specification.
- B. Provide fully operational PLC and HMI Systems for the grit process. The operation of the process under PLC and HMI control and operation shall be as per the Contract Drawings and the Control Strategies as defined in Sections 40 65 01.
- C. Be fully cognizant of Allen-Bradley Ladder Logic programs and include all those functions that are required to operate and monitor the facilities using the PLC.
- D. The Contractor shall be responsible for performing the detailed design and programming of the PLC equipment and shall have a minimum of five (5) years' experience in similar projects. The Contractor shall assume full responsibility for system design.

1.02

1.02 SUBMITTALS

- A. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Software Submittals 30%, 60%, and 90% per PLC programming development Section.
 - 2. Final Software Submittal (100%) with O&M manuals.
 - 3. Software programming shall include:
 - a. I/O, program, and SCADA databases; block diagrams of logic sequence; PLC program with fully commented ladder logic; and all support information necessary for review.
 - b. Submit USB thumb drive. All programs shall be submitted to Project Representative for review. Submitting just the program on electronic media is unacceptable.
 - c. Provide documented Studio 5000 program (.acd) and program listing in PDF format with all submittals.

1.03 PROGRAMMING SOFTWARE

- A. Utilize Rockwell Automation Studio 5000 Standard Edition Programming Software, King County approved version - No exception.

1.04 DOCUMENTATION

- A. Provide complete documentation of all programs. Utilize all of the available documentation services available through the Studio 5000 Programming Software. All application programs shall be fully commented. Program databases shall be fully expanded and shall include a comments field.
- B. All PLC programs shall be fully documented. Include references to drawings, original rung comments and requirements defined in the King County's latest "PLC and HMI Installation and Programming Requirements" document.

1.05 PROGRAMMING LANGUAGE

- A. King County has standardized on Ladder Logic language for programming the PLC. All programs shall utilize Ladder Logic language and Studio 5000 programming software. In addition, Function Block Language may be used sparingly for analog signal processing with written permission from King County. Specifically, forbidden are the use of Structured Text language and Sequential Function Charts without written permission from King County. Time spent by the Contractor to correct programming that is not compliant with the programming software and programming language defined in this Section will be at the Contractor's expense and shall not affect the project schedule or milestone dates.

1.06 SOFTWARE REVISIONS

- A. Provide a formal revision tracking procedure for all software being submitted and delivered to the Project Representative after the Factory Acceptance Test. 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 to 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 PLC for delivery.

1.07 SCADA COMMUNICATIONS

- A. The PLC shall communicate with the Ovation system via Modbus TCP. The PLC shall connect to the Ovation network through an Ethernet Cat 6 cable.
- B. All input/output (I/O) points must be capable of being transmitted to the Ovation system whether or not they are utilized.
- C. Organize the Modbus TCP registers as defined in King County's latest "PLC and OIT Installation and Programming Requirements" document. Coordinate addresses with the King County system maintenance staff.

1.08 SOFTWARE FUNCTIONS

- A. Provide PLC programs capable of performing the following functions at a minimum:
 - 1. Analog input processing and conversion to engineering units
 - 2. Discrete input processing for alarms and interlocks
 - 3. Discrete output processing for Alarm generation to local annunciators and other equipment
 - 4. Real-time clock for scheduling of control functions and tasks
 - 5. Display of process data on HMI
- B. Provide HMI programming that allows adjustment of loop setpoints, timer and counter presets, and loop tuning parameters.

PART 2 PRODUCTS

2.01 PROGRAMS

- A. Provide each of the facilities defined by the Contract Documents with a fully functioning program that is without error, does not perform abnormal stops or actions, and is fully documented.

- B. HMI graphic displays shall include both text and simple graphical representations of the facility. Refer to Appendix D of King County's latest "PLC and OIT Installation and Programming Requirements" document for structure of screen displays and color standards.

2.02 PLC PROGRAM DEVELOPMENT

- A. Provide a schedule showing program development tasks including milestones. The schedule shall include the following steps as a minimum:
 - 1. Preliminary Software Submittal (30%)
 - 2. Intermediate Software Submittal (60%)
 - 3. Operational Software Submittal (90%)
 - 4. Final Software Submittal (100%)
- B. Provide a Preliminary Software Submittal (30%) including:
 - 1. Detailed database and program structure information.
 - 2. Variables List and I/O configuration printouts: Shows organization of memory usage.
 - 3. Complete List of Tags and Descriptors for I/O points, internal variables, and SCADA communications data
 - 4. Key to program sections in the long comments of the Main Task.
 - 5. Program Block diagram - with keyed long comments on Sub-tasks and Routines.
 - 6. List of proposed display screens for OIT and sketches of layout for display screens.
 - 7. Develop basic program organization, structure and documentation, including block diagram, using King County's latest "PLC and OIT Programming and Installation Requirements" document.
 - 8. Draft Functional Descriptions.
- C. Submit an Intermediate Software Submittal (60%) including draft coding all of the following items:
 - 1. For PLC programming, submit the items below in electronic media format, compatible with Studio 5000 software King County approved version.
 - a. Discrete Alarms and Interlocks
 - b. Analog inputs and alarms
 - c. PID loops
 - d. Equipment sequencing and control logic
 - e. Runtime accumulators and flow integrators
 - f. SCADA Interface logic
 - g. Watchdog timer and Facility controls failover logic
 - h. Power-fail and Power-on restart logic
 - i. 100% Functional Descriptions
 - 2. For HMI programming, submit the items below as hard copy screen captures and in electronic media format compatible with Factory Talk View Studio ME software – King County approved version.
 - a. System Overview Graphic screens
 - b. Setpoint and Data Entry screens
 - c. Alarm History screens
 - d. Control Mode & Equipment Status screens
 - e. Maintenance screens
 - 3. Approved 60% Submittal shall be the basis for Factory Acceptance Test.
- D. Submit program and documentation when 90% complete. Documentation shall be in accordance with PLC Program Documentation of this Section and include:
 - 1. Final draft of the PLC program and HMI graphics in original file format in electronic media.
 - 2. Final draft of the PLC program in the PDF file format and PDF of the HMI graphics in electronic media.
 - 3. Approved 90% Submittal shall be the basis for the Site Acceptance Test.
- E. Final software submittal (100%): Submit programs and documentation incorporating modifications from Site Acceptance Test and/or commissioning as part of O&M manuals.

2.03 PLC PROGRAM DOCUMENTATION

- A. Program documentation shall be in accordance with King County's latest "PLC and HMI Installation and Programming Requirements" document.
- B. Provide complete descriptors for all elements used in the programs. This includes:
 - 1. Inputs
 - 2. Outputs
 - 3. Coils
 - 4. Contacts
 - 5. Tasks and Routines
 - 6. Data Structures
 - 7. Tables and Arrays
 - 8. Sections
- C. Fully utilize all descriptor fields provided by the programming software, including:
 - 1. Tags and Aliases
 - 2. Descriptions
 - 3. Comments
 - 4. Titles
- D. Provide clear and concise tags for all active components within a rung of logic. Tags shall be descriptive in nature. Provide narrative in Rung, Task, and Routine comments fields for complex rungs of logic or where the function is not readily understood without clarification.
- E. Use cross-references. Label all coils with descriptive tag names. Label rungs according to function and equipment tag name. Label all input contacts with the equipment tag name.
- F. Allen-Bradley programming version shall be as stipulated by Project Representative.
- G. Programs shall be fully documented and an electronic copy shall be provided to Project Representative as a submittal demonstrating compliance to the full documentation requirements. Electronic copy shall include:
 - 1. Tags
 - 2. Descriptors
 - 3. Program, Task and Routine Comments
 - 4. Titles
 - 5. I/O Rack configuration
 - 6. Communications Interface Configurations
 - 7. Listing of Data structures and ASCII message tables

PART 3 EXECUTION

3.01 PROGRAM INSTALLATION

- A. When a facility is operating under PLC control, edits to the PLC software shall comply to 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 PLC. The Project Representative shall be present at the facility when changes are downloaded to the PLC.
 - 3. All programming changes shall be downloaded locally, not remotely transmitted .
 - 4. Install electrical equipment or devices together with all required interconnections.
 - 5. All documentation, drawings, copies of the program and narratives shall be revised by the Contractor to reflect the edits to the program.

3.02 PROGRAM TESTING

- A. Test programs in accordance with Section 01 75 20 and 40 61 21.

3.03 TRAINING

- A. Provide twenty-four (24) hours of training for the County's personnel on all aspects of design, operation and maintenance of the PLC and HMI applications programs and Control Strategies.
- B. Provide training at a County facility specified by the Project Representative at a time mutually agreed between the Contractor and the Project Representative.
- C. Notify the Project Representative at least two weeks prior of the proposed training date.
- D. Complete forms 01 79 00-A and 01 79 00-B included in Section 01 33 10 at the end of Startup and Training. Submit the forms to the Project Representative for approval.

END OF SECTION

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.
- B. Equipment List: See Instrument Schedule in Section 40 06 71.

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. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Catalog cuts and product data per Section 40 61 13.
 - 2. Calibration and test data per Section 40 61 13.
 - 3. Flow calculation for each differential-type flow element.
 - 4. Operation and Maintenance information per Section 01 78 23.

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 manufacturers:
 - 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 manufacturers:
 - 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 manufacturers:
 - a. Anderson Greenwood M5 AVS-44.
 - b. Hoke 6802L8Y.
 - c. Approved Equal.
- D. Manifolds:
1. Three-valve bar-stock type.
 2. Body: 316 SS
 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 tap: 1/8-inch NPT shall be furnished on manifolds where water purge is specified on Drawings.
 7. Acceptable manufacturers:
 - 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 manufacturers:
 - 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: 100 series
 - 3. Unless otherwise specified, fill fluid shall be DC200 silicone oil.
 - 4. Acceptable manufacturers:
 - 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: 316L SS
 - 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. Factory filled and assembled.
 - 6. Acceptable manufacturers:
 - a. Ashcroft Series 80, No substitutions.

2.04 BUSHINGS AND THERMOWELLS

- A. Comply with SAMA PMC17-10.
- B. Unless otherwise specified, machined from 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. 304 stainless steel body.
 - b. 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. 316 stainless steel body.
 - c. Viton diaphragm.
 - d. 316 stainless steel ball valve.
 - e. 316 stainless steel springs.
 - f. Stainless steel regulator piping.
 - g. Maximum pressure rating 200 psi.
 - h. Maximum differential pressure rate 100 psi.
 - 4. Acceptable manufacturers:
 - 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 manufacturers:
 - 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 FLOW STRAIGHTENING VANES

- A. Acceptable manufacturers:
 - 1. Apollo Engineering Co.
 - 2. Daniel Industries Model 1106F.
 - 3. Approved Equal.

2.07 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 manufacturers:
 - a. Gates Corporation, Premo Flex®.
 - b. Approved Equal.
- B. Hose Clamps:
 - 1. All 300-series stainless steel.
 - 2. Lined.
 - 3. Liner and mechanical housing mechanically interlocked, no spot welds.
 - 4. Designed for use with silicone hose.
 - 5. Marine grade.
 - 6. 9/16-inch wide band.
 - 7. Slotted hex head screw.
 - 8. Acceptable manufacturer:
 - a. Grainger series 54235K.
 - b. Approved Equal.

2.08 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

- A. General requirements for primary elements specified in this Section are listed on INSTRUSPEC sheets in this Section.

2.09 INSTRUSPEC SHEETS

- A. The following INSTRUSPEC sheets are included in this Section:

SYMBOL	INSTRUMENT DESCRIPTION	INSTRUMENT FUNCTION
FVA	Rotameter	Flow Measurement

SYMBOL	INSTRUMENT DESCRIPTION	INSTRUMENT FUNCTION
PG	Pressure gage	Pressure 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:	PG
Instrument Description:	Pressure gage
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.

PART 3 EXECUTION

3.01 INSTALLATION

A. Process Connections:

- a. Unless otherwise specified, process taps shall comply with API RP550.
- b. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps.
- c. Arrange, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels.
 - 1) Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
 - 2) 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:
 - a. 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.
 - b. 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
 - c. 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:
 - a. 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.
 - b. Flexible or rigid transmission lines:
 - 1) Bubbler tubing shall be supported to prevent sagging or other low points that may block flow or prevent drainage.
 - 2) Bubbler tubing shall be continuous (e.g. without cuts, breaks, fittings) between the bubbler panel and air discharge point.
 - 3) 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.
- B. Equipment List: See Instrument Schedule in Section 40 06 71.

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. Procedure: 01 33 00
- B. Provide the following submittals:
 - 1. Catalog cuts and product data per Section 40 61 13.
 - 2. Calibration and test data per Section 40 61 13.
 - 3. Operations and Maintenance information per Section 01 78 23.

PART 2 PRODUCTS

2.01 GENERAL

- A. Unless otherwise specified, transmitters shall comply with the following requirements:
 - 1. Load variations within the range of 0 to 500 ohms with the power supply at 24 volts DC.
 - 2. Output shall be galvanically isolated.
 - 3. 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.
 - 4. Output shall increase with increasing measurement.
 - 5. When located outdoors, provide with surge protectors: Rosemount Model 470A or approved equal.

2.02 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.

2.03 INSTRUSPEC SHEETS

A. The following INSTRUSPEC sheets are included in this Section:

SYMBOL	INSTRUMENT DESCRIPTION	INSTRUMENT FUNCTION
PDT	Differential pressure transmitter	Pressure Measurement

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:	<ol style="list-style-type: none">1. Pressure transmitter shall be capacitance or Silicon piezo-2. Resistive bridge type.3. Wetted parts: 316 SS unless otherwise specified in 40 06 714. Fill fluid shall be DC 200 Silicone oil5. Adjustable damping time: 0.5 to 10 seconds6. External zero adjustment7. Accuracy: ± 0.1 percent of span.8. Provide differential pressure transmitters with a three-valve manifold per Section 40 61 13 and 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:	<ol style="list-style-type: none">1. Rosemount – Emerson Process Management. No substitutions.
Execution:	
Installation:	<ol style="list-style-type: none">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.

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 78 00

PANEL MOUNTED INSTRUMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes 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. Procedure: 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

INSTRUMENT SPECIFICATION SHEET—INSTRUSPEC

INSTRUMENT IDENTIFICATION:	XXS
Instrument Description:	Selector Switch
Instrument Function:	Operator Interface
Power Supply:	120 VAC, 60 Hertz
Signal Input:	N/A
Signal Output:	Contact
Process Connection:	N/A
Product Requirements:	<ol style="list-style-type: none"> 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:	Senasys Inc., Series CMC; to match existing. 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:	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; to match existing. 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.

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 41 22 13.16

PORTABLE GANTRY CRANE AND HOISTS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies adjustable portable gantry cranes with hand operated ultra low-profile trolley and chain hoist.

B. Equipment List:

EQUIPMENT	EQUIPMENT NO.
Crane	705-C12BH011
Hoist	705-H12BH011

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 B30.2	Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.17	Cranes and Monorails (with Underhung Trolley or Bridge)
ASME B30.16	Overhead Hoists (Underhung)
CMAA	Crane Manufacturer's Association of America
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

2.

A. Design Requirements:

3.

Gantry shall be adjustable in height (adjustable in 6-inch increments) and have center castings for brace leg attachment to main support legs.

4.

Gantry shall be adjustable in span, so that operators may adjust the crane to an inboard braced, outboard braced, or combination of the two configuration.

Gantry shall be adjustable in caster frame spread and have aluminum casting for attachment of casters.

The steel I-beam shall have a design deflection limit of no greater than 1/800 of span. I-beams shall be free swinging and self-aligning to lift off-center loads.

B. Performance Requirements:

	Equipment # 705-C12BB001 & 705-H12BB001
Capacity, Ton	2
Bridge beam clear span, feet:	15
Bridge beam length, feet	20
Caster frame spread, feet (max/min)	10 / 6
Overall height, feet (max/min)	12.67 / 8.17
Trolley height, inches	11.4
Headroom (distance from beam to hook), inches	5.7
Vertical lift, feet	13

1.04 SUBMITTALS

A. Procedure: 01 33 00

B. Provide the following submittals:

Manufacturer's drawings of the gantry crane.

Manufacturer's catalog data for bridge beam, ultra-low profile trolley, and hoist confirming rated capacity, structural requirements, and compliance with HMI and CMAA standards.

1. Manufacturer's experience per paragraph 1.05.

2. All applicable operation and maintenance information specified in Section 01 78 23.

3. Manufacturer's certification of installation with form 43 05 01-A in Section 01 33 10.

4. A written report describing the results of the field testing specified in the paragraph 3.02.

5.

6.

1.05 QUALITY ASSURANCE

A. The gantry 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.

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.

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 MANUFACTURERS

- A. Acceptable manufacturers: Wallace Cranes (tri-adjustable crane model S4T12-20SSC with Trolley-hoist model HHSHB020V and accessories as specified herein), Spanco Inc., or 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
Bridge beam and trolley	Steel
Hoist, trolley wheels, hook	Steel
Wire rope	Steel

2.03 FEATURES AND COMPONENTS

- A. The gantry crane capacity, portability, and adjustable dimensions shall meet or exceed the requirements of this specification.
- B. The telescoping legs shall be adjustable in 6" increments and also be equipped with malleable iron safety stops for everyday use as well as when adjusting height.
- C. Spread adjustment on the caster frame shall be in 6" increments. Over spreading of the caster frame adjustment shall be prevented by means of an internal steel safety cable.
- D. The main leg malleable iron center castings shall have spring-loaded pearlitic grade load-adjusting pins for adjusting/maintaining height adjustment of crane as well as attachment of brace legs.
- E. Gantry shall be equipped with four, 360 degree rotating, non-marking phenolic resin casters with 4-position swivel locks, at 90 degrees, to provide easy steering of crane by locking "lead" casters only, or to allow positioning of crane more firmly than a brake by locking all four casters 90 degrees to each other. Casters shall be 6" or 8" diameter as determined by capacity, height and span of crane.
- F. The I-beam and I-beam brackets shall be painted with red gloss industrial quality paint.
1.
2. G. The frames, including brace legs, caster frames, and main legs shall be dip painted with red gloss
3. industrial quality paint for protection of both inner and outer tubing walls.
- H. Ultra-low headroom trolley and hoist:
Fit beams with end bumpers to limit hoist trolley travel.
Hand chains: endless coil-type with a drop that is approximately two feet less than the specified left of the hoist.
Maximum headroom shall be 5.7-inches and shall have a pull to lift load of 58 pounds.
- I. Jack kit: provide height adjustment kits with four detachable gantry jacks (one for each crane leg).
- J. Kart Kit: provide tube and caster attachments to convert disassembled crane into a portable cart.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the complete gantry crane, trolley, and hoist as specified in accordance with the manufacturer's recommendations. Once testing is complete, Contractor shall disassemble crane system and store at location identified by Project Representative.

3.02 FIELD TESTING

- A. Manufacturer's representative shall test bridge crane, trolley, and hoist to verify smooth 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.

3.03 TRAINING

- A. Procedures: 01 79 00
- B. Representative of the manufacturer to assist with start-up and provide a minimum of two 4-hour sessions of on-site training for each bridge crane. Conduct one training session per week on consecutive weeks to accommodate the shift schedules of operation and maintenance staff.

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 23, 26, 40, 41, 43, and 46.

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. Procedure: 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.

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 Responsibility.

System	Components
Classifier systems	Classifier components, concentrators, motors, support requirements, drives, grit feed and drain piping
HVAC control system	Radiant heaters, motors, controls, mounting supports, hot water supply and return piping

C. Balance:

1. Unless specified otherwise, all rotating elements in motors, augers, and miscellaneous equipment: 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.

1.05 SHIPMENT, PROTECTION, AND STORAGE

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

1.06 SEISMIC REQUIREMENTS

- A. Anchor and brace equipment: Section 01 73 00.

1.07 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 50,000 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: used when necessary. 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. Not applicable. Reserved.

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. AESSEAL RDS with throat bushing
 - c. John Crane 3740 seals with Type 24SL 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 and a bronze lantern ring.
 3. Packing: die-molded packing rings of material suitable for the intended service and as recommended by the manufacturer (non-asbestos).
 4. Lantern rings: of 2-piece construction and provided with tapped holes to facilitate removal.
 5. Unless otherwise specified, mechanical seals:
 - a. Pack-Ryt system with SpiralTrac™
 - 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 ANCHOR BOLTS

- A. Anchor bolts: designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 23. Drilled-in epoxy or expansion anchor bolts will not be permitted for permanent application where subject to pull-out forces. Unless otherwise stated in the specifications, anchor bolt materials shall be Type 316 stainless steel and conform to the provisions of Section 05 05 23.

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 23, 26, 40, 41, 43, 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 must 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. 100 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.

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 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. Procedure: 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 structural drawings.
- 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 46 23 63

GRIT CLASSIFYING AND WASHING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies grit washing equipment; the County has pre-selected standardized equipment for this Project and specified herein. The equipment shall be suitable for cleaning organic material from grit-laden slurries and for separating and dewatering grit to a high total solids content prior to discharging to a dewatered grit receptacle. Contractor shall furnish and install four (4) grit washers, each unit will include three (3) cyclones, a stirring device with gear motor, a conveying and dewatering screw with motor, a motorized organics drain valve, and auxiliary equipment as specified herein.
- 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.
705-ME12BH011	Grit Dewatering Screw No. 1
705-ME12BH021	Grit Dewatering Screw No. 2
705-ME12BH031	Grit Dewatering Screw No. 3
705-ME12BH041	Grit Dewatering Screw No. 4
705-ME12BH012	Grit Washer Stirrer No.1
705-ME12BH022	Grit Washer Stirrer No.2
705-ME12BH032	Grit Washer Stirrer No.3
705-ME12BH042	Grit Washer Stirrer No.4
705-ACT12BH011	Motor Operated Organics Drain Valve No. 1
705- ACT12BH021	Motor Operated Organics Drain Valve No. 2
705- ACT12BH031	Motor Operated Organics Drain Valve No. 3
705- ACT12BH041	Motor Operated Organics Drain Valve No. 4
705-ME12BG011	Grit Cyclone No.1
705-ME12BG021	Grit Cyclone No.2
705-ME12BG031	Grit Cyclone No.3
705-ME12BG041	Grit Cyclone No.4
705-ME12BG051	Grit Cyclone No.5
705-ME12BG061	Grit Cyclone No.6
705-ME12BG071	Grit Cyclone No.7
705-ME12BG081	Grit Cyclone No.8
705-ME12BG091	Grit Cyclone No.9
705-ME12BG101	Grit Cyclone No.10
705-ME12BG111	Grit Cyclone No.11
705-ME12BG121	Grit Cyclone No.12

Table Note: See Specification Section 01 78 40 (form 01 78 40A) for equipment tag numbers of additional assets associated with washer/classifier (including

washer solenoid valves, pressure sensors, high level sensor) that are supplied by washer/classifier manufacturer, as specified herein.

- D. Performance Requirements: Each grit washing equipment furnished under this Section shall include three cyclone concentrators, a sedimentation zone, a fluidized bed grit washing zone with batch blowdown of removed organics, and an intermittently operated, inclined, shafted, dewatering screw that is effectively separated from the sedimentation and fluidization zones.

1.02 QUALITY ASSURANCE

- A. Referenced Standards: This Section incorporates by reference the latest revisions of the following documents. They are part of this Section. In case of conflict between the requirements of this Section and the listed documents, the Contractor shall point out the conflict to the Project Representative; lacking a definitive answer otherwise, the requirements of the Contract Specifications shall prevail.

Reference	Title
ASTM A240	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Stainless Steel Bars and Shapes
ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A320	Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service
ASTM A480	Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A484	Stainless Steel Bars, Billets, and Forgings
AWS D1.6	Structural Welding Code-Stainless Steel
NEMA ICS 2	Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts

- B. Shipment and Storage: Upon arrival of the equipment at the project site, an authorized manufacturer's representative and the Contractor shall make a joint inspection of the condition of each piece of equipment, in the presence of the Project Representative. Any damage or defects shall be noted in writing. Damaged items will not be accepted.
- C. All of the equipment furnished under this Section shall be of latest design and supplied by a single manufacturer.

1.03 SUBMITTALS

- A. Procedures: Section 01 33 00.
- B. Items to be Submitted for this Specification:
1. A copy of the Contract Document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal.
 2. Listing of equipment components and materials.
 3. Detailed installation drawings showing equipment layout and the size and location of all piping, electrical, instrumentation, and structural connections.
 4. Copy of Manufacturer's ISO 9001 certification.
 5. Gear drive data including service factor, efficiency, torque rating and materials.
 6. Lifting point and equipment weight.
 7. Manufacturer's data confirming conformance to the specified conditions. Include, as a minimum, equipment rated hydraulic capacity, head loss, overflow rate, horsepower, electrical requirements, and efficiencies.
 8. Motor submittal information as specified in Section 40 05 93.
 9. Equipment support, anchor bolt and mounting requirement calculations specified in Section 05 05 19 and Section 01 73 00 and as defined in the drawings.

- a. Manufacturer shall provide equipment support design (for all equipment supplied: washing classifiers and cyclones). Support and anchorage shall be from floor (not ceiling) as shown on the drawings. Drawings shall be used as a guidance for minimum requirements, final design of support layout shall remain the responsibility of the manufacturer.
 - b. Equipment support systems shall be Type 316L Stainless Steel in accordance with Section 05 50 00. Fasteners shall be in accordance with Section 05 05 23.
 - c. Complete structural design calculations and details, signed and sealed by a Washington licensed Professional Civil or Structural Engineer.
10. Drawing and catalog information detailing all control devices in the control cabinets as well as overall panel layout, interconnection diagrams, control diagrams, and construction.
11. Control panel nameplate and equipment tagging schedules.
12. Control descriptions for internal equipment control and interface with plant control system.
13. Applicable operating and maintenance information as specified in Section 01 78 23.
14. Completed Manufacturer's Installation Certification Form 43 05 01-A.
15. Completed Manufacturer's Instruction Certification Form 43 05 01-B.
16. Manufacturer's recommendations for prestart preparation and preoperational checkout procedures.

1.04 SERVICE REQUIREMENTS

A. Service Conditions:

Item Description	Service Conditions
Location	WPTP, Grit Classifier Building
Fluid type	Pumped grit slurry (from pre-aeration tanks)

B. Operating Conditions: Each of the grit washer provided under this Section shall meet the following operating requirements:

Item Description	Operating Condition
Cyclone Inlet Hydraulic capacity, gpm	750 (250 to each cyclone)
Washer Inlet Hydraulic capacity, gpm	150 (50 underflow from each cyclone)
Washer Inlet Design Capacity, gpm	37.5 (7.5 to 12.5 underflow from each cyclone)
Operating flow range, gpm	250 to 750
Solids content of washed grit, %	>85
Organic content of washed grit, %	<5
Grit processing capacity, ton/hr	1
Minimum combined performance of grit washer to remove particles while operating continuously at the rated design capacity, %	95% removal efficiency (at >200 µm)

C. Design Requirements:

Item	Design Requirement
Cyclone	
Quantity	12 (3 per washer)
Inlet size, inches	4
Overflow size, inches	6
Outlet size, inches	4
Grit Washer	
Quantity	4
Piping connection size, inches, minimum	

Inlet	4
Overflow	10
Organic drain	4
Tank drain	2
Wash water	1
Screw conveyor diameter, inches	
Wash water supply	
Flow, gpm	22
Minimum pressure, psi	29
Stirrer Drive Motor	
Motor type	460 V, 3-phase, 60 Hz
Motor horsepower, maximum	0.75
Maximum motor speed, rpm	1760
Motor enclosure, type	Explosion Proof (Class 1, Div 1)
Screw Conveyor Drive Motor	
Motor type	460 V, 3-phase, 60 Hz
Motor Mount	90-degree and 180-degree angle gearbox mount
Motor horsepower, maximum	1.5
Maximum motor speed, rpm	1760
Motor enclosure, type	Explosion Proof (Class 1, Div 1)

1.05 WARRANTY

- A. For the work of this Section, provide all warranties as described in the General Conditions, see Division 0 specifications, and provide all normal commercial warranties available as described in the General Conditions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS/PRODUCTS

- A. The County has pre-selected standardized equipment for this project. The pre-selected manufacturer of the grit washers shall be Huber Technology, Inc, model RoSF4.1. The grit washer manufacturer's standard models or products may require modification to conform to specified requirements.

2.02 MATERIALS

- A. Materials of construction shall be as follows:
- Grit Washer:

Component	Material
Washer and screw housing, plates and sheets	ASTM A240, Type 304 ASTM A480, No. 1 finish for sheets and "hot-rolled or cold-rolled, and annealed or heat treated, and blast cleaned or pickled" finish for plates
Support bars, angles, and shapes	316 Stainless Steel, per Spec Section 05 50 00.
Support tubes and process tubes	ASTM A312, Grade TP304
Dewatering screw	ASTM A240, Type 304
Bolts, washers, nuts	ASTM A320, Class 1
Control panel	ASTM A240, Type 316 stainless steel, NEMA 4

Component	Material
Electrical conduit	PVC-coated, galvanized, rigid steel

2. Cyclones:

Component	Material
Cone housing	Aluminum or steel, ASTM A131, 1015
Cone lining	Natural rubber
Inlet head housing	Ductile iron, ASTM A395
Vortex finder	Ni-hard or hardened high chrome iron, ASTM A532, with minimum Brinell hardness of 550
Apex housing	Aluminum
Cylinder housing	Steel, ASTM A131, 1015
Cylinder lining	Natural rubber
Retainer ring	Steel, ASTM A131, 1015 to 1020

- B. All stainless steel components shall be treated in a fully immersed pickling bath, in accordance with ASTM A380, to protect the stainless steel against corrosion. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence ensures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection.

2.03 FEATURES

A. Fluidized Bed Grit Washer:

1. Service water creates a fluidized bed to wash and concentrate grit.
2. The chamber wall, weir piping, and chamber bottom shall be 0.1-inches thick.
3. Grit washer body cover shall include a minimum 16- x 30-inch inspection port suitable for connection of a 4-inch-diameter aspiration pipe.
4. The overflow weir shall be arranged to discharge overflow over the overflow weir of the grit washer body.
5. The conical section of the grit washer body shall be provided with a flanged connection for periodic discharge of organic particles. Connection shall be located below the overflow weir. Furnish with an electrically actuated ball valve that matches the pipe drain size.
6. A stirrer shall be provided. Mount stirrer drive on the washer tank with shaft penetrating the washing chamber. Rake arm shall be provided above the perforated bottom plate and shall move grit towards the center axis. Second rake arm shall rotate in the conical portion of the body and shall drive organic material toward the organic solids discharge connection.
7. Grit washing shall occur in a fluidized grit bed in the cylindrical bottom section of the grit washer through a 1-inch C3 water connection. Furnish with a manual ball valve, an automatic solenoid valve and a flow indicator.
8. Washed grit shall be automatically discharged through a grit discharge pipe provided at the center of the tank and through its bottom. Grit discharge pipe shall have a flanged connection.
9. Manufacture shall provide design of washer tank support and anchorage system; submit as detailed above.

B. Screw Conveyor (auger):

1. Inclined grit conveyor screw (auger). Screw conveyor inlet hopper shall have a flanged connection to the grit discharge pipe. Auger discharge elevation as indicated in the Drawings. Provide with a 2-inch-diameter drain and ball valve on screw conveyor inlet hopper.

2. Provide a 1-inch flushing connection with ball valve for the conveyor screw drain.
 3. Screw conveyor housing shall be 0.2-inches thick.
 4. Grit outlet piping from the grit conveying screw shall be no less than 30 degrees from the horizontal plane.
 5. Belt-driven screw conveyors are not acceptable.
 6. Shaftless screw conveyors are not acceptable. Lower end of the screw shaft shall be supported by a maintenance-free ceramic bearing. Wear strips are not acceptable.
 7. Grit conveying screw shall be equipped with an electronic overload protection device to stop the grit washing plant and alarm on over current. Shear pins for overtorque protection are not acceptable.
 8. Provide organic discharge valve limit switches for open and closed position indication rated for 120 VAC.
 9. Provide wash water solenoid valve limit switches for open and closed position indication rated for 120 VAC.
 10. Grit washing plant shall stop and alarm if pressure probe fails.
 11. Manufacture shall provide design of auger support and anchorage system; submit as detailed above.
- C. Gear Drives: Gear speed reduction drives shall be provided for the grit washer stirrer and the screw conveyor. Screw conveyor motors shall be mounted on angle gearbox drives, mounted at 90-degrees and 180-degree positions, or as otherwise shown on the drawings.
- D. Grit Stirrer: The center stirrer shaft diameter shall be 60 mm and shall have a thickness of 5 mm. The stirrer arms shall be 30 mm in diameter and constructed of 304L stainless steel. The stirrer shall consist of a minimum of 2 arm sections. The stirrer design shall promote better discharge of organics, grit bed fluidization, and ability to discharge larger stones. Air and or water scouring shall not be acceptable for generating high turbulences in lieu of a slow speed stirrer.
- E. Cyclones: Each grit washer shall include three cyclones.
1. General: Each cyclone shall be low-profile (to avoid existing building ceiling conflicts) and have a long sweep involuted feed inlet designed to minimize turbulence within the cyclone and minimize wear along the feed inlet. Tangential feed inlets will not be accepted.
 2. Inlet and Overflow: Inlet and overflow shall be provided with fittings for connection to pipe using grooved end pipe couplings.
 - a. Inlet connection point is different on each classifier (to avoid existing building conflicts). See drawings for cyclone connection points.
 3. Vortex Finder and Apex: The vortex finder shall be easily replaceable. The apex assembly shall be configured to accept a 4-inch-diameter flanged end pipe connection.
 4. Liners: All interior surfaces in contact with high velocity water shall be fully lined. The liners shall be replaceable.
 5. Manufactured by Krebs model D10LB, or approved equal.
 6. Manufacture shall provide design of cyclone support and anchorage system; submit as detailed above.
- F. Level Sensor: Each grit washer shall include high water level sensor.
1. General: Each cyclone shall have a threaded high water level sensor coupled to the washer tank with single probe. Probe and body material shall be 316 SST with Teflon insulation.
 2. Provide (2) form C dry contacts for high and high high level alarms outputs with adjustable setpoints.
 3. Provide high level alarm at local grit control panel and transmit alarm to Ovation system.
 4. Manufactured by Warrick model 3E1C, or approved equal.

2.04 EQUIPMENT ELECTRICAL AND CONTROL REQUIREMENTS

- A. General:
1. The vendor-supplied control system shall be as specified in Section 40 61 13. The vendor shall provide the systems configuration and programming as required to fully automate the supplied system. The vendor configuration shall include all programming of the field level processors (PLCs)

- and provide supervisory control functions, Process Control System functions, graphical interface, reporting, and alarm management configuration following King County standards and programming requirements specified in Section 40 68 70. The vendor shall configure any network communication devices resident within its supplied control system that are required to communicate with Ovation as shown on the Drawings.
2. The instrument and control panels and components shall be as specified in Section 40 67 00.
 3. All instruments shall be as specified in Division 40.
 4. All electrical components at or within the grit washer shall be NEMA 4X.
 5. Power supply shall be a single 480V, three-phase, 60-Hz nominal feeder to the grit washers local control panel. The manufacturer shall provide control circuit transformers and any other power conditioning devices required. Control panel shall meet all requirements in Section 26 27 16.
 6. Motor starters for all electrical devices shall be in local control panel.
 7. Panel shall be designed for 65,000A symmetrical short-circuit current withstand interrupt.
 8. Control panel shall be factory wired and tested.
 9. Motors shall be per Section 40 05 93.
- B. System Control Requirements: Sequence of operation as follows:
1. The grit washer is set in operation by a start signal from the Local Control Panel and shall be operated as described in Specification Section 40 65 01.
 2. Operation of system may also be by continuous mode. In this mode of operation, stirrer, washer, and organics valve will be automatically called to start by time delay. Auger will turn on open based on pressure.
- C. Local Control Panel: Two NEMA 4X stainless steel local control panels shall be supplied (each panel shall control two washing classifier units). The local control panel shall include the following minimum devices and/or functions:
1. Externally operable and lockable power disconnect switch.
 2. Single-speed full voltage motor starter for stirrer with overcurrent motor protection.
 3. Single-speed full voltage reversing motor starters for screw conveyor and organic discharge valve operator with overcurrent motor protection circuit.
 4. Organic discharge valve limit switches and wash water solenoid valve limit switches to alert valve failure.
 5. Control power transformer.
 6. Surge arrester.
 7. Programmable logic controller (PLC): See 40 67 00, Control System Equipment Panels and Racks.
 8. External hand switches for the following functions:
 - a. Emergency shutoff.
 - b. Hand-off-auto operation mode.
 - c. Manual forward-reverse conveyor screw operation.
 - d. Manual on-off stirrer operation.
 - e. Manual on-off wash water operation.
 - f. Manual open-close organic discharge valve operation.
 - g. Lamp test.
 - h. Grit washer reset pushbutton.
 9. External operating and warning lights for the following:
 - a. Power on.
 - b. Grit screw running.
 - c. Grit stirrer running
 - d. Organics valve open
 - e. Grit screw fault.
 - f. Grit Stirrer fault.
 - g. Organics valve fault.
 - h. High water level
 10. Internal PLC displays and setting interfaces for the following:
 - a. Elapsed time - grit washer running.
 - b. Elapsed time, screw drive
 - c. Elapsed time, stirrer drive

- d. Impulse time setting for conveyor screw operation (0 to 10 seconds).
- e. Pause time setting for conveyor screw operation (0 to 300 seconds).
- f. Post washer operation run-on time setting for wash water (0 to 10 minutes).
- g. Post washer operation run-on time setting for stirrer (0 to 10 minutes).
- h. Grit level pressure transducer maximum setting (99 percent).
- i. Grit level pressure transducer minimum setting (0 percent).
- j. Organic discharge valve periodic opening interval setting (0 to 24 hours).
- k. Organic discharge valve open period setting (0 to 300 seconds).
- l. Washer water operation period after organic discharge valve setting (0 to 300 seconds).
- m. Intermittent automatic mode, continuous automatic mode, and manual mode selector
- 11. Grit level pressure transducer signal transmitter.
- 12. Organic discharge valve actuator controller.
- 13. High water level alarm
- 14. Input-output contacts for connection to plant control system for the following functions:
 - a. Digital input - feed pumps (one or more) running.
 - b. Digital output - grit washer in auto.
 - c. Digital output - motor overload, each motor.
 - d. Digital output - grit washer running.
 - e. Digital output - grit discharge cycle on.
 - f. Digital output - organic discharge valve open.
 - g. Digital output - organic discharge valve fail.
 - h. Digital output - wash water solenoid valve fail
 - i. Analog output - grit level pressure transducer.
 - j. Digital output – high water level alarm
 - k. Digital outputs (status contacts) to the plant control system shall be electrically isolated contact closures rated 10A at 120V with power supplied at the plant control system.
 - l. Digital inputs (control contacts) from the plant control system shall be electrically isolated contact closures with power supplied by the local control panel.
 - m. Fiber optic patch panel, as shown on the Drawings.
 - 1) UL Listed 1863
 - 2) Rugged metal construction
 - 3) Mounting: Surface or DIN-Rail
 - 4) Splice termination: patch or fusion
 - 5) Duplex connectors: SC, ST, ST-SC or Quad LC
 - 6) Cable compatibility: OM1, OM2, OM3, OM4

2.05 SPARE PARTS

- A. Procedures: See Section 01 78 44.
- B. Provide the following spare parts for each grit washer model furnished for this Section:
 - 1. One bearing box for stirrer
 - 2. One complete stirrer (without drive)
 - 3. One perforated diaphragm
 - 4. One solenoid valve assembly
 - 5. Each cyclone shall have:
 - a. three sets of liners
 - b. three vortex finder gaskets
 - c. three retainer rings
- C. Spare parts shall be tagged and stored in accordance with Section 43 05 01.

2.06 EQUIPMENT AND SYSTEM CONTROLS

- A. The Process Control System (Section 40 61 13) provides equipment and system controls for grit washers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The equipment specified in this Section shall be installed in accordance with the manufacturer's written recommendations.
- B. The equipment shall be unloaded and installed by the Contractor under the supervision of the manufacturer's field representatives. Upon completion of installation, and prior to start-up and testing, the manufacturer shall submit Form 43 05 01-A, specified in Section 01 33 10, to the Project Representative.

3.02 COATINGS

- A. Procedures: Section 09 90 00.
- B. Products: Prime and finish coatings in accordance with Section 09 90 00.
- C. All stainless-steel parts/equipment, after its fabrication, shall undergo a passivation (pickling) process to ensure maximum resistance to corrosion and to remove all embedded iron and heat tint. All stainless-steel components and structures shall be submersed in a chemical bath of nitric acid and hydrofluoric acid to remove any residues that may be present on the material as a result of forming, manufacture, or handling. After removal from the pickling bath, the equipment must be washed with a high-pressure wash of cold water to remove any remaining surface debris and promote the formation of an oxidized passive layer which is critical to the long life of the stainless steel. Submergence insures complete coverage. Spray on chemical treatments and glass bead blasting are specifically not acceptable due to their inability to provide complete and uniform corrosion protection. Surfaces shall be subjected to a 24-hour water test or ferroxyl test to detect the presence of residual embedded iron and shall be re-treated, as needed, to remove all traces of iron contamination. All field welds shall be cleaned and passivated to remove iron (and prevent corrosion) in accordance with ASTM A380. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

3.03 FIELD 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.
- B. Component Test Phase: Following the preoperational test phase specified in Section 01 75 20, perform the following field tests during the component test phase.
 - 1. Demonstrate that all external system protective functions, whether provided under the installation contract, or within this contract scope, are functional and have been tested.
 - 2. Demonstrate that all internal protective functions are operational.
 - 3. Contractor may use C3 water during component testing phase.
- C. System Test Phase: Following the component test phase, perform the following tests as part of the system test phase.
 - 1. The grit washer shall be operated with the minimum and peak rated flow. During 10 hours of continuous operation a composite sample of the washed grit product shall be made of three grab samples. The composite sample shall be analyzed by an independent laboratory for water content and volatile solids content. The water content must not exceed 10 percent and the volatile solids content must not exceed 5 percent.
 - 2. King County shall bear the laboratory costs of the first testing. Manufacturer shall bear the laboratory costs of the second testing.
 - 3. If the test should not be passed successfully, the manufacturer shall have the opportunity to make improvements at his costs.

4. If a second test should not be passed, the equipment shall not be accepted and the manufacturer shall reimburse King County for all costs associated with providing and installing other equipment.
5. Contractor shall use grit slurry (from aerated grit chamber via grit feed pumps) during system testing phase.

3.04 MANUFACTURER'S SERVICES

- A. On-Site Inspections and Training: Provide a factory-trained manufacturer's representative at the site for the following activities. Specified durations do not include travel time to or from the project site.
 1. Installation Inspections: Assist, supervise, and inspect the Contractor's activities during the installation of the grit washers. Provide 4 hours of installation inspection during installation of each grit washer.
 2. System Test Phase Testing Inspections: Assist, supervise, and inspect the Contractor's activities during the system test phase testing specified in Section 01 75 20 and this Section. Provide 4 hours for inspection of system test phase testing for each grit washer installation. Complete Form 43 05 01-A, Section 01 33 10.
 3. Operational Test Phase Testing Inspections: Assist, supervise, and inspect the Contractor's activities during the operational test phase testing specified in Section 01 75 20 and this Section. Provide 4 hours of inspection of the operational test phase testing for each grit washer.
 4. Two Training Sessions: Procedures Section 01 79 00. Provide a minimum of 4 hours of classroom training on grit washer installations for each training session. Conduct one training session per week on consecutive weeks to accommodate the shift schedules of operation and maintenance staff. Certify completion of training on Form 43 05 01-B, Section 01 33 10.

END OF SECTION

APPENDIX A

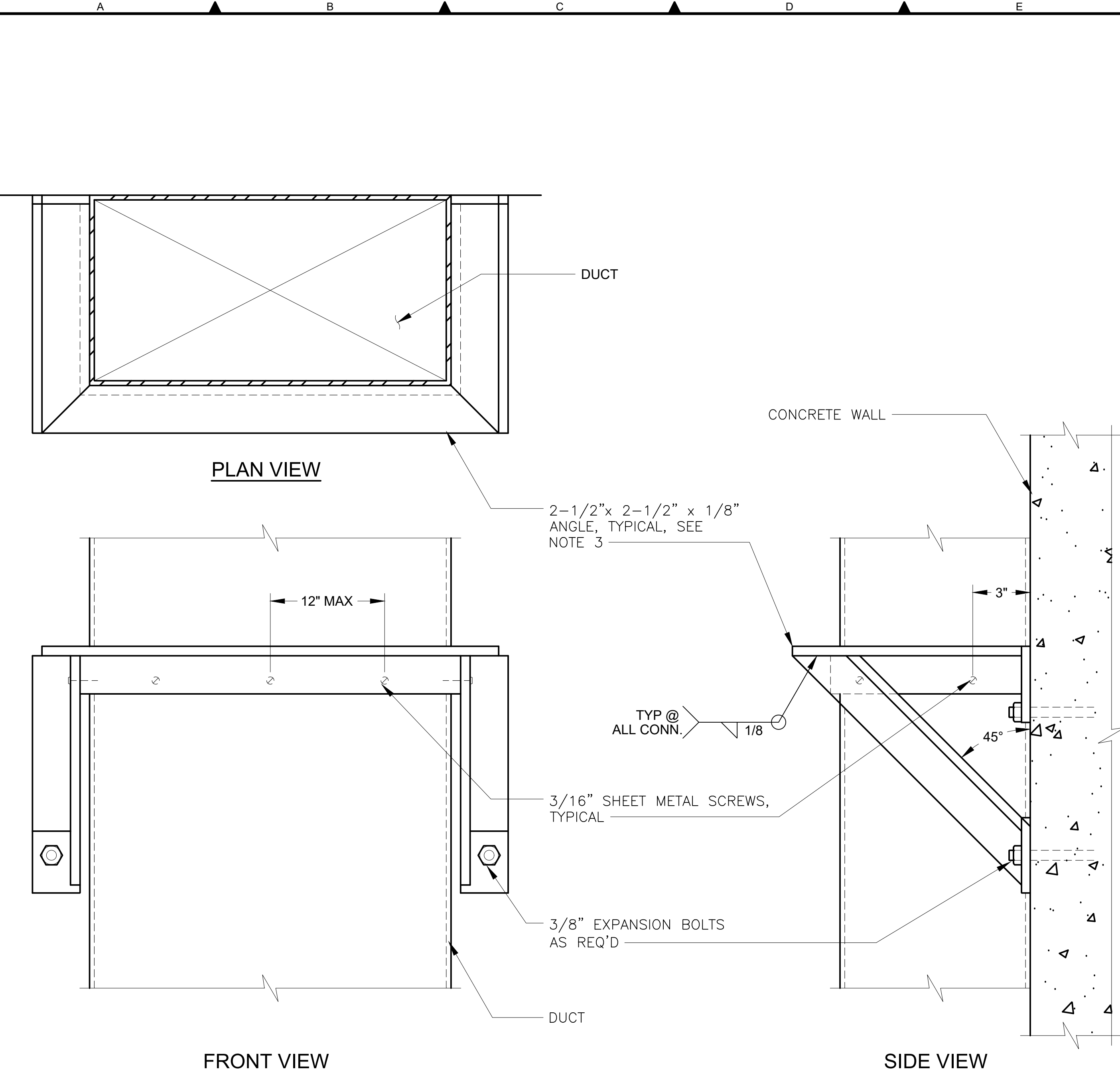
County Standard Details

Prepared by:

King County Wastewater Treatment Division



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NOTES:

- 1. DUCT MAY BE MOUNTED TIGHT AGAINST WALL.
- 2. SUPPORT ANGLES, SCREWS AND ANCHORS TO BE SAME MATERIAL AS DUCT.
- 3. USE 2-1/2"x 2-1/2"x 3/16" SUPPORT ANGLE FOR DUCTS OVER 60" IN SIZE.

NO	REVISION	BY	APVD	DATE

DESIGNED/DRAWN:
M.MACDONALD

CHECKED:
K. MARTINEZ

DESIGN ENGINEER:
ENGINEER

DESIGN APPROVAL:
ENG LEAD



DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION
DIVISION 23 - HEATING, VENTILATING, AIR CONDITIONING (HVAC)
23 31 13 SHEET METAL DUCTWORK





**VERTICAL DUCT SUPPORT
AT WALL**

DATE: OCTOBER 2019	
STANDARD DETAIL NO: 2331-101	
SCALE: 1:1	REV NO: 0



1. INTEGRAL FILTER-REGULATOR-COMBINATION, WITH 1" CONNECTION PORT. FACTORY ASSEMBLED WITH INTERCONNECTING INSERT CONNECTORS. FOR SPECIFICATION, SEE SECTION 15150.
2. INTEGRAL FILTER-REGULATOR-LUBRICATOR COMBINATION, WITH 1/2" CONNECTION PORT. FACTORY ASSEMBLED WITH INTERCONNECTING INSERT CONNECTORS. FOR SPECIFICATION, SEE SECTION 15150.
3. PROVIDE 1/2" BALL VALVE UPSTREAM OF QUICK COUPLER TO RELIEVE AIR PRESSURE BEFORE DISCONNECTING AIR HOSE.
4. DESIGNER TO MODIFY DRAWING TO REFLECT SPECIFIC PROJECT REQUIREMENTS, INCLUDING PIPING, COMPRESSOR WORKING PRESSURE, RECEIVER TANK SIZE, ETC.

LEGEND:

- | | | |
|---|-------------------------------------|---|
|  | BALL VALVE (NORMALLY OPEN) | |
|  | BALL VALVE (NORMALLY CLOSED) | 1 |
|  | SPRING LOADED PRESSURE RELIEF VALVE | |
|  | AIR LINE QUICK COUPLER | |

NO	REVISION DESCRIPTION	BY	APVD	DATE

DESIGNED/DRAWN:	M.MACDONALD
CHECKED:	K. MARTINEZ
DESIGN ENGINEER:	ENGINEER
DESIGN APPROVAL:	ENG LEAD



DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION
DIVISION 40 - PROCESS INTERCONNECTIONS
40 05 01 PIPING SYSTEMS

GENERAL FACILITY SERVICE AIR SYSTEM

DATE: OCTOBER 2019	
STANDARD DETAIL NO: 4005-041	
SCALE: 1:1	REV NO: 0

1"
REFERENCE
0
6
5
4
3
2
1

A

B

C

D

E

1. WHERE PIPES PASS THROUGH WALLS, FLOORS, OR CEILINGS, PENETRATIONS SHALL CONFORM TO TABLE 15**02, EXCEPT AS OTHERWISE SPECIFIED.

2. IN TABLE 15**02, "TANK" SHALL MEAN ANY PART OF A STRUCTURE CONTAINING LIQUID, OR IN CONTACT WITH THE EARTH.

3. IN TABLE 15**02, "PASSAGE" SHALL MEAN ANY ROOM, GALLERY, TUNNEL, OR SIMILAR ENCLOSURE.

4. IN TABLE 15**02, WATER SURFACE "WS" SHALL MEAN AN ELEVATION 9-INCHES ABOVE MAXIMUM WATER SURFACE SHOWN.

5. ALL STEEL SLEEVES SHALL BE HOT DIPPED GALVANIZED AFTER FABRICATION.

6. IN CONDITION 5, TYPE D,E,H,J, OR K SHALL BE USED WHERE ONE SIDE CONTAINS EXPLOSION PROOF EQUIPMENT, WHERE FLOODING IS POSSIBLE, OR WHERE SPECIFIED (TYPE D OR E ONLY FOR COPPER).

7. SEAL FLANGES SHALL BE FACED AND DRILLED TO 150 POUND STANDARD, EACH JOINT SHALL BE FULL FACE GASKETED.

8. WHERE SPECIFIED, CAST IRON FLANGES MAY BE INSTALLED FLUSH WITH WALL AND TAPPED FOR STUDS.

9. PROVIDE CURB WHERE PENETRATING FLOOR, EXCEPT FOR PENETRATION TYPES A, C, AND H. CURB SHALL BE 4" HIGH BY 3" WIDE.

10. PROVIDE A MINIMUM OF 3" CLEARANCE BETWEEN REINFORCING STEEL AND FERROUS METAL PENETRATIONS.

11. WHEN MSS TYPE 8 PIPE CLAMP IS USED FOR COPPER PIPE, CLAMP SHALL BE PLASTIC COATED BY MFR.

12. TYPE X2 PENETRATION FOR EXISTING STRUCTURES SHOWS SLEEVE INSTALLATION DETAIL ONLY. USE TYPE A,B,C,D,E,H OR K DETAILS FOR ACTUAL PENETRATION.

13. INSULATION SHALL NOT EXTEND THROUGH SLEEVES, UNLESS OTHERWISE SPECIFIED.

14. WHERE CAST IRON PIPE IS EMBEDDED IN CONCRETE AT AN EXPANSION JOINT, USE TYPE L PENETRATION DETAIL.

15. "TANK SIDE OF WALL" SHALL MEAN SIDE OF WALL NORMALLY EXPOSED TO LIQUID, EARTH, OR OUTSIDE ATMOSPHERE.

16. SEAL WITH MASTIC SEALANT WHERE WALL IS EXPOSED TO LIQUID, EARTH OR AN EXPLOSION HAZARD AREA.

17. FOR COPPER PIPE IN A "PASSAGE" TO "PASSAGE" CONDITION (SEE TABLE 15**02), PROVIDE A FULL 360 DEGREE WRAP OF 1/16 INCH THICK NEOPRENE. BOND NEOPRENE TO PIPE WITH A COMPATIBLE WATERPROOF ADHESIVE. EXTEND NEOPRENE 1 INCH MINIMUM BEYOND LIMITS OF PENETRATION SLEEVE.

18. WHEN MODULAR MECHANICAL EXPANDING RUBBER SEAL IS USED ON COPPER PIPE, PROVIDE GLASS REINFORCED NYLON PRESSURE PLATES IN PLACE OF STANDARD STEEL UNITS.

19. FLANGE BOLT HOLES SHALL EQUALLY STRADDLE THE VERTICAL CENTER-LINE OF THE FLANGE TO ASSURE PROPER CONNECTION TO ADJOINING PIPE, VALVES AND FITTINGS.

6
5
4
3
2
1


A

B

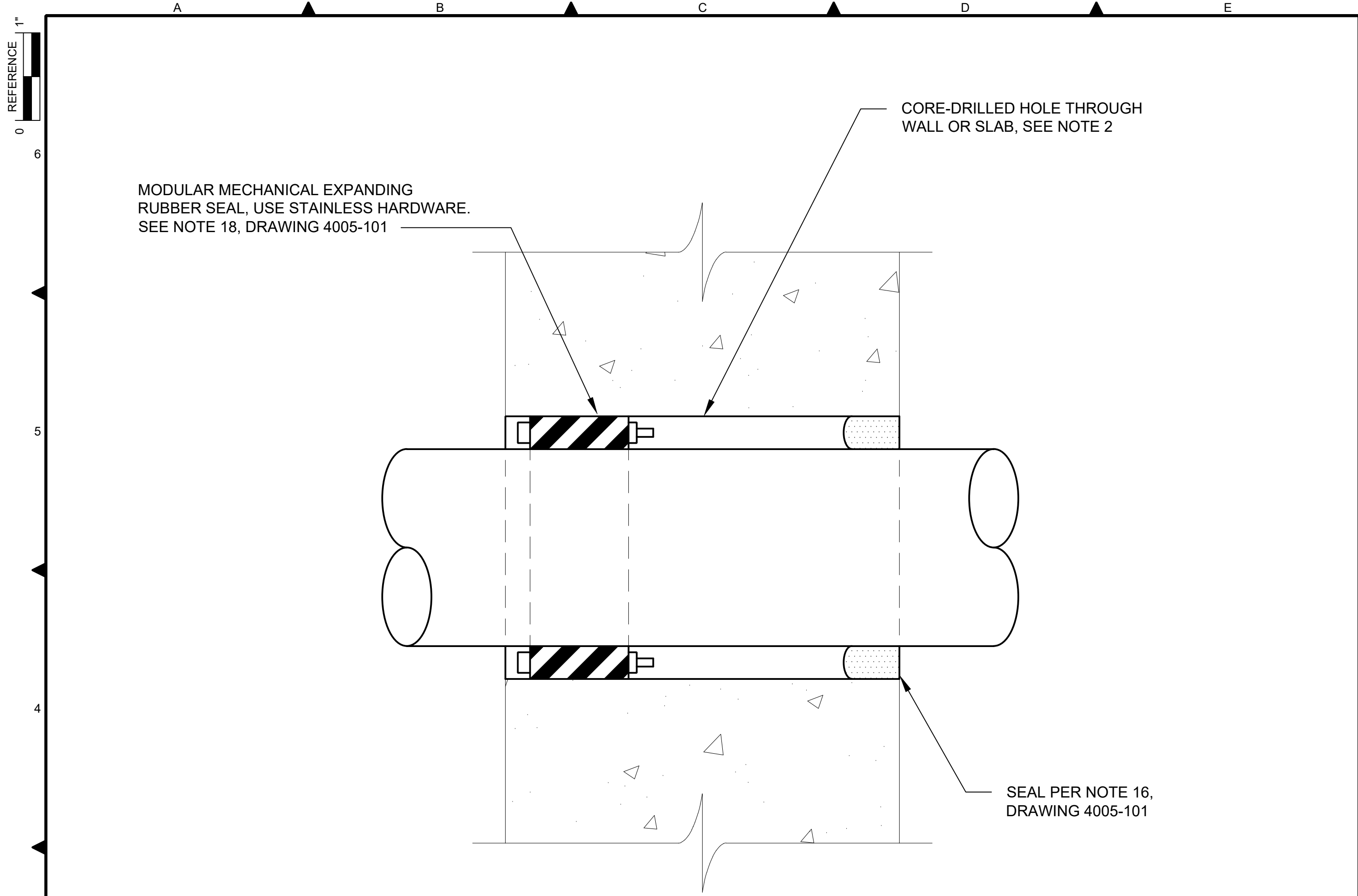
C

D

E

					DESIGNED/DRAWN: R. BULGER		DEPARTMENT OF NATURAL RESOURCES & PARKS WASTEWATER TREATMENT DIVISION DIVISION 40 - PROCESS INTERCONNECTIONS 40 05 01 PIPING SYSTEMS PIPE PENETRATION NOTES	DATE: SEPTEMBER 2019	
					CHECKED: CAD LEAD			STANDARD DETAIL NO: 4005-101	
					DESIGN ENGINEER: ENGINEER				
					DESIGN APPROVAL: J. LUNDT				
NO	REVISION	BY	APVD	DATE				SCALE: 1:1	REV NO: 0

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FOR EXISTING WALLS, FLOORS AND CEILINGS

NOTES:

- WHERE APPLICABLE, PROVIDE CLAMP TO SUPPORT PIPE WHEN PENETRATING FLOOR.
- DIAMETER SHALL BE AS RECOMMENDED BY THE MECHANICAL SEAL MANUFACTURER.

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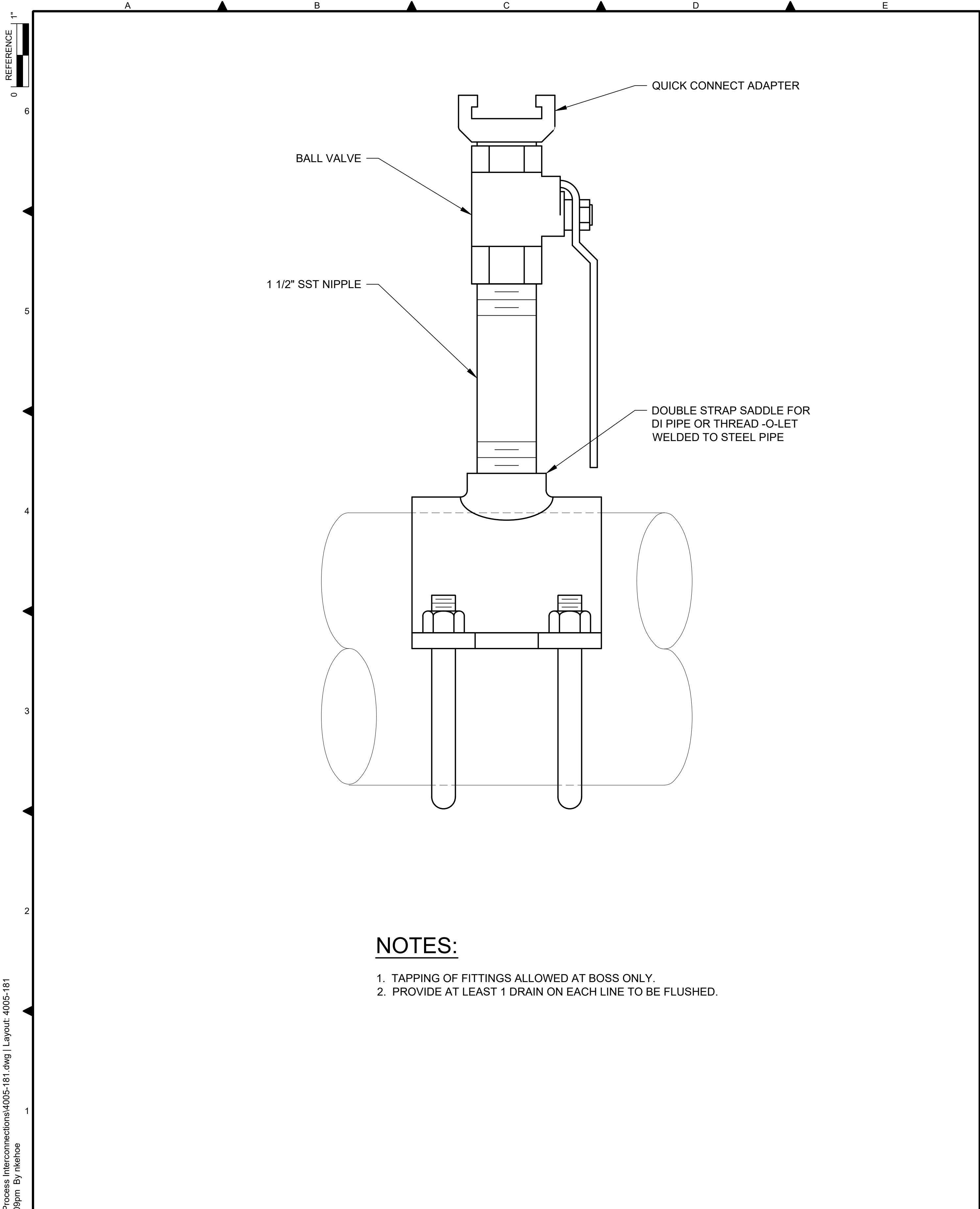
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CHECKED: CAD LEAD
DESIGN ENGINEER: ENGINEER
DESIGN APPROVAL: J. LUNDT



DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION
DIVISION 40 - PROCESS INTERCONNECTION
40 05 01 PIPING SYSTEMS

**TYPE X1 PIPE
PENETRATION**

DATE: SEPTEMBER 2019	
STANDARD DETAIL NO: 4005-131	
SCALE: 1:1	REV NO: 0



NOTES:

- 1. TAPPING OF FITTINGS ALLOWED AT BOSS ONLY.
- 2. PROVIDE AT LEAST 1 DRAIN ON EACH LINE TO BE FLUSHED.

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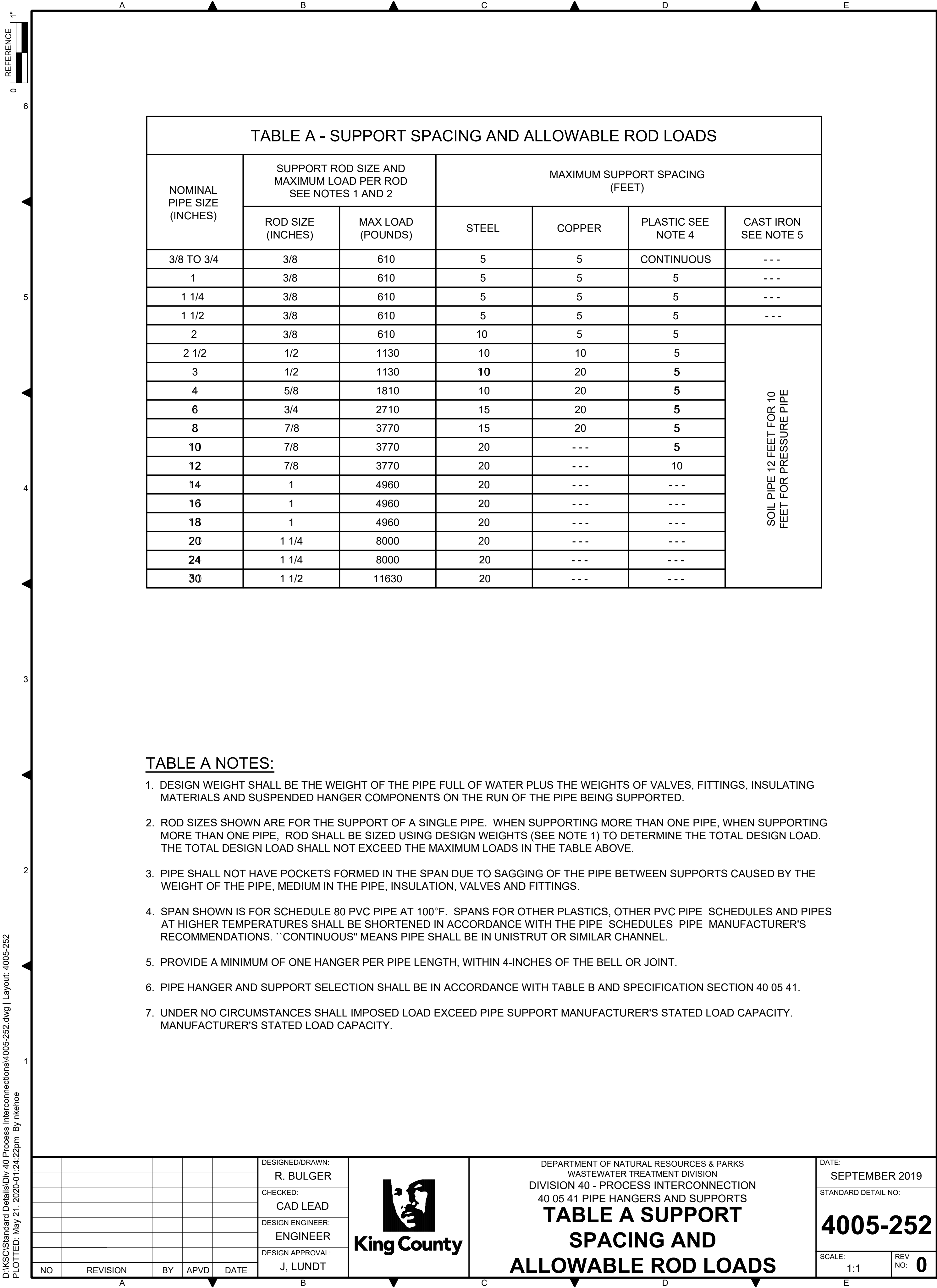
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CHECKED: CAD LEAD
DESIGN ENGINEER: ENGINEER
DESIGN APPROVAL: J. LUNDT

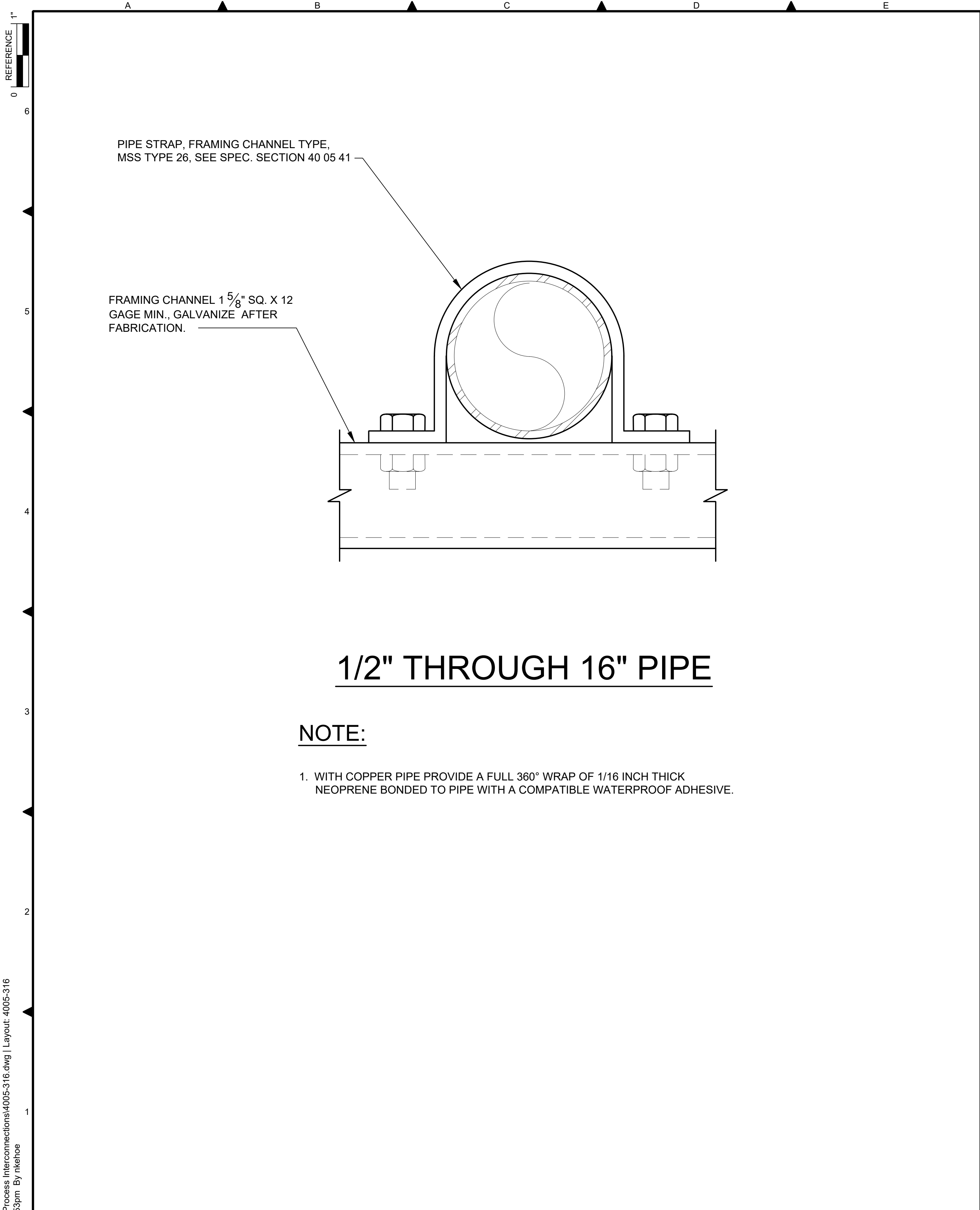


DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION
DIVISION 40 - PROCESS INTERCONNECTIONS
40 05 01 PIPING SYSTEMS

**TYPE 1 FLUSHING
CONNECTION**

DATE: NOVEMBER 2019
DETAIL NO: 4005-181
SHT NO / TOTAL # #
REV NO: 0





1/2" THROUGH 16" PIPE

NOTE:

- 1. WITH COPPER PIPE PROVIDE A FULL 360° WRAP OF 1/16 INCH THICK NEOPRENE BONDED TO PIPE WITH A COMPATIBLE WATERPROOF ADHESIVE.

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NO	REVISION	BY	APVD	DATE

DESIGNED/DRAWN: R. BULGER
CHECKED: CAD LEAD
DESIGN ENGINEER: ENGINEER
DESIGN APPROVAL: J. LUNDT



DEPARTMENT OF NATURAL RESOURCES & PARKS WASTEWATER TREATMENT DIVISION DIVISION 40 - PROCESS INTERCONNECTIONS 40 05 41 PIPE HANGERS AND SUPPORTS
TYPE 13 PIPE HANGER

DATE: OCTOBER 2019
DETAIL NO: 4005-316
SHT NO / TOTAL # #
REV NO: 0