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**DIVISION 11**

# GENERAL PROCESS PROVISIONS

## 1. GENERAL

### 1.1 Intent

.1 Provide complete, fully tested, and operational process systems to meet requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless stated otherwise. They establish scope, material, and installation quality, and are not detailed installation instructions.

.3 Follow manufacturer's recommended installation instructions and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown, with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other contractors or by the City. Uncrate equipment, move in place and install complete; start-up and test.

### 1.2 Regulations

.1 All Work carried out under this Division shall be in full accordance with all applicable Codes, Regulations, Bylaws, and Ordinances and nothing in the Drawings and Specifications shall remove this responsibility.

### 1.3 Permits, Fees and Inspections

.1 Apply for all permits, supply all test certificates and pay all fees to authorities having jurisdiction regarding the installation and inspection of the complete process systems, installed under this Contract.

### 1.4 Existing Conditions and Other Trades

.1 Visit the Site to determine existing conditions affecting the Work of this Division. Failure to do so shall not remove the responsibility for the effects of such conditions on the Work.

.2 Examine all Drawings and become fully familiar with the Work of other trades in all Divisions under this Contract.

.3 Cooperate with all other trades. Pay particular attention to the proximity of the Work to all electrical cables, control conduits, and utilities. Maintain maximum clear ceiling heights throughout. Provide connections of sizes as shown on the Drawings for connection by other trades.

**1.5 Materials**

.1 Materials and equipment installed shall be new, full weight, and of quality specified. Use same brand or manufacturer for each specific application.

**1.6 Scope of Work**

.1 Refer to Section 01010 for the Scope of Work. The Work requires the supply and installation of such components as are necessary to construct complete functional and operational systems for all Sections of the Work.

.2 Consideration will not be granted for any alleged misunderstanding of the extent of the Work to be performed. Submitting a Bid shall convey full agreement to all items and conditions specified, indicated on the Drawings, and required by the nature of the Site.

**1.7 Discrepancies and Omissions**

.1 These Specifications shall be considered as an integral part of the Drawings, which accompany them, and neither the Drawings nor Specifications shall be used alone. Any items or subject omitted from one but which is mentioned or indicated in the other shall be considered as properly and sufficiently specified and shall therefore be provided.

.2 Should the Contractor find discrepancies or omissions in the Contract Documents, or be in doubt as to the intent thereof, he shall immediately obtain clarification from the Contract Administrator.

**1.8 Transportation and Hoisting**

.1 Assume responsibility for transportation, hoisting, warehousing, and demurrage for all equipment and materials to be furnished and installed under this Division.

**1.9 Definitions and Interpretations**

.1 Where the term “Provide” is used herein, it shall be understood to include labour, materials, and services necessary to supply, install, and make functional the items or Work referenced.

.2 Where the term “Instructions” or “As Instructed” or “Where Instructed”, etc. is used herein, it shall be understood to mean as instructed in writing by the Contract Administrator.

.3 Where the term “Listed” is used herein, it shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards and methods, have been approved and listed for the intended use by a testing authority which itself has been approved by the authorities having jurisdiction.

.4 Where the term “Approved”, “Approval”, etc. is used herein, it shall be understood to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, Bylaws, etc.

.5 Where the term “Acceptable” or “Acceptance”, etc. is used herein, it shall be understood to mean acceptable to the Contract Administrator as conforming to the requirements of the Contract Documents.

.6 Where the term "Submit for Review" is used herein, it shall be understood to mean submit to the Contract Administrator.

.7 Where the term "Subject to Review" etc. is used herein, it shall be understood to mean Work shall be laid out for review by the Contract Administrator. No Work shall proceed until written instructions have been obtained from the Contract Administrator. Submit further information, Shop Drawings, samples, etc. as specified and/or as may be reasonably requested by the Contract Administrator.

.8 Where the term "Accessible" is used herein, it shall be understood to mean readily approachable by person or tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.

.9 Where working pressure or pressure ratings are specified or shown on the Drawings for valves, piping, fittings, equipment, etc., these items shall be suitable for operating at specified pressures and corresponding temperature unless noted otherwise.

**1.10 Shop Drawings**

.1 Refer to Section 01300 for the general requirements for Shop Drawings.

.2 For specific requirements for Shop Drawings for various pieces of equipment, refer to the relevant specific Sections describing the equipment.

.3 Shop Drawings shall be complete; capable of illustrating fully that the product to be supplied is in accordance with the Specifications; including design considerations, materials, and accessories and spare parts. Include wiring diagrams for power supply and control schematics for all electrically powered and/or controlled equipment.

.4 Shop Drawings, which are not considered complete, will be returned to the Contractor "Not Reviewed" or "Rejected". It is the responsibility of the Contractor prior to submittal to ensure that they are in accordance with the requirements of the Specifications.

.5 Submit Shop Drawings in an expedient fashion in accordance with the Contract requirements and allowing sufficient time for review and implementation prior to Contract completion.

.6 Shop Drawings of equipment supplied under other Contracts will be made available to the Contractor to assist in the installation.

**1.11 Coordination**

.1 Coordinate locations of openings, housekeeping pads, and anchor bolts with other Divisions.

.2 Coordinate the connection of the services of other Divisions to the equipment and material supplied under this Division.

## 1.12 Minor Changes

.1 Equipment and materials shall be located and arranged generally as shown on the Drawings. However, minor changes may be required to suit the precise requirements of the actual equipment or materials supplied, or to avoid conflict between services.

.2 Prior to the installation of the relevant equipment or materials, the Contractor shall advise the Contract Administrator of the requirement for any minor changes (including box-outs and coring) and shall undertake such minor changes as instructed by the Contract Administrator. Such changes shall be undertaken at no extra cost except where the connection or arrangement is modified in length, or alignment, or position, by more than one metre; or if the change involves the addition of more than two fittings greater than 150 mm in diameter.

## 1.13 Housekeeping Pads

.1 Housekeeping pads are required for all pieces of equipment unless otherwise noted. Dimensions shown on the drawings are for guidance only. Housekeeping pads shall be at least 100 mm larger than the equipment base plates a minimum of 200 mm deep, unless greater or lesser depths are required to support the equipment at the proper elevation. The final housekeeping pad dimensions shall be based on the dimensions of the actual equipment to be installed, and the manufacturer's recommendations.

.2 The Contractor shall coordinate the location and installation of all the housekeeping pads, to be done by other Divisions.

## 1.14 Metric Conversion

.1 All units in this division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specifications.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

| mm | inches | mm | inches | mm | inches |
|---|---|---|---|---|---|
| 3 | 1/8 | 65 | 2-1/2 | 375 | 15 |
| 6 | 1/4 | 75 | 3 | 450 | 18 |
| 10 | 3/8 | 100 | 4 | 500 | 20 |
| 15 | 1/2 | 125 | 5 | 600 | 24 |
| 20 | 3/4 | 150 | 6 | 750 | 30 |
| 25 | 1 | 200 | 8 | 900 | 36 |
| 30 | 1-1/4 | 250 | 10 | 1050 | 42 |
| 40 | 1-1/2 | 300 | 12 | 1200 | 48 |
| 50 | 2 | | | | |

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment, and piping.

.2 When CSA-approved SI metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI metric pipes and all new and existing pipes, fittings, and equipment.

## 1.15 Cutting and Patching

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective Section.

## 1.16 Substantial and Total Performance

.1 Prior to Substantial Performance Inspection, provide complete list of items, which are deficient at the time of the Substantial Performance Inspection.

.2 Perform the following items prior to Substantial Performance Inspection.

.1 Make systems capable of operation with alarm controls functional and automatic controls in operation generally, but not necessarily finally calibrated.

.2 Make necessary tests on equipment including those required by authorities. Obtain certificates of approval.

.3 Complete valve tagging and identify equipment. Paint equipment and piping, and install escutcheons.

.4 Lubricate equipment as per manufacturer's instructions.

.5 Mail warranty forms to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.6 Submit O&M Manuals as in accordance with Section 01300.

.3 Prior to Total Performance Inspection, provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Total Performance Inspection:

.1 Complete final calibration of controls.

.4 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

**1.17 Equipment Protection and Clean-Up**

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with crates and polyethylene covers.

.3 Thoroughly clean both existing and new piping, ducts and equipment of dirt, cuttings, and other foreign substances.

.4 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

**1.18 Temporary Usage**

.1 Usage by the City of any process device, apparatus, machinery, or equipment prior to Total Performance being issued is not to be construed as acceptance.

**1.19 Painting and Identification**

.1 Coordinate colour coding of piping and equipment with that of the existing plant. All piping and equipment is to be painted.

.2 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.3 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

## 1.20 Acceptable Products and Acceptable Manufacturers

.1 The first product specified in a product list is considered the "Design Standard" unless noted otherwise. The Design Standard product has been used as the basis for design. Dimensions, operating protocol, basic materials, etc. of the Design Standard have been incorporated in the design.

.2 Where one or more Acceptable Products or Acceptable Manufacturers have been listed for an item of equipment, these are accepted as equivalent in concept to the Design Standard, if a Design Standard is listed. Incorporation of equipment options to satisfy the intent of the Specifications such that the process system would function as intended with the Design Standard is the responsibility of the Contractor. Modifications to the equipment services, supports, structure, etc., to suit Acceptable Products shall be the responsibility of the Contractor.

.3 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance Specifications and physical dimensions of the specified product.

.4 The Contractor shall be fully responsible for any additional Work or materials, to accommodate the use of equipment from the acceptable manufacturers and suppliers' list.

.5 Submit within 14 days of Contract award a copy of the list underlining the name of the manufacturer whose price was carried in the Bid. If no manufacturer's names are submitted, it will be assumed that the price carried in the Bid was that of the specified manufacturer or, where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.

## 1.21 Delivery Schedule

.1 The Contractor is to coordinate the equipment and material delivery schedule with the suppliers of the equipment and materials supplied under this Contract to suit the construction schedule. The dates for delivery shall be identified within 20 working days of Contract award. These delivery dates may be altered by mutual agreement between the Contractor and the Contract Administrator.

## 1.22 Delivery

.1 The Contractor shall be responsible for unloading the equipment and materials supplied under this Contract and shall examine all packages on delivery, compare with the shipping list, and inform the supplier, the Contract Administrator and the carrier of any visible damages or defects. The Contractor shall arrange with the supplier to have the supplier replace any damaged or defective items.

## 1.23 Storage

.1 The Contractor shall provide temporary buildings and covered space for storage at the Site of all equipment prior to installation. The location of such buildings will be subject to acceptance by the Contract Administrator and the City.

.2 Pipe and any other materials shall be stored in a manner which prevents rust, deformation, weathering, or any other physical deterioration. Covered space shall be provided by the Contractor if necessary to provide for this protection.

.3 The Contractor shall adhere to the manufacturers' storage recommendations.

.4 Heated covered storage space shall be provided by the Contractor for sensitive items of equipment such as motors and pumps, as well as other equipment or supplies specified in this Division or other Divisions.

**1.24 Spare Parts and Special Tools**

.1 If spare parts or special tools are to be provided with any equipment specified, the specific parts or tools will be listed in the relevant Specification Section and are to be supplied with the equipment.

.2 Where the operation of the equipment for a period of two years would require that some specific spare parts are likely to be required, but are not listed in the Specification, the Contractor shall so inform the Contract Administrator. Costs, delivery periods, and any other information relevant to the procurement of the identified spare parts shall be identified.

.3 Where special tools are required for the maintenance or operation of a specific item of equipment, but are not listed, the Contractor shall so inform the Contract Administrator. Costs, delivery periods, and any other information relevant to the procurement of the identified special tools shall be provided.

.4 This clause does not relieve the Contractor of the responsibility to provide, at no cost, any spare parts required during the warranty period to repair malfunctioning or failed equipment. At the end of the maintenance period, the spare parts inventory shall be replenished to allow for the above.

**END OF SECTION**

# PROCESS EQUIPMENT INSTALLATION

## 1. GENERAL

### 1.1 Description

.1 Installation, including the supply of anchor bolts, and testing of equipment supplied by others and supplied under other Sections in Division 11.

### 1.2 Definitions and Interpretations

.1 Testing: in this Division, testing is defined as the operation of a specific item of equipment under actual or simulated conditions for the purpose of ensuring the equipment satisfies its basic design criteria. Testing shall be conducted by the Contractor. All materials, labour, power and equipment required to conduct the tests shall be the Contractor's responsibility. The manufacturer is to provide technical assistance to the Contractor for the installation, testing, start-up, and commissioning of the equipment supplied. Refer to Section 01650.

.2 Commissioning: in this Division, Commissioning is defined as the operation of equipment systems under actual and/or simulated conditions for the purpose of ensuring the system performs its intended functions. Refer to Section 01670.

### 1.3 Submissions

.1 Check all the Shop Drawings relative to the equipment and materials, dimensions, measurements, size of members, type of materials, controls, list of equipment being supplied, names of manufacturers, and other details to affirm that they are correct and conform to the requirements and intent of the Contract.

.2 Where the Shop Drawings are submitted with coordination information missing, such as dimensions of structures, the Contract Administrator will return the submission as soon as practicable marked "Revise and Resubmit."

## 2. PRODUCTS

### 2.1 Equipment Schedule

.1 Unless indicated otherwise, supply and install all equipment listed on the Equipment Schedule, detailed on the equipment Specification sheets, or shown on the Drawings.

.2 Determine the extent of equipment to be supplied from the Specifications, list of equipment and materials and manufacturer's Drawings covering the equipment. Furnish and install all additional materials necessary to complete the installation.

.3 Incorporate all ancillary devices in the installation including those providing for cooling water, seal water, lubricant supply, process drains, electrical connection, and instrumentation and control requirements.

### 2.2 Mounting Requirements

.1 Provide all supports, anchorage, and mounting of all equipment in accordance with the manufacturer's recommendations, the National Building Code, and industry standard requirements, unless otherwise specified.

.2 Design and provide all elements required to resist the calculated forces described herein or required by the element manufacturer.

.3 Design anchorage for all equipment bases, supports, and foundations in accordance with National Building Code for Seismic Zone 0.

.4 For rotating equipment, where specified, submit design notes and calculations for anchorage, signed and sealed by a Professional Engineer registered in the Province of Manitoba.

## 3. EXECUTION

### 3.1 Coordination

.1 Coordinate the Work specified under this Section with the Work of other Sections to produce a complete and workmanlike job.

.2 Coordinate the placement of equipment bases and housekeeping pads with Division 3.

.3 Coordinate the routing of ancillary piping with Division 15.

.4 Coordinate the routing of electrical and control wiring and conduit with Division 16.

### 3.2 Preparation

.1 Before commencing installation of the Work, inspect and take field measurements and ensure that Work conducted previously in the area is not prejudicial to the proper installation of the Work.

.2 Refer to the equipment Specifications and Specification sheets for assistance in determining the form in which equipment is to be shipped and the extent of field assembly required.

.3 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Contract Administrator.

.4 Schedule the visits to the site of the manufacturer's representative for the times and periods specified in other sections. Cooperate in his supervision of the installation and start-up. Follow all reasonable instructions of the manufacturer's representative. Should the Contractor require the manufacturer' representative to attend for longer or more frequent periods, he shall arrange this, at his own expense, with the manufacturer.

## 3.3 Installation of Equipment

.1 Install all equipment specified in other Sections, detailed on the equipment Specification sheets, and shown on the Drawings.

.2 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Contract Administrator.

.3 Supply and install all necessary shims, gaskets, etc., required to complete the installation.

.4 Provide for the use of all necessary lifting and loading equipment and all tools required to complete the installation.

.5 Comply with the specific requirements for installation noted in other Sections of this Specification and with the instructions of the manufacturer. Where there is a conflict in these requirements, identify the conflict to the Contract Administrator and proceed as directed.

## 3.4 Equipment Bases and Anchorage

.1 Equipment will be mounted on housekeeping pads that are a minimum of 100 to 200 mm high.

.2 For rotating equipment of 7.5 kW or above and for equipment requiring structural anchoring, set anchor bolts in advance. Where required, set anchor bolts in sleeves to permit minor adjustment during installation. Use machine base templates where shown.

.3 Prepare grout as specified in Division 3 and provide full contact with the equipment bases unless otherwise recommended by the equipment manufacturer and accepted by the Contract Administrator. Neatly bevel, form, or trim the grout.

.4 Where equipment is supplied with a plate steel base, provide access holes in the top of the plate and use a pour grade, non-shrink, non-metallic grout as specified in the structural concrete Specifications to fill the entire void under the base.

.5 Fixings to concrete structures shall be by adhesive anchors suitably designed for the application.

## 3.5 Alignment

.1 Set and align all rotating equipment in accordance with the more stringent requirements of either the manufacturer's requirements or the following:

.1 Level base, use machinists level on all machined bases.

.2 Align couplings to satisfy the following criteria:

| Coupling Speed | Allowable Angular Misalignment | Allowable Parallel Misalignment |
|---|---|---|
| Under 100 rpm, below 50 hp | 4' 00" | 0.25 mm |
| Under 100 rpm, 50 hp and over | 3' 00" | 0.12 mm |
| 100 to 600 rpm | 2' 00" | 0.12 mm |
| 600 to 1800 rpm | 1' 00" | 0.10 mm |
| 1800 to 3600 rpm | 0' 35" | 0.05 mm |

.3 Check for soft foot, maximum permissible 0.002 mm.

.2 Where equipment undergoes a substantial differential temperature rise (30°C between driver and driven unit), provide precision benchmarks in foundation and on equipment and perform alignment at operating temperatures.

.3 Demonstrate to the Contract Administrator and manufacturer's representative the final alignment.

## 3.6 Lubricants

.1 Extend any inaccessible lubrication points and lubricant drains to convenient locations.

.2 Remove storage lubricant and provide the initial fill of new lubricants for the equipment. Lubricant grade to be as recommended by the manufacturer.

.3 Provide a Lubrication Schedule for all process equipment. Include the following:

.1 Equipment name and number

.2 Date(s) of lubrication

.3 Lubricant type installed

.4 Frequency of lubrication

## 3.7 Vibration Survey

.1 Conduct a vibration survey under normal operating conditions for all equipment with a motor size exceeding 37 kW and for smaller units where specified.

.2 Use a calibrated vibration sensor, accepted by the Contract Administrator, and capable of measuring unfiltered vibration velocities and peak-to-peak amplitudes. Select a sensor capable of measuring velocities at a precision of 0.1 mm/s and an accuracy of plus or minus 0.2 mm/s.

.3 Monitor vibration in all three dimensions at the head and tail end of both the driver and driven units, at intermediate bearing points, and at other critical locations which may be identified by the Contract Administrator.

.4 Record the vibration velocities for each item of rotating equipment and submit a report to the Contract Administrator detailing the findings. Include a description of the measuring equipment, identification of equipment on which vibration monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Unless specified otherwise, use unfiltered velocities as the vibration criteria. Unfiltered velocities less than 5 mm/sec shall be considered acceptable. Undertake corrective action where unfiltered velocities exceed 5 mm/sec.

**3.8 Noise Survey**

.1 Conduct a noise survey for all equipment over 37 kW and for smaller units where specified.

.2 Use a calibrated noise meter, accepted by the Contract Administrator, and capable of measuring noise in the A Scale at a precision of 0.5 dBA and an accuracy of 1.0 dBA.

.3 Measure noise levels at an elevation similar to the major noise emitter from the equipment (bearing housing, muffler, etc.) and at a horizontal distance of 1.0 metre.

.4 Record the noise levels for each item of equipment and submit a report to the Contract Administrator detailing the findings. Include a description of the measuring equipment, identification of equipment on which noise level monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Equipment is to operate at a noise level less than 85 dBA, when measured in free field at 1.0 metre. Noise requirements may be more stringent in areas where more than one item of process equipment is intended to operate concurrently. Specific requirements for equipment that differ from 85 dBA are listed in the sections related to those items of equipment.

.6 Noise abatement features (acoustic panels, acoustic insulation, etc.) are specified in other Sections.

.7 In any process area, recommend whatever measures necessary to maintain a composite noise level below 90 dBA. Where directed by the Contract Administrator, undertake those corrective actions.

**3.9 Quality Assurance Forms**

.1 Test all process equipment to ensure the equipment operates in accordance with the basic design criteria listed in the Specification Sections or equipment Specification sheets. Complete the series of forms that attest to the proper installation and functioning of the equipment. Refer to Section 01650 and 1670 for the Forms.

**END OF SECTION**

**PROCESS PIPING**

## 1. GENERAL

### 1.1 Description

.1 This Section describes the pipe materials, fittings, appurtenances, installation and testing of the process systems.

.2 Use the general requirements specified in this Section integrally with the more specific requirements listed in Section 11055 – Detailed Piping Specification Sheet.

.3 Piping supports are generally not shown on the process Drawings. Provide the design of piping supports, pipe guides, expansion joints and anchors based upon final piping layout. Typical support details and structural attachments shown on the Drawings indicate the level of quality that will be considered acceptable.

.4 The Contractor must provide the necessary submittals and ensure the proper registration of piping systems and system components as required by the Manitoba Labour and Immigration.

.5 Standard of Acceptance: items specified by manufacturer's name and/or catalogue number form part of this Specification in order to define the standard regarding performance, quality of material and workmanship. When used in conjunction with a referenced standard, shall be deemed to supplement the standard.

### 1.2 Definitions

.1 Pressure terms used in this and other related sections are defined as follows:

.1 Operating Limits: the minimum and maximum pressure at which the piping system operates for sustained periods of time

.2 Test Pressure: the hydrostatic pressure used to determine system compliance.

.2 Unless otherwise specified or shown, the interface between piped commodities common to process-mechanical and yard piping is below grade and 450 mm from the exterior face of a building or tunnel wall.

.3 Pipe and appurtenance location terms used in this and other related sections are defined as:

.1 Tunnels, Pumphouse and Buildings: within an environmentally controlled enclosure where temperature is maintained above 5°C.

.2 Exposed, Aboveground: outside or within an enclosure which is not environmentally controlled so that the temperature is maintained above 5°C. For the purpose of defining exterior protection systems, this definition is extended to vertical piping to a point of 0.5 m below finished ground level.

.3 Underground or Buried: placed in soil and not tied to structures.

.4 Below Structures: below concrete slabs such as tanks, channels, buildings, pipe chases, foundation slabs, etc., but not including roadways or walkway structures.

.5 Submerged: regularly or occasionally immersed in liquid; inside tanks or channels, and within 3.0 m above maximum water level of open tankage, including pipe and appurtenances within manholes, vaults, and chambers.

## 1.3 Reference Standards

.1 Conform to the most recent version of the following reference standards:

.1 ANSI/ASME A13.1, Scheme for the Identification of Piping Systems

.2 ANSI/ASME B1.20.1, Pipe Threads, General Purpose

.3 ANSI/ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

.4 ANSI/ASME B16.3, Malleable Iron Threaded Fittings Class 150 and 300

.5 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings

.6 ANSI/ASME B16.9, Factory-Made Wrought Steel Butt Welding Fittings

.7 ANSI/ASME B16.11, Forged Steel Fittings, Socket Welding and Threaded.

.8 ANSI/ASME B16.12, Cast Iron Threaded Drainage Fittings

.9 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250

.10 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings

.11 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

.12 ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes

.13 ANSI/ASME B31.1, Power Piping

.14 ANSI/ASME B31.3, Process Piping

.15 ANSI/ASME B31.9, Building Services Piping

.16 ANSI/ASME B36.10M, Welded and Seamless Wrought Steel Pipe

.17 ANSI/ASME B36.19M, Stainless Steel Pipe

.18 ASME Section IX, Boiler and Pressure Vessel Code, Welding and Brazing Requirements

.19 ASTM A47, Malleable Iron Castings

.20 ASTM A53, Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless

.21 ASTM A74, Cast Iron Soil Pipe and Fittings

.22 ASTM A105/A105M, Forgings, Carbon Steel, for Piping Components

.23 ASTM A106, Seamless Carbon Steel Pipe for High Temperature Service

.24 ASTM A126, Grey-Iron Castings for Valves, Flanges, and Pipe Fittings

.25 ASTM A135, Electric-Resistance-Welded Steel Pipe

.26 ASTM A139, Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)

.27 ASTM A167, Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate

.28 ASTM A181/181M, Forgings, Carbon Steel, for General Purpose Piping

.29 ASTM A182/182M, Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

.30 ASTM A193/193M, Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service

.31 ASTM A194/194M, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service

.32 ASTM A197, Cupola Malleable Iron

.33 ASTM A234/A234M, Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

.34 ASTM A240, Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels

.35 ASTM A269, Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

.36 ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes

.37 ASTM A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

.38 ASTM A307, Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength

.39 ASTM A312/312M, Seamless and Welded Austenitic Stainless Steel Pipe

.40 ASTM A320/320M, Alloy Steel Bolting Materials for Low-Temperature Service

.41 ASTM A351/A351M, Standard Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts

.42 ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems

.43 ASTM A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings

.44 ASTM A409/A409M, Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service

.45 ASTM A480/A480M, General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

.46 ASTM A536, Ductile Iron Castings

.47 ASTM A563, Carbon and Alloy Steel Nuts

.48 ASTM A570/A570M, Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

.49 ASTM A774/A774M, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

.50 ASTM A778, Welded, Unannealed Austenitic Stainless Steel Tubular Products

.51 ASTM A967, Standard Specification for Chemical Passivation Treatment for Stainless Steel Parts

.52 ASTM B32, Standard Specification for Solder Metal

.53 ASTM B88, Seamless Copper Water Tube

.54 ASTM C76, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

.55 ASTM C564, Rubber Gaskets for Cast Iron Soil Pipe and Fittings

.56 ASTM D638, Test Method for Tensile Properties of Plastics

.57 ASTM D792, Test Method for Specific Gravity and Density of Plastics by Displacement

.58 ASTM D1248, Polyethylene Plastics Moulding and Extrusion Materials

.59 ASTM D1457, PTFE Moulding and Extrusion Materials

.60 ASTM D1599 – Standard Test Method for Short-Time Hydraulic Failure Pressure or Plastic Pipe, Tubing and Fittings

.61 ASTM D1784, Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

.62 ASTM D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

.63 ASTM D2105, Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Tube

.64 ASTM D2241, Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)

.65 ASTM D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

.66 ASTM D2466, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

.67 ASTM D2467, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

.68 ASTM D2513, Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

.69 ASTM D2529, Standard Practice for Measuring Beam Deflection for Reinforced Thermosetting Plastic Pipe Under Full Bore Flow

.70 ASTM D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings

.71 ASTM D2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

.72 ASTM D2665, Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

.73 ASTM D2996, Filament-Wound Reinforced Thermosetting Resin Pipe

.74 ASTM D3212, Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals

.75 ASTM D3261, Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings

.76 ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fitting Materials

.77 ASTM D4024, Standard Specification for Reinforced Thermosetting Resin (RTR) Flanges

.78 ASTM D4101, Propylene Plastic Injection and Extrusion Materials

.79 ASTM D4174, Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems

.80 ASTM F441, Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

.81 ASTM F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on outside Diameter

.82 ASTM F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

.83 AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids

.84 AWWA C110, Ductile-Iron and Grey-Iron Fittings, 3 Inch through 48 Inch, for Water and Other Liquids

.85 AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings

.86 AWWA C115, Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges

.87 AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast in Metal Moulds or Sand-Lined Moulds, for Water and Other Liquids

.88 AWWA C200, Steel Water Pipe, 6 Inches and Larger

.89 AWWA C203, Coal Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape - Hot Applied

.90 AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4 Inches through 144 Inches

.91 AWWA C206, Field Welding of Steel Water Pipe

.92 AWWA C207, Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch through 144 Inch

.93 AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings

.94 AWWA C209, Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines

.95 AWWA C210, Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipe

.96 AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines

.97 AWWA C301, Pre-stressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids

.98 AWWA C303, Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pre-tensioned, for Water and Other Liquids

.99 AWWA C600, Installation of Ductile-Iron Water Mains and their Appurtenances

.100 AWWA C606, Grooved and Shouldered Joints

.101 AWWA C651, Disinfecting Water Mains

.102 AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches through 12 Inches, for Water

.103 AWWA C906, Standard for Polyethylene (PE) Pressure Pipe and Fittings 4 inches through 63 in., for Water Distribution

.104 AWWA M11, Steel Pipe - A Guide for Design and Installation

.105 CGA, Canadian Gas Association Standards

.106 CAN/CGA B105 - Installation Code for Digester Gas Systems

.107 CAN/CSA B70, Cast Iron Soil Pipe, Fittings and Means of Joining

.108 CISPI 301, Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings

.109 CAN/CSA B139, Installation Code for Oil Burning Equipment

.110 CAN/CSA B149.1, Natural Gas and Propane Installation Code

.111 CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Applied Petroleum Products Part 5

.112 CPC, Canadian Plumbing Code

.113 CSA B52, Mechanical Refrigeration Code

.114 CSA B137.1, Polyethylene Pipe, Tubing and Fittings for Cold Water Pressure Services

.115 CSA B137.3, Rigid PVC Pipe for Pressure Applications

.116 CAN/CSA B181.2, PVC Drain, Waste, and Vent Pipe and Pipe Fittings

.117 CAN/CSA B182.2, PVC Sewer Pipe and Fittings (PSM Type)

.118 CSA CAN-Z183, Oil Pipeline Systems

.119 CSA CAN3-Z299.3, Quality Verification Program Requirements

.120 EJMA STDS-93, Standards of Expansion Joint Manufacturers' Association, Edition No. 6

.121 Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division

.122 FEDSPEC, L-C-530B(1), Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy

.123 MIL-H-13528B, Hydrochloric Acid, Inhibited, Rust Removing

.124 MIL-S-8660C, Silicone Compound

.125 MIL-STD-810C, Environmental Test Methods

.126 MSS SP25, Standard Marking System for Valves, Fittings, Flanges and Unions

.127 MSS SP43, Wrought Stainless Steel Butt Welding Fittings

.128 NACE RP0178, Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service.

.129 SAE J1227, Assessing Cleanliness of Hydraulic Fluid Power Components and Systems

.130 SSPC-P3, Canadian Government Standards Board

.131 SSPC-SP6, Canadian Government Standards Board

.132 SSPC-SP10, Canadian Government Standards Board

.133 Methanex 2002 Technical Information and Safe Handling Guide for Methanol

.134 National Fire Code of Canada

.135 NFPA 300 (2003 Edition)

.136 NPC, National Plumbing Code

.137 Plastics Pipe Institute's PPI Handbook of Polyethylene Piping, chapter "Underground Installation of PE Piping" and chapter "Specifications, Test Methods and Codes for Polyethylene"

.138 TSSA, Technical Standards and Safety Association

.139 Provincial Building Code

.140 Provincial Plumbing Code

## 1.4 Design Requirements

.1 The design has been completed to the degree necessary for the Contractor to Bid. It is not fully detailed and will require the Contractor to undertake design of and responsibility for minor aspects for the piping systems to be installed.

.2 All process piping shall meet requirements of the Process Piping Code, B31.3, whether or not it falls within the Code scope. Manitoba Department of Labour and Immigration shall be the Code Authority whenever the piping system falls within the Code scope. The Contract Administrator shall be the Code Authority for process piping that does not fall within the Code scope.

.3 Piping and Instrumentation Drawings, piping schematics, and piping layout Drawings are contained in the Drawings set. The Piping and Instrumentation Drawings (P&IDs) indicate all major pipework, valves, and appurtenances (other than cleanouts, purge points, etc.) The layout Drawings indicate the design concepts and are intended to illustrate a constructible method for the piping systems. Some appurtenances, supports, guides and anchors, and expansion joints are not fully shown. The Contractor's design will complement and detail these Drawings.

.4 It is understood that some conflicts will arise that will require that the Contractor re-route some of his piping to allow for the installation of wiring, ventilation duct, or similar.

.5 The Contractor is required to engage a Professional Engineer registered in the Province of Manitoba to be responsible for the final aspects of the design. The components of the design that will be generated will be as follows:

.1 Final layout, illustrated using layout and isometric drawings.

.2 Piping flexibility and stress analysis proving that the allowable stresses prescribed by the Process Piping Code B31.3 are not exceeded under any prescribed combination of conditions, and indicating the forces and moments in each direction under each condition at each support, guide or anchor.

.3 Piping support system design, including details and spacing of all supports. The support system will ensure that the weight of the pipework and the need for lateral and vertical support are considered fully.

.4 Expansion and contraction design, including the layout and details for all necessary expansion joints needed to compensate for thermal expansion and contraction, structural movement, and the isolation of equipment.

.5 Thrust restraint design, including thrust restraint required due to any forces imposed during construction, pressure testing, normal operation, and/or surging, if applicable. The thrust restraint design shall include a minimum safety factor of 2.0 using the maximum thrust force that will be experienced during construction, pressure testing, normal operation, and/or surging, if applicable. This requirement applies to new piping systems as well as to existing piping systems that may be modified.

.6 The piping system shall have sufficient flexibility to prevent thermal expansion or contraction or movements of piping supports and terminals causing:

.1 Failure of piping or supports from overstress or fatigue

.2 Leakage at joints

.3 Detrimental stresses or distortion in piping and valves or in connected equipment or piping systems not designed by the Contractor, resulting from excessive thrusts and moments in the piping.

.6 Design documentation will be submitted to the Contract Administrator as necessary to indicate compliance with the requirements of the piping systems. The documentation will be signed and sealed by a Professional Engineer registered in the Province of Manitoba, who must provide evidence of experience with such systems.

.7 Note that for large diameter, thin walled (thickness less than 1 percent of diameter) piping comprehensive flexibility and stress analysis is required, even if the design met the exception granted under section 319.4.1(c) of the Process Piping Code B31.3.

## 1.5 Submittals

.1 For each piping system refer to Section 11055, submit documentation listing pipe, fittings, flexible connectors, expansion joints, linings, coatings, and valving to be used for each pipe size and category.

.2 Radiographic Weld Testing

.1 Submit the name and qualifications of at least two independent firms for the radiographic weld testing to be undertaken by the Contractor if and as required by the applicable Code. The selected firm will be subject to the review and acceptance of the Contract Administrator.

.3 A copy of this Specification Section and all referenced sections with each paragraph check-marked to show compliance or highlighted to indicate deviation.

.4 For all pipes greater than or equal to 50 mm diameter, submit isometric drawings, to indicate the assembly details, the welds, flanges, valve placement, cathodic protection, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details.

.5 Submit piping layout drawings by plant area which indicate location and placement of valves, fittings and other appurtenances for all piping, greater or equal to 150 mm diameter, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.)

.6 Submit copies of all original submittals and all related correspondence made as part of the regulatory submission required by the Manitoba Department of Labour and Immigration and any submissions required by other regulatory authorities.

.7 Product Samples

.1 Where specified or when directed by the Contract Administrator, provide mill test results or product samples.

.8 Provide hanger, guide, and anchor, support system design details including locations, load information, design calculations and illustrative drawings, signed and sealed by a Professional Engineer registered in the Province of Manitoba. Refer to Section 11052.

.9 For expansion joints submit manufacturer's catalogue data, Shop Drawings and assembly drawings confirming general arrangement, dimensions, tolerances, materials of construction, weights and installation details. Submit calculations to substantiate expansion joint selection and amount of pre-compression, signed and sealed by a Professional Engineer registered in the Province of Manitoba. Refer to Section 11053.

.10 Welding

.1 Prior to commencing any welding of stainless steel pipe, prepare and submit to the Contract Administrator a written description of welding techniques including but not limited to materials, methods, and quality control. Identify differences in shop and field techniques. Written procedures will be signed and sealed by a Professional Engineer registered in the Province of Manitoba and qualified for welding design. For stainless steel welds exposed to process fluids, the weld procedure should provide for maximizing the corrosion resistance of the final weld as well as providing the mechanical strength required.

.11 Radiographic weld test results

.12 Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.

## 1.6 Coordination

.1 Process and Utility Piping identification

.1 Refer to Section 11910 for process piping identification.

.2 Process and utility piping is identified in the Drawings by a two component alpha-numeric code, (Line Label) as follows:

.1 The first component of the code indicates the nominal line size.

.2 The second component of the code identifies the process fluid being conveyed, (Commodity).

.3 The process fluid (commodity) codes are defined in the Drawings.

.3 Detailed process pipe Specifications are provided for each commodity in Section 11055.

.4 Routing

.1 Coordinate piping installation routes and elevations with installation of sheet metal, process equipment, HVAC, instrumentation, and electrical work.

.5 Pipe sleeves

.1 Coordinate with other divisions to locate and place sleeves in cast-in-place concrete and in masonry building elements prior to construction.

.6 Coordinate with Division 17 to provide correct piping configuration for primary instrumentation elements. For example, provide required minimum straight run of pipe upstream and downstream of flow meters. Coordinate with Division 17 for meter manufacturer's requirements.

## 1.7 Quality Assurance

.1 Welding certification

.1 All welders are to be certified under the Manitoba Department of Labour and Immigration and Regulations. As a minimum, welders will hold a Level B Journeyman Welder's Certificate.

.2 All welders who work on this project must provide the correct documentation.

.3 Welders working on stainless steel piping must not work on welding of any other material.

.4 Tools used for stainless steel piping welding must be new and marked for this use. These tools must not be used for any other Work. Tools must not be made of materials that could contaminate the stainless steel surface.

.2 Weld tests

.1 All piping welds shall be 100 percent visually inspected by a registered inspector and any imperfections shall be made good as required by the applicable Code and to the satisfaction of the Contract Administrator.

.2 For piping required by the applicable Code to be subject to radiographic inspection, or for welds not found satisfactory during the Contract Administrator's visual inspection provide for one full circumference radiographic inspection for every 20 welded pipe-to-pipe and pipe-to-fitting joints. All sizes and types of pipe welds to be tested at locations identified by the Contract Administrator.

.3 Contractor to provide for one full circumference radiographic inspection for every 20 welded pipe-to-pipe and pipe-to-fitting joints. All sizes and types of pipe welds to be tested at locations identified by the Contract Administrator.

.4 Have radiographic test firm evaluate welds in accordance with ANSI/ASME B31.3 Process Piping Code Normal Service and prepare report summarizing results.

.5 Have radiographic weld test report, complete with results, submitted directly to Contract Administrator.

.6 For each defective weld, three (3) additional radiographic inspections at locations identified by the Contract Administrator will be required plus a radiograph of the repair.

.3 Regulatory submissions

.1 Complete all regulatory submissions as required by the Manitoba Labour and Immigration.

.2 Complete all other submissions as required by other regulatory authorities.

## 1.8 Conflicts

.1 Review the Drawings prior to installation of piping, conduit services, and fixtures by this or any other division. Identify any conflicts and cooperate with the Contract Administrator to determine the adjustments necessary to resolve these conflicts.

.2 Confirm the routing of each section of pipework with other services prior to commencement of installation. Advise the Contract Administrator of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Contract Administrator.

## 1.9 Shipment, Protection and Storage

.1 Refer to Section 01600 for Shipment and Storage.

.2 Deliver pipe, fittings, and specials to Site using loading methods which do not damage pipe or coatings.

.3 Piping materials delivered to Site will be clearly marked to indicate size, type, class/schedule, and coatings.

.4 Until ready for incorporation in the Work, store on-site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.

.5 Store materials at least 200 mm above ground with sufficient supports to prevent undue bending.

.6 Protect non-UV light inhibited plastic from sunlight.

.7 Ship pipe expansion joints, anchors, guides and flexible connectors pre-assembled to the degree which is practical.

.8 Provide shipping devices to maintain the face-to-face dimension of each expansion joint during shipment, storage and installation. Design and place shipping devices so as not to inhibit installation of the joints.

## 1.10 Warranty

.1 Contractor shall supply new materials and re-do the Work should materials be found to be defective or not in compliance with the Specifications, or should the workmanship be found to be inadequate or the Work was not performed in accordance with the Specifications and referenced standards, codes and regulations. This warranty shall remain in effect for the maximum period of time allowed under Law.

.2 Neither the Contract Administrator's inspections, checks, or any other tests or subsequent authorization to proceed with the Work, nor the Contract Administrator's waiving of the Contract Administrator's right to perform such tests, nor the Contract Administrator's decision not to solicit submission of material certificates or other quality assurance documentation relieve the Contractor from any degree of responsibility in regard to the Work or the corresponding warranty above. The Contractor agrees that the Contract Administrator's ability to fully assess the suitability of materials, procedures, worker qualifications and other relevant issues is limited. The Contractor bears full responsibility and is solely liable in these matters.

.3 The use of faulty materials or materials that do not meet the Specifications and referenced standards, codes and regulations shall constitute a hidden defect.

.4 Employment of labour not properly qualified, the performance of the Work not in accordance with the Specifications and the referenced standards, codes and regulations, and the use of inadequate of sub-standard workmanship shall constitute hidden defects.

## 2. PRODUCTS

### 2.1 Function

.1 Provide the pipe materials, fittings, and appurtenances as described below, for the piping systems shown.

### 2.2 Pipe Materials - General

.1 All pipe materials to be new, free from defects and conforming to the reference standards identified in Section 11055.

.2 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the new standard.

### 2.3 Pipe Sizes

.1 Where the pipe size is not specified, provide pipe with the sizes required by the National Plumbing Code. For small piping not described by the National Plumbing Code, use 12 mm nominal diameter.

### 2.4 Fittings

.1 General

.1 Provide eccentric reducers in horizontal lines with the flat side on top, unless shown otherwise.

.2 Provide concentric reducers in vertical lines unless indicated otherwise.

.3 Provide long radius elbows unless otherwise shown. Provide smooth flow carbon or stainless steel elbows 350 mm and less, to ANSI B16.9. Provide mitred elbows greater than 350 mm, to AWWA C208 unless otherwise shown or specified. Use three piece construction unless otherwise shown or specified.

.4 Provide fittings in concrete cylinder pipe fabricated from metal plate, cement lined and coated, and in accordance with AWWA C301. Dimensions to AWWA C208.

.2 Steel Pipelines

.1 75 mm diameter or greater: conform to ANSI B16.9, ANSI B16.11 or ANSI B16.5. Provide fittings with a wall thickness equal to or greater than the pipe.

.2 Less than 75 mm diameter: provide threaded malleable iron fittings, conforming to ANSI B16.3.

.3 Provide long radius steel grooved-joint fittings conforming to ANSI B16.9 in steel grooved-joint pipeline systems. Grooved joint adapters may be welded to fitting ends; dimension and cut the groove of the adapter in accordance with the coupling manufacturer's recommendations; materials and inside diameter to be the same as the pipe; grind the interior weld smooth and meet the lining Manufacturer's recommendations.

.4 For steel grooved-joint pipe of diameters of 150 mm and less, the Contractor may provide ductile iron grooved-joint fittings which have an outside diameter equal to the steel pipe diameter. Provide ductile iron to ASTM A536, dimensioned to 1.5 diameter radius bends, and cut grooving dimensions to AWWA C606 IPS dimensions. The lining and coating of the ductile iron fittings must equal the lining and coating of the steel pipeline system.

.5 Standard radius elbows to dimensions of ANSI B16.5 may be provided on clean water grooved-joint piping systems only.

.3 Stainless steel pipelines

.1 Less than 75 mm diameter: provide fittings of the same class as the pipe, conforming to ASTM A403 and ANSI B16.11.

.2 Equal to or greater than 75 mm diameter: fabricate fittings using similar materials and classes as the pipe and conform to ASTM A774 (scale removed).

.4 Ductile iron pipelines

.1 For flanged piping systems, provide fittings that conform to ANSI B16.1 and in grooved end or mechanical joint ductile iron pipelines to AWWA C110.

.2 For ductile iron grooved-joint pipelines, provide ductile iron grooved-joint fittings which have an outside diameter equal to the pipe diameter. Provide ductile iron to ASTM A536, dimensioned to 1.5 diameter radius bends, and cut grooving dimensions to AWWA C606 IPS dimensions. The lining and coating of the ductile iron fittings must equal the lining and coating of the pipeline system.

.5 PVC pipelines

.1 Provide ductile iron fittings that conform to AWWA C110 or provide PVC to CSA B137.3, of the same material and class as the pipe.

.6 FRP pipelines

.1 Provide fittings of the same material and class as the pipe. Provide flanges to meet ANSI B16.5 Class 150 bolt hole patterns.

.2 Provide adhesive kits suitable for the selected FRP material.

.7 Copper pipelines

.1 Provide copper fittings in conforming to ANSI B16.26.

.8 Polyethylene pipelines:

.1 Provide fittings in the same material and class as the pipe.

.2 Thermal butt fusion joints to ASTM D2774.

.9 Buried pipelines

.1 For buried piping and piping inside carrier pipes, refer to Division 2.

## 2.5 Grooved Piping System – IPS Carbon Steel

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes, and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved couplings:

.1 Grooved couplings shall be manufactured from ductile iron conforming to ASTM A536.

.2 All grooved couplings to be designed with angle pads to provide a rigid joint unless otherwise noted. Standard of Acceptance: Victaulic Style 07 (Victaulic Data Sheet 06.02).

.3 Where expansion, contraction, or angular deflection is designed into pipe system flexible couplings shall be used. Standard of Acceptance: Victaulic Style 77 (Victaulic Data Sheet 06.04).

.3 Grooved fittings: all grooved fittings to be manufactured from ductile iron conforming to ASTM A536, forged steel conforming to ASTM A234 or carbon steel conforming to ASTM A53. Standard of Acceptance: fittings manufactured by Victaulic (Victaulic Data Sheet 07.01).

.4 Bolted mechanical branch connections: branch connections may be provided by bolted, mechanical branch connections manufactured from ductile iron conforming to ASTM A536 complete with synthetic rubber gaskets approved for line service. Standard of Acceptance: Victaulic Style 920 N (Victaulic Data Sheet 10.01).

.5 Flange adapters: for connection to ANSI Class 125/150 or Class 250/300 flanged components, grooved flange adapters manufactured from ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47 may be used. Standard of Acceptance: Victaulic Style 741 and Style 743 (Victaulic Data Sheet 06.06 and 06.07).

.6 Noise and vibration attenuation: where it is necessary to suppress noise or vibrations in piping system, three (3) Victaulic Flexible Grooved couplings may be installed close to the source of noise or vibration in lieu of Elastomeric Flexible "Arch Type" connectors or Flexible Metal Hose connectors. Standard of Acceptance: Victaulic Style 77 (Victaulic Data Sheet 26.04).

**2.6 Grooved Piping System – Stainless Steel – Specify Type 304 or Type 316 SS**

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes, and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved Couplings

.1 Grooved couplings shall be manufactured from stainless steel conforming to ASTM A351, ASTM A743 or ASTM A744.

.2 Grooved couplings to be designed with angle pads to provide a rigid joint, unless, otherwise noted. Standard of Acceptance: Victaulic Style 489 (Victaulic Data Sheet 17.25). Note: in some applications painted or galvanized ductile iron couplings may be used to joint stainless steel pipe. Confirm with manufacturer.

.3 Where expansion, contraction or angular deflection is designed into piping system flexible couplings shall be used. Standard of Acceptance: Victaulic Style 77S and Victaulic Style 475 (Victaulic Data Sheet 17.03 and 17.14).

.3 Grooved fittings: all grooved fittings to be manufactured from stainless steel conforming to ASTM A312, ASTM A403 or ASTM A774. Standard of Acceptance: fittings manufactured by Victaulic (Victaulic Data Sheet 17.04).

## 2.7 Grooved Piping System – AWWA Ductile Iron

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes, and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved couplings:

.1 Grooved couplings shall be manufactured from ductile iron conforming to ASTM A536. Gaskets shall be Grade "M" FlushSeal Halogenated Butyl for water service. Standard of Acceptance: Victaulic Style 31 (Victaulic Data Sheet 23.02).

.2 For connecting components of IPS dimension to components of AWWA dimension, grooved transition couplings may be used. Gaskets shall be Grade "M" FlushSeal Halogenated Butyl for water service. Standard of Acceptance: Victaulic Style 307 (Victaulic Data Sheet 23.03).

.3 Grooved fittings: grooved fittings shall be manufactured from ductile iron conforming to ASTM A395, Grade 65-45-12 or ASTM A536, Grade 65-45-12 or cast iron conforming to ASTM A48, Class 30-A. Standard of Acceptance: fittings manufactured by Victaulic (Victaulic Data Sheet 23.05).

.4 Flanged adapters: for connection to ANSI Class 125/150 or Class 250/300 flanged components, grooved flange adapters manufactured from ductile iron conforming to ASTM A395 or ASTM A536 may be used. Standard of Acceptance: Victaulic Style 341 (Victaulic Data Sheet 23.04).

## 2.8 Grooved Piping System – Copper Tubing

.1 General:

.1 All grooved components shall be of one manufacture and approved for use by the authorities, agencies, codes, and standards named in the Specifications.

.2 All approved manufacturers shall be certified to ISO 9001 standards.

.2 Grooved Couplings:

.1 Grooved couplings shall be manufactured from ductile iron conforming to ASTM A536.

.2 All grooved couplings to be designed with angle pads to provide a rigid joint unless otherwise noted. Standard of Acceptance: Victaulic Style 606 (Victaulic Data Sheet 22.02).

.3 Couplings shall be complete with FlushSeal gaskets or equivalent.

.3 Grooved fittings: all grooved fittings to be manufactured from wrought copper conforming to ASTM B75, C12200 or ASTM B152, C1100 or cast bronze per ASTM B584. Standard of Acceptance: Fittings manufactured by Victaulic (Victaulic Data Sheet 22.04).

.4 Flanged adapters: for connection to ANSI Class 125 / 150 or Class 300 flanged components, grooved flange adapters manufactured from ductile iron conforming to ASTM A536. Standard of Acceptance: Victaulic Style 641 (Victaulic Data Sheet 22.03).

## 2.9 Gaskets

.1 For flat-faced flanges, use full-face gaskets. For Van Stone, lap joint and raised-face flanges, use full face or ring type gaskets. Conform to ASTM B16.21.

.2 Use gasket materials for flanged connections suitable for the temperature, pressure, and corrosivity of the fluid conveyed in the pipeline. Refer to the Detailed Pipe Specification Sheets for the recommended gasket material. Material designations used in the Detailed Pipe Specification Sheets are as follows:

.1 EPDM: ethylene-propylene-diene-terpolymer 70 durometer

.2 Bl. Neoprene: neoprene (black) 70 durometer (not acceptable in stainless steel pipe systems)

.3 Nitrile: nitrile (Buna N)

.4 SBR: Styrene-butadiene (red)

.5 Natural rubber: natural rubber

.6 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)

.7 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152). 0.1 mL/h Leakage Fuel A (ASTM F37)

.8 Gylon Type 1: Garlock Style 3500. 1.35 MPa (ASTM F152). 0.22 mL/h Leakage Fuel A (ASTM F37)

.9 Gylon Type 2: Garlock Style 3510. 1.35 MPa (ASTM F152). 0.04 mL/h Leakage Fuel A (ASTM F37)

.10 CPE - chlorinated polyethylene

.3 Unless otherwise specified, minimum Gasket Material Thickness for full face gaskets:

.1 Up to 250 mm pipe diameter: 1.6 mm thick

.2 Greater than 250 mm pipe diameter: 3.2 mm thick

.4 Unless otherwise specified, minimum gasket material thickness for raised face rings gaskets:

.1 Up to 100 mm pipe diameter: 1.6 mm thick

.2 Greater than 100 mm pipe diameter: 3.2 mm thick

.5 Grooved type gaskets:

.1 Select material as recommended by the manufacturer for the service conditions indicated.

.2 Unless otherwise specified; for epoxy- and glass-lined piping systems for solids-carrying liquids, provide end-seal type gaskets.

.3 Unless otherwise specified, provide flush seal type gaskets for all other grooved joint systems. Acceptable Products: Gustin-Bacon Rigigrip, Victaulic Flush-Seal.

## 2.10 Bolts and Nuts

.1 Provide hex head bolts and nuts. Threads to be ANSI B1.20.1, standard coarse thread series.

.2 For general indoor service, use bolts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Grade A.

.3 Provide stainless steel bolts, nuts and washers for exposed, submerged, buried and concrete encased service; bolts conforming to ASTM A193, Grade B8, C1.1; nuts conforming to ASTM A194, Grade 8. Provide these also for connections above normal water level but which may be subjected to direct contact with splashed water.

.4 Provide hot dip galvanized bolts, nuts and washers for use with hot dip galvanized Van Stone flange back-up rings and Lap-joint flange back-up rings.

.5 Provide hex nuts equal to or less than 25 mm. Greater than 25 mm, provide heavy hex.

## 2.11 Structural Element Penetrations

.1 Structural element penetrations are shown and referenced to a detail or Process/Mechanical Standard Detail. Where a structural element penetration is not referenced, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

.2 Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during blockwork erection.

.3 Supply wall or floor penetrations into submerged areas, under slab areas, and where shown with a 6 mm thick water stop flange at least 50 mm larger than the pipe or pipe sleeve outside diameter. Continuously weld the water stop flange, both sides, onto the pipe or pipe sleeve. Fill annular space between the sleeve and pipe, where a sleeve is used, with non shrink grout in accordance with Division 3. Form reglets between the grout and the concrete and between the grout and the pipe, on "wet" sides of the wall penetration. Fill reglet with sealant.

.4 For structural concrete wall and floor penetrations of non-insulated pipe between dry areas, furnish a sleeve which has an internal diameter at least 50 mm larger than the outside diameter of the pipe. For pipes 75 mm and less furnish a pipe sleeve 25 mm larger than the outside diameter of the pipe.

.5 For masonry wall penetrations of non-insulated pipe, furnish a sleeve which has an internal dimension of at least 50 mm larger than the pipe outside diameter. For pipes 75 mm and less furnish a pipe sleeve 25 mm larger than the outside diameter of the pipe.

.6 A Standard Detail is shown for segmented modular pipe seals. Where this detail is used for the penetration of a wall separating a dry area from an underground area, tighten the bolts from the inner face and fill the outer annular space with grout. Use stainless steel bolts and nuts in penetrations through walls separating underground or exterior areas from any other area. If seepage occurs during the warranty period, the Contractor is responsible for repair and/or replacement, at no cost to the City. Do not use this type of wall penetration below maximum ground water level elevation.

## 2.12 Insulation

.1 Provide insulation in accordance with Section 11059. Minimum insulation thickness: 25 mm. Use greater thicknesses as recommended by the manufacturer if more than 25 mm is required to lower the outer skin temperature to below 40°C.

.2 Provide stainless steel bands over the insulation at a maximum of 300 mm centers.

.3 Provide insulation and recovering for all piping where the pipe surface will sweat, where heat retention is required, and at the locations indicated on the Drawings. Conform to Section 11059.

.4 Where pipe runs below ground, continue insulation and recovering to a depth 2.5 m below finished ground surface in grassed areas or 3.0 m below roads, walkways, and access pads.

.5 Do not insulate over expansion joints or flexible hose connectors, in order to permit periodic inspection of connector bolting.

.6 Recover all insulated pipe. Align longitudinal seams in aluminum recovering to shed water. Overlap radial seams a minimum of 50 mm.

.7 Refer to Division 16 for electrical heat tracing.

## 2.13 Interior Finishes (Linings)

.1 General

.1 Provide products with factory applied linings and finishes unless otherwise noted. Fittings and pipe of any one pipe system to be lined by the same manufacturer.

.2 Do not shop coat the internal surface of stainless steel or plastic piping.

.3 Provide No. 1 or No. 2B standard finish for gauge stainless steel pipe, as specified in ASTM A480. Finish heavier pipe to No. 1 mill finish or better, as specified in ASTM A480.

.4 Unless otherwise specified, finish fittings in the same manner as the pipe run.

.2 Epoxy, E2a, E2b or E2c

.1 Where specified in the Detailed Pipe Specification Sheets, apply epoxy to the internal surface of piping in accordance with AWWA C210. Refer to Section 09900.

.3 Asphaltic Varnish

.1 Provide asphaltic varnish as the standard finish for ductile iron and cast iron pipe, in accordance with AWWA C151.

.4 Cement Mortar Lining

.1 Where specified in the Detailed Pipe Specification Sheets, apply cement mortar lining and an asphaltic seal to the internal surface of ductile iron piping in accordance with AWWA C104.

.2 Where specified in the Detailed Pipe Specification Sheets, apply cement mortar lining and an asphaltic seal to the internal surface of steel piping in accordance with AWWA C205.

.5 Glass Lining

.1 Where specified in the Detailed Pipe Specification Sheets, apply glass lining to pipe interior in two coats.

.2 Sandblast interior pipe surfaces prior to lining application to white metal finish in accordance with SSPC-10.

.3 After application of first and each subsequent coat, expose to naturation temperature above 750°C.

.4 Finished lining will be:

.1 200 to 300 microns thick

.2 Density of 2.5 to 3.0 grams per cubic centimetre

.3 Hardness in excess of 5.0 on the MOHS scale

.4 Capable of withstanding 175°C thermal shock without crazing, blistering, or spalling

.5 No visible loss of surface gloss after immersion in 8 percent sulphuric acid solution at 65°C for a period of ten minutes.

.6 No more than 0.01 percent exposure of the base metal due to defects in the glassed surface

.5 Provide sample to Contract Administrator for use as a comparison guide.

.6 Acceptable products modified to meet this specification are:

.1 Vitco

.2 Waterworks

.7 The glass lining shall provide continuous coverage when tested by a low voltage wet sponge holiday detector, with only isolated voids permitted due to casting anomalies and which represent less than 0.01 percent of the total glassed surface. Testing procedure and acceptance criteria shall be as per "MP-92, Porcelain Enamel Continuity Testing", as listed in Clauses 2.10.5.7.1 – .3.

.1 Purpose: proper application of the porcelain enamel coating provides beneficial long term characteristics of lubricity, adherence, and resistance to corrosion and high temperature. Currently, there is no test method, either destructive or non-destructive, which directly measures these characteristics. Rather, the industry has developed a testing method utilizing a holiday detector, which determines the continuity of the glass lining and indicates the relative quality of the process. This method is commonly referred to as "spark test".

.2 Test Description

.1 Equipment: the equipment consists of a Tinker and Rasor electronic device or equivalent designed to locate holidays (pinholes, voids, ridges, etc.) in the non-conducting porcelain enamel lining. It functions by applying a 67.5 V potential across the glass lining. Any pinholes or other holidays in the glass lining will close the circuit and produce an audible signal from the detector for any resistance less than 10,000 ohms. The current is applied through a circular sponge which has been wetted using water containing approximately 1 percent of a wetting agent such as Kodak "Photo Flo".

.2 Procedure: for testing long pipe sections, the diameter of the wetted sponge shall exceed the diameter of the pipe so that the sponge is in full circumferential contact with the porcelain enamel lining of the pipe. The sponge is attached to a rod which allows the sponge to be pushed through at least 50 percent of the pipe. Any discontinuities will result in an audible signal which will be recorded with regard to position along the pipe. Testing is performed from both ends of the pipe.

.3 Special techniques are required at the exposed pipe ends which are not enameled. If, due to excess water on the sponge, the electric current short circuits to the end of the pipe resulting in an audible signal (typically within 75 mm of the end), a visual inspection shall be made to determine if discontinuities exist.

.3 Acceptance criteria: the pipe or fittings as tested by the procedure shall be rejected from shipment if testing reveals more than isolated voids due to casting irregularities which represent more than 0.01 percent of the total glassed surface (no more than one to two pinholes per fitting or an average of five or less per 6 m pipe spool). Rejected pipe shall be evaluated for additional coating with porcelain enamel or for total reblasting, reprocessing, and retesting.

## 2.14 Exterior Finishes - (Coatings) Shop Applied

.1 Provide Products with factory applied coatings and finishes as specified in the Detailed Pipe Specification Sheets. If no coating is specified in the Detailed Pipe Specification Sheets, refer to Section 09900 for general painting requirements. Refer to Section 11910 for colour coding requirements.

.2 Yellow Jacket

.1 High density polyethylene (HDPE) jacket extruded over a mastic base

.2 Manufacture, test, inspect, and report procedures to meet or exceed CAN3-Z299.3 (Quality Assurance Program - Category 3).

.3 Prior to mastic application, sandblast pipe in conformance with requirements or SSPC SP6.

.4 Adhesive consists of rubberized asphalt mastic, non-hygroscopic, formulated for use with Yellow Jacket. Apply to prepared surfaces in thickness exceeding 0.175 mm.

.5 HDPE has the following minimum properties: ultimate tensile strength, 21 MPa; Tensile elongation at break, 600 percent; Shore "D" hardness, 60; and Brittleness temperature - 50°C.

.6 Apply HDPE by extruding over adhesive in an even thickness to provide a smooth continuous outer sheath, free of pinholes, bubbles, wrinkles, blisters, cracks, or mechanical damage.

.7 Minimum HDPE thickness will be as follows:

| **Nominal Pipe Diameter (mm)** | **Minimum HDPE Thickness (mm)** |
|---|---|
| 20 | 0.55 |
| 25 | 0.55 |
| 30 | 0.60 |
| 40 | 0.65 |
| 50 | 0.70 |
| 65 | 0.70 |
| 75 | 0.70 |
| 100 | 0.75 |
| 150 | 0.90 |
| ≥200 | 1.00 |

.8 All flaws (up to three per pipe) will be repaired by cutting out each damaged area and applying sealant lined 200 mm diameter patch or heat shrink sleeve not exceeding 400 mm in length. Overlap undamaged area by a minimum of 75 mm around cut out section.

.9 Where the number of flaws or damaged areas per pipe exceeds three or any flaw is too large to be repaired with a patch or sleeve, the pipe will be rejected.

.10 Tape wrap: shop-applied tape wrap may be used as an alternative to Yellow Jacket. Two or three layer methods can be used, meeting or exceeding the application and performance requirements of AWWA C214.

.3 Epoxy, E2a, E2b or E2c

.1 Apply epoxy (E2a, E2b or E2c) to the exterior of piping in accordance with AWWA C210. Refer to Section 09900 for details.

## 2.15 Exterior Finishes - (Coatings) Field Applied

.1 General

.1 Use field applied finishes only for

.1 Short lengths of metal pipe in a piping system where the length of pipe which requires coating is less than 3.0 m unless otherwise specified

.2 To repair shop-applied exterior finishes

.3 To make up cutback distances at joints

.4 For fittings, couplings, valves and other appurtenances

.2 Refer to Section 09900 for painting requirements for aboveground piping and piping located in tunnels, buildings, pump houses, and other structures. Also refer to Section 09900 for painting requirements for exposed piping within insulated systems.

.2 Tape wrap

.1 For welded joints on Yellow Jacketed pipe and as other indicated locations apply tape to buried pipe and fittings. Use Polyken, Tec-Tape or Denso tape, consisting of primer and tape applied to minimum thickness of 0.90 mm in accordance with AWWA C209.

.2 For flanged or coupled joints and for fittings use petrolatum primer, mastic and tape; Polyken, Tec-Wrap or Denso, in accordance with AWWA C217.

.3 For piping systems for flammable liquids or combustible liquids shall be wrapped with synthetic rubber or adhesive plastic tape for corrosion protection.

.3 Shrink sleeve

.1 As an alternative to tape wrap, shrink sleeves are acceptable if material and method of installation is reviewed and accepted by the Contract Administrator prior to use.

.4 Epoxy, E2a, E2b or E2c

.1 Apply epoxy, E2a, E2b or E2c, to the exterior of piping in accordance with AWWA C210. Refer to Section 09900.

**2.16 Galvanizing**

.1 Where piping is to be galvanized, hot dip zinc coat to CSA G164 with a minimum coating of 550 $g/m^2$.

.2 All carbon steel parts, such as elements of flanges, anchors, guides, and supports shall be galvanized, hot dip zinc coat to CSA G164 with a minimum coating of 550 $g/m^2$. Elements welded to components that do not lead themselves to hot dip galvanizing shall be thoroughly cleaned and cold zinc galvanized to similar coat thickness. Surface preparation for cold galvanizing shall meet specifications of the manufacturer of the cold galvanizing product. Product shall meet 2000 hours resistance test to salt spray (ASTM B-117).

**2.17 Grout**

.1 Non-shrink grout: conform to Section 03300.

**2.18 Concrete**

.1 Provide concrete for concrete surround placed around buried pipe, and fill placed over buried pipe, in accordance with Section 03300 and as shown.

**3. EXECUTION**

**3.1 Preparation**

.1 Prior to installation, inspect and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

.2 Make all minor modifications to suit installed equipment and structural element locations and elevations.

.3 Piping arrangements indicated on the Drawings have been established on the basis of the "Design Standard" listed in the specific process equipment sections. If the equipment to be provided is not the Design Standard, modify the piping arrangement as necessary at no additional expense to the City.

.4 Advise the Contract Administrator of all modifications. Do not commence work on the related piping until all modifications have been reviewed by the Contract Administrator.

.5 Include any piping modifications in the Shop Drawings submitted prior to fabrication or installation.

## 3.2 Pipe Handling

.1 Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings. Do not use sections of large diameter, thin walled stainless steel piping that may have been deformed out of roundness or dimpled. Such damaged sections shall be discarded.

.2 Remove all foreign matter from inside of pipe prior to installation.

.3 Repair pipe with damaged protective coatings with material similar to the original in accordance with the manufacturer's directions and to the satisfaction of the Contract Administrator.

.4 Damaged glass lining cannot be repaired. Damaged pipe must be replaced.

.5 Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe or coatings.

.6 When lifting sections of large diameter, thin wall piping onto the supports, use methods that will prevent damage or deformation. Lift evenly at several places to ensure that the piping deflection between lifting points does not exceed 6.3 mm.

## 3.3 Sleeves

.1 Unless otherwise noted or approved by the Contract Administrator, provide sleeves where piping passes through a wall, floor, or ceiling.

.2 Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

## 3.4 Installation of Pipe Underground/Buried and Below Structures

.1 Trenching and backfill for buried pipe: conform to Division 2

.2 Pipe laying and bedding: conform to Division 2

.3 Unless otherwise shown, protect pipe laid below structures with a concrete surround having a minimum coverage of 100 mm all around the pipe; extend concrete surround to undisturbed ground.

.4 For concrete surround, comply with the following:

.1 Install pipe in straight alignment. Do not exceed 10 mm variance from the true alignment in any direction.

.2 Ensure the pipe alignment stays true during and after placement of concrete surround.

.3 Ensure that the method used to prevent pipe uplift during placement of concrete surround results in a level invert and crown.

.4 Maintain pipe circular cross section.

.5 Provide lean concrete to within 150 mm of the underside of the slab or footing for backfill over pipe laid below structures, except as detailed otherwise.

.6 Place concrete in accordance with Section 03300.

.7 Provide Yellow Jacket or tape wrap on all fittings and flanged, grooved, plain end and welded joints underground and below structures.

.8 Unless otherwise specified or shown, for underground piping, provide groove joints or flex coupled joints at 6 m on center.

.9 Use anti-seize compound with all stainless steel nuts and bolts.

.10 Prior to installation provide a manufacturer's representative, from the HDPE pipe manufacturer, for a minimum of one day to instruct personnel on installation procedures of HDPE pipe.

## 3.5 Installation

.1 Fabricate and install process and pressure piping in accordance with the Process Piping Code B31.3 and the Manitoba Department of Labour and Immigration. Fabricate and install domestic hot and cold water piping, sanitary piping, and storm drainage piping in accordance with the National Plumbing Code.

.2 Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage. Supports, bracing, and expansion joints shown in the Drawings are schematic only. The Contractor is responsible for the design, supply, and installation of the piping system in general accordance with the indicated requirements.

.3 Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag, or stress.

.4 Install expansion joints where shown and at other locations as necessary to allow for piping expansion and contraction.

.5 Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves, or pipe.

.6 Accurately cut all piping for fabrication to field measurements. Process air piping sections shall be measured and cut at a temperature between 15°C and 20°C. If the installation in the field takes place at lower outdoor temperatures, provide circulation of hot air inside the piping to expand the material such that flanges can be bolted. Expansion joints for process air piping shall be blocked at their natural length at 15°C to 20°C and such that they will not deflect excessively during handling and installation. These blocks shall be removed prior to pressure testing.

.7 Install pipes in straight alignment. For large diameter (500 nominal diameter and greater), thin-walled (6.4 mm and less) stainless steel piping provide laser alignment of all pipe supports. Lateral and vertical misalignment between any three (3) consecutive supports shall not exceed the pipe wall thickness.

.8 For piping other than large diameter, thin-walled stainless steel, do not exceed 10 mm in 10 m variance from the true alignment, in any direction.

.9 Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. The "springing" of pipework to ensure alignment is not permitted. Undo and subsequently remake all pipework connections to ensure that springing does not occur. Take care not to damage equipment, valves, or flanges.

.10 Slope instrument air piping to condensate traps. Provide condensate traps as recommended by the manufacturer of the instrument air compressor.

.11 Do not cut or weaken the building structure to facilitate installation.

.12 In parallel pipe runs, offset flanges, and grooved joint fittings by a minimum of 200 mm.

.13 In vertical pipe runs of diameter greater than 250 mm, provide 200 mm long spool piece on lower side of each valve.

.14 Provide aluminum watertight drip trays under pipe carrying corrosive commodities crossing over cable trays. The drip trays will be 300 mm wider and 600 mm longer than the piping area over the cable tray.

## 3.6 Mild Steel Welding

.1 Use manual shielded metallic arc welding (SMAW), submerged arc welding (SAW), or inert gas shield arc welding (GMAW) or gas tungsten arc welding (GTAW).

.2 Welding procedures shall conform to CSA Z183.

.3 Bevel plain pipe ends prior to welding.

.4 Clean and dry welding surfaces thoroughly prior to welding, in an area not less than 0.3 m wide on each side around the welding line.

.5 Do not proceed with welding when metal temperatures fall below minus 18°C. Apply supplemental heat when metal temperatures are below 0°C, to heat the metal to 20°C.

.6 Maintain flanges, pipes, fittings, etc., in alignment during welding. Ensure that no part of the weld is offset by more than 20 percent of the pipe wall thickness.

.7 Make tack welds of material equal to the root pass. Tack welds which have not cracked may be incorporated in the root pass.

.8 Ensure the first bead obtains full root penetration with a minimum of weld material projecting within the pipe.

.9 For butt welds of pipe diameters less than 200 mm use a minimum of two passes. For larger pipe, use three passes minimum.

.10 For lap joints, weld joint in two passes minimum.

.11 Between passes, visually inspect bead for pinholes or other defects. Repair any defects prior to the placement of the next pass.

.12 Clean all flux, slag and other foreign material from the weld prior to applying a successive bead, and on completion of the weld.

.13 Do not start successive passes at the same point.

.14 Completely fill the joint with weld, and have reinforcement greater than 1.5 mm and less than 3.0 mm, with no undercutting at the weld edges.

.15 Provide a smooth surface for coating application to exterior surfaces of pipe. Grind or buff all welds to a minimum radius of 6mm on all edges and corners. Adhere to latest edition of NACE RP0178. Refer to Section 09900.

.16 Contractor to provide access to all external welds in fabricated spool pieces for grinding purposes. This will ensure that the coating application on welds can be properly ground to achieve proper coating application. Provide maximum of 400 mm distance from any weld.

.17 Repair linings and coatings after welding.

**3.7 Stainless Steel Welding**

.1 Conform to reviewed stainless steel pipe welding procedures, which have been signed and sealed by a Professional Engineer registered in the Province of Manitoba, and to Section 05500.

.2 Remove all scale, rust, and any other surface deposits from the entire pipe and fittings before welding. Be particularly thorough with the internal surface preparation.

.3 For all stainless steel pipe intended to convey liquids, use inert gas backing for field and shop welds (GMAW or GTAW). For these services, "Solar Flux" and similar products will not be allowed.

.4 Ensure the first bead obtains full root penetration with a minimum of weld material projecting within the pipe.

.5 Grind or buff all welds to a minimum radius of 6 mm on all edges and corners to achieve a smooth surface, eliminate any pockets and eliminate any protruding root passes. Adhere to latest edition of NACE RP0178. If material thickness will not allow 6 mm radius, make radius one half of material thickness.

.6 Ensure the outside diameter weld (weld cap) is free of excessive weld cap and free of discoloration due to welding. Ensure all inside diameter welds (root pass) or outside diameter welds exposed to wastewater or corrosive fluids or environments are ground flush and have no discoloration.

.7 Passivation

.1 Passivate the inside of all stainless steel piping after completion of all piping and supports welding. Any welding after passivation will require passivation of the entire piping section again. A piping section is the length between flanges.

.2 Comply with ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems, and ASTM A967, Standard Specification for Chemical Passivation Treatment for Stainless Steel Parts, latest edition.

.3 Use fine grit carbide sandpaper to remove any discoloration, such as bluish due to overheating.

.4 Thoroughly clean the interior of the pipe and ensure there are no oil or grease deposits or particulate (such as from the sandpaper) using trisodium phosphate (TSP) solution per manufacturer's recommendation. Thoroughly rinse with tap water.

.5 Acid pickle using a solution of 20 percent nitric acid and 2 percent hydrofluoric acid in chloride-free water. Treat for no less than two hours at 20ºC to 40ºC. Do not do the work at less than 20ºC. An equivalent pickling paste shall be used for air piping not designed to be filled with water. Follow the manufacturer's instructions. Rinse thoroughly with chloride-free water (distilled or de-ionized) until the rinse water shows less than 0.1 mg/L of fluoride. Rinse thoroughly with chloride-free water (distilled or de-ionized) brought to pH 10 using ammonia (preferred). Alternatively caustic soda or soda ash may be used to increase the final rinse water pH, but the maximum concentration of chloride allowed in this solution is 1 mg/L. Note that chloride concentration in commercially available caustic soda and soda ash may be too high for this use. Completely drain and leave drying in warm air (not less than 20ºC at the outlet end) overnight.

.6 Collect all acids, caustics, and rinses and take all necessary precautions to prevent spills on the ground. Neutralize as needed, for example blending acid and caustic wastes and using pebble or ground limestone, lime, or other suitable material. Dispose of the neutralized waste as indicated by the City at the closest primary effluent channel. Note that the City may limit the volume that may be discharged over any period of time. Take measures to prevent freezing.

.7 Process air piping may not be filled with water unless laid flat on the ground or otherwise supported every 5 m and on each side of sliding supports.

.8 Pickling and passivating may require the ingress of an individual into the process air pipe. A single individual may do so once the pipe has been installed. Provide adequate ventilation that will blow any fumes away from the worker. This individual shall wear adequate protection per MSDS and clean, thick cloth socks over footwear. Confined entry procedures shall apply. Footwear, other items or tools that could scratch the stainless steel surface shall not be carried into the pipe.

## 3.8 Grooved Piping System – Installation

.1 All grooved products shall be installed according to manufacturer's installation instructions.

.2 Carbon steel pipe may be either cut grooved or roll grooved as appropriate for pipe and service specified.

.3 Schedule 5 and Schedule 10 stainless steel pipe shall be roll grooved using "RX" rolls in accordance with manufacturer's installation instructions.

.4 Ductile iron pipe shall utilize "radius cut grooves". Grooves shall conform to either "rigid" or "flexible" cut groove dimensions as specified for application. Pipe shall have wall thickness of Class 53 pipe or greater.

.5 Copper piping shall be roll grooved in accordance with manufacturer's installation instructions.

## 3.9 Insulation

.1 Insulate piping systems in accordance with Sections 11055 and 11059.

## 3.10 Testing

.1 Give the Contract Administrator 24 hours notice prior to testing.

.2 Do not insulate or conceal Work until piping systems are tested and accepted.

.3 Complete any required weld tests.

.4 Interior of stainless steel piping shall be bright metal with no discoloration. Any discoloration, such as bluish tint at welds, will require spot pickling and passivation using paste containing nitric acid and hydrofluoric acid, followed by rinsing and drying as indicated previously.

.5 Spot check the interior of the stainless steel piping and weld areas as indicated by the Contract Administrator. Use 5 percent copper sulphate solution. After ten minutes at not less than 15°C there shall be no observable deposit of metallic copper. Otherwise, pickling and passivation shall be repeated for the entire piping section. Carefully wipe off copper sulphate solution with several damp pieces of cloth.

.6 Supply all water, air, and inert gases required for pressure testing.

.7 Supply all pumps, compressors, gauges, etc., required for testing.

.8 Install air threadolets, air relief valves and line fitting valves as necessary to complete testing. Remove after testing and plug the threadolets.

.9 Cap or plug all lines which are normally open ended. Remove on completion of testing.

.10 Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

.11 Test all underground lines prior to backfilling. Do not place concrete surround until lines are tested.

.12 Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Contract Administrator of such failure.

.13 Isolate all low pressure equipment and appurtenances during testing so as not to place any excess pressure on the operating equipment.

.14 Where defective material or equipment is identified, repair or replace using new material.

.15 Release pressure safely, flush and drain liquid pipes after pressure tests. Release pressure safely and purge if needed all gas pipes after pressure tests.

.16 Dispose of flushing water in manner approved by the Contract Administrator, which causes no damage to buildings or Siteworks.

## 3.11 Pressure Testing of Liquid Lines

.1 Hydrostatically test all lines normally used for the conveyance of liquid using water as the test medium.

.2 Test pressures and durations shall be as specified in the Detailed Piping Specification Sheets.

.3 Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

.4 Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

.5 Show evidence of leakage rates below 0.01 L/h per mm pipe diameter per 100 m of pipe length for buried piping, unless otherwise specified.

.6 Test drains in accordance with the National Plumbing Code.

## 3.12 Pressure Testing of Gas, Air and Vapour Lines

.1 Hydrostatically or pneumatically pressure test, as shown in the table below, all lines normally used for the conveyance of gas, air, and/or vapour in accordance with Process Piping Code B31.3 procedures for testing pressure piping and CAN/CGA B105 for buried digester gas piping. Pneumatically test all instrument air lines in accordance with ISA-RP7.1.

.2 For gas and air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the Contract Administrator. At the Contract Administrator's request, provide calculations indicating design of temporary support system.

.3 Other than for chlorine and sulphur dioxide piping systems, use the following test medium:

| Pipe Size Specified | Test Pressure | Test Medium |
|---|---|---|
| 50 mm and smaller | 500 kPa or less | Air or water |
| 50 mm and smaller | Greater than 500 kPa | Water |
| Greater than 50 mm | 500 kPa or less | Air or Water |
| Greater than 50 mm | Greater than 500 kPa | Water |

.4 Test pressures are identified in the Detailed Piping Specification Sheets.

.5 Zero leakage rate for insulated systems, and systems tested with water is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

.6 Do not exceed 5 percent of the specified test pressure as the allowable leakage rate over the test period for other systems tested with air. Provide feed air pressure regulator with gauge and pressure safety valve with ring pressure set at not more that 20 kPag above the test pressure and adequately sized for both the compressor capacity and any condition that could result in pressure increases.

.7 Wet all joints using a mixture of soap and water in systems tested with air. Remake all joints which display leakage and retest. For stainless steel piping, repeat cleaning and passivation procedure indicated above for the entire piping section, then test for adequate passivation in the re-worked area.

.8 Test natural gas piping in accordance with CAN/CGA B139-1.

## 3.13 Cleaning and Flushing

.1 After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 150 mm and less than 600 mm by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater than 600 mm may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 150 mm an initial flush or purge.

.2 After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

| Suction Diameter, mm | Maximum Screen Opening, mm |
|---|---|
| 0 - 25 | 1.5 |
| 30-75 | 6.25 |
| 80-150 | 12.5 |
| >150 | 25 |

.3 Maintain the screens during testing, flushing, purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Contract Administrator's acceptance, screens may be removed for performance tests.

.4 Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

.5 Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Screens in solids handling systems are exempt; remove prior to placing the system in service.

.6 In air or gas systems with pipe sizes less than or equal to 150 mm, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.3 standards for instrument air systems.

.7 Brush clean steel pipe exterior to SSPC-P3 standard prior to painting. Also refer to Section 09900.

## 3.14 Disinfection

.1 Disinfect lines intended for potable water service after testing in accordance with AWWA C651.

**END OF SECTION**

# PROCESS PIPE JOINTS AND EQUIPMENT CONNECTIONS

## 1. GENERAL

### 1.1 Description

.1 This Section describes acceptable methods for jointing and connecting piping to equipment and appurtenances.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this Section and Section 11050 integrally with the more specific requirements listed in Section 11055.

### 1.2 Submittals

.1 With the submittals required in Section 11050, provide a listing of joining and connecting techniques used in the performance of the Work.

### 1.3 Coordination

.1 Coordinate the jointing techniques with the piping requirements and ensure that the connection techniques match the requirements of the equipment and ancillary devices to which piping must attach.

### 1.4 Quality Assurance

.1 Refer to Section 11050 for welding quality assurance requirements.

### 1.5 Shipment, Protection and Storage

.1 Refer to Section 01600 and Section 11050.

## 2. PRODUCTS

### 2.1 Function

.1 Provide for the joining of the pipe materials, fittings, and appurtenances as described below, for the piping systems shown.

### 2.2 General

.1 Connect piping using joints not readily disassembled only where shown and where not otherwise specified. Provide joints which may be disassembled as indicated on the Drawings, and at the minimum, within 1000 mm of any connection to equipment, on both sides of structural penetrations, within 600 mm of all threaded end valves, and at the spacing specified in the detailed piping specification sheets.

.2 Where new pipe crosses a new or existing structural expansion joint and the pipe is supported from each side of the structure, provide a flexible coupling in pipe to allow for differential settlement. Select flexible connection suitable for pipe material.

## 2.3 Welding Materials

.1 Use welding materials conforming to CSA W48.1.

.2 Provide electrodes compatible with the material welded and which deposit metal with strength and corrosion resistance properties at least equivalent to the base metal.

.3 Provide proper storage for welding rod. Provide rod ovens in cold or inclement weather.

.4 Keep stainless steel rods in marked containers, separate from other materials.

## 2.4 Dissimilar Metal Connections

.1 Where dissimilar metals are to be connected, furnish dielectric fittings or isolating flanges.

## 2.5 Carbon Steel Piping

.1 Less than 75 mm in diameter: butt-weld or use threaded couplings. Use unions where disassembly is required.

.2 Equal to or greater than 75 mm in diameter: where not specified or shown otherwise, butt-weld according to ASME Boiler and Pressure Vessel Code or furnish flanges, conforming to ANSI B16.5, Class 150. Where disassembly is required, flanges are sufficient.

.3 Companion flanges for connection to cast iron or ductile iron equipment flanges shall be refaced to be flush with the companion flange.

.4 Where grooved joint fittings are shown for use in steel piping systems, meet the following requirements:

.1 Use flexible style couplings for all buried service pipe, all pipe greater than 300 mm in diameter, for pipe less than 300 mm in diameter in rack mounted piping assemblies, and for grooved joints adjacent to pump or blower suction and discharge where grooved joints are used for noise and vibration control. Acceptable products are Gustin-Bacon 100 and Victaulic Style 77.

.2 Use rigid style couplings in all other applications. Acceptable products are Gustin-Bacon 120 Rigi-Grip and Victaulic Style 07 Zero-Flex.

.3 With the Contract Administrator’s prior acceptance, flange assemblies may be substituted for above ground steel piping which is not lined where rigid style couplings are shown or specified. Note any such substitutions in the submittals prior to fabrication.

.5 For above-ground methanol piping, provide welded flanges.

## 2.6 Stainless Steel Tubing

.1 Use stainless steel compression fittings.

.2 Furnish compression couplings for stainless steel tubing of the same material as the pipe, capable of withstanding the maximum pressure to which the pipe is subjected.

**2.7 Schedule Stainless Steel Pipe**

.1 Less than 75 mm in diameter: socket-weld pipe. Where disassembly is required, use threaded unions.

.2 Equal to or greater than 75 mm in diameter: butt-weld pipe; where disassembly is required, use flanges.

.3 Flanged Connections:

.1 Make flanges on stainless steel piping stainless steel slip-on, rolled-angle collar Van-Stone type, with a galvanized steel back-up ring drilled to ANSI B16.1, Class 125. Make the angle ring thickness equal or greater than the pipe or fitting to which it is welded. Stamped (pressed) collars are not acceptable.

.2 For submerged joints, make the backup ring stainless steel.

.3 For digester gas services, make the flanges Lap-joint type with galvanized steel back-up ring and in accordance with CGA B105. For submerged joints, make the back-up ring stainless steel.

.4 Conform to ASTM A182 or ASTM A276, Class 150, for threaded connections to stainless steel pipe, threadolets to be shop welded to the pipe at the locations specified.

**2.8 Gauge Stainless Steel Pipe**

.1 Less than 75 mm in diameter: socket-weld pipe. Where disassembly is required, use socket weld unions.

.2 Equal to or greater than 75 mm in diameter: butt-weld pipe; where disassembly is required, use flanges.

.3 Flanged Connections:

.1 Make flanges on stainless steel piping stainless steel slip-on, rolled-angle collar Van-Stone type, with a galvanized steel back-up ring drilled to ANSI B16.1, Class 125. Make the angle ring thickness equal or greater than the pipe or fitting to which it is welded. Stamped (pressed) collars are not acceptable.

.2 For submerged joints, make the backup ring stainless steel.

.4 Conform to ASTM A182 or ASTM A276, Class 150, for threaded connections to stainless steel pipe, threadolets to be shop welded to the pipe at the locations specified.

**2.9 Copper or Brass Piping**

.1 Use soldered couplings. Where disassembly is required, use compression unions.

.2 Use soldered couplings conforming to ANSI B16.26. Use lead-free solder conforming to ASTM B32 and the National Plumbing Code.

.3 In potable water systems, use lead-free solder conforming to ASTM B32 and National Plumbing Code.

.4 Furnish compression couplings for copper and brass tubing of copper, suitable for the maximum pressure of the pipe, conforming to ANSI B16.26.

**2.10 Ductile Iron Piping**

.1 For above ground ductile iron piping, where not shown or otherwise specified, use grooved joints in accordance with AWWA C606. Flanges may be used if approved by the Contract Administrator and where needed to connect to equipment or piping appurtenances.

.2 For below ground piping systems, use slip-on joints for unrestrained systems. Where shown or indicated, use bolted mechanical joints.

.3 Provide Class 125 flanges on cast or ductile pipe, conforming to ANSI B16.1.

.4 For grooved piping systems, provide pipe with rigid cut grooves for exposed services, and flexible cut grooves for buried services. Acceptable coupling products are Gustin-Bacon 500 series and Victaulic Style 31.

.5 Push-on joints: rubber ring compression, bell and spigot type. Assemble in accordance with AWWA C600 and manufacturers recommendations. Do not use on fittings or other appurtenances.

.6 Bolted mechanical joints: comply with ANSI A21.10 and ANSI 21.11.

.7 Where restrained mechanical joints are shown or specified, ensure joints can be disassembled after installation. Do not use internal restraints. Factory apply retainer weldments. Do not use joints which employ set screws, retainer glands, or concrete thrust anchors. Acceptable products are Lok-Ring and TR Flex.

.8 When tying into existing ductile iron piping, replace existing ductile iron pipe back to the nearest joints to avoid field cutting.

**2.11 Cast Iron Piping**

.1 For cast iron drain pipe inside structures or concrete encased, use gasket and retaining clamp type mechanical joint conforming to CSA B70.

**2.12 PVC and FRP Piping**

.1 Where not shown or otherwise specified, use solvent weld joints for PVC and FRP piping. Provide flanges or unions where disassembly is required.

## 2.13 Concrete Cylinder Piping

.1 Bell and spigot joint: fabricate to AWWA C301 or AWWA C303. Provide and assemble rubber gasket joints in accordance with the pipe manufacturer's recommendations. After the joint has been made, verify the position of the gasket. Separate, rejoin, and check joints which are not properly positioned.

.2 Welded joint: use only where shown or approved by the Contract Administrator. Weld exterior of joint. Use compatible filler rod as necessary to provide appropriate weld size.

.3 Restrained joints

.1 Type 1: flanges to AWWA C207. Complete with a reinforcing ring welded to pipe cylinder

.2 Type 2: specially fabricated U-shaped clamps, ductile iron to ASTM A536, which when used with wedge rings to ASTM A36, rubber gaskets and stop rings, minimize pipe movement. Bolt in accordance with manufacturer's recommendations

.3 Type 3: a grooved joint style complete with a reinforcing ring welded to the pipe cylinder and grooved to accept the fitting.

.4 Ensure pipe design can withstand stresses induced by joint design.

.5 Grout each joint after installation with cement mortar in accordance with manufacturer’s directions.

## 2.14 HDPE Piping

.1 Refer to pipe manufacturer's specifications for product information and installation instruction.

.2 HDPE pipe joined by method of thermal butt fusion should conform to ASTM D 2657.

.3 Provide bell and spigot type joints conforming to ASTM D3212.

.4 Provide pipe, pipe support, and restraints to withstand stresses induced by joint design.

.5 Provide pipe, pipe supports, and restraints to withstand the stresses incurred during placement of concrete surround.

## 2.15 Flanges

.1 General requirements for flanges are as follows:

.1 Provide compatible flanges for mating to equipment or valves.

.2 Provide flat-faced flanges on each side of butterfly valves.

.3 For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

.4 A lap joint flange on digester gas services or Van Stone flange on schedule 10S stainless steel piping systems is acceptable.

.2 Do not use slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.)

.3 Flammable liquids or combustible liquids

.1 Flanged joints shall be made with forged or cast steel flanges designed, constructed, and installed in conformance with ANSI/ASME B16.5 "Pipe flanges and Flanged Fittings NPS 1/2 Through NPS 24."

.2 Bolting materials for flanged connections shall be of alloy steel equivalent to ASTM A193/A193M "Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service"

.3 Gaskets in flanged connections shall be of a material resistant to the liquid being carried and capable of withstanding temperatures of 650 degrees C without damage.

**2.16 Threaded Couplings**

.1 Make screwed joints using American Standard threads to ANSI B1.20.1.

.2 Use Teflon tape as thread lubricant for threaded joints.

.3 Provide threaded-end to flanged-end adapters where required to connect to flanges.

.4 Threaded joints in piping systems for flammable liquids or combustible liquids shall be made using joint compound or PTFE tape conforming to CAN/ULC-S642-M, "Compounds and Tapes for Threaded Pipe Joints".

**2.17 Grooved Joint Couplings**

.1 Fabricate grooved joint couplings of ductile iron to ASTM A536, and in accordance with AWWA C606.

.2 For ductile iron pipe, provide cut grooves in pipe and fittings in accordance with AWWA C606. Rolled grooves and roll-groove type joints are not acceptable.

.3 For steel pipe, provide cut grooves in pipe and fittings in accordance with AWWA C606. Alternatively, rolled grooves and roll-groove type joints may be used on bare steel pipe. Rolled grooves and roll-groove type joints are not acceptable on steel pipe that is internally lined.

.4 Cut or rolled grooved joints are not acceptable in stainless steel piping less than schedule 40S, carbon steel piping less than Schedule 40, and PVC piping less than schedule 80. Provide suitable end pipe piece for grooving as needed if piping wall is thinner.

.5 For all grooved joints, grind or buff edges to a minimum radius of 6 mm. Coordinate with coupling manufacturer to ensure proper fit.

.6 In grooved joint piping systems requiring end-seal type gaskets, provide grooved joint couplings and grooved pipe in accordance with gasket manufacturers recommendations. Acceptable manufacturers: Gustin-Bacon, Victaulic.

.7 Where grooved joint piping systems connect to equipment or to flanged valves, meters, or other sensing devices; use grooved joint flanges or flange adapters. Flange adapters have been used to develop the piping layout shown in the Drawings unless specifically noted otherwise. Acceptable products are Tyler Groove-to-Flange Fittings and Victaulic Flange adapters. Where the Contractor chooses to use grooved joint flanges rather than the indicated adapters, piping modifications required to suit this change are the responsibility of the Contractor. Make full allowance for piping disassembly and access to the face of equipment.

## 2.18 Flexible Couplings - Type I

.1 General Requirements:

.1 Centre ring: steel, shop coated for corrosion protection.

.2 Gaskets: fabricated of material suitable to the service conditions.

.3 For submerged, buried or below structure applications, use stainless steel bolts, nuts and washers.

.4 Provide the necessary amount and appropriate size of restraining rods and gussets as recommended by the manufacturer.

.5 Type 1 (Restrained): use a flexible sleeve-type coupling with restraining rods, and gussets welded to the pipe. Provide sufficient restraint to resist pressure equal to twice the system test pressure.

.2 Unless specifically shown otherwise use Type I flexible couplings where a flexible coupling is shown or required, Contractor will determine which class, A, B, or C as described below.

.1 Flexible Couplings - Type IA

.1 Flexible sleeve type couplings: Cylindrical centre ring, two follower rings, two resilient gaskets, and connecting bolts.

.2 Acceptable Products are:

.1 Dresser Style 38

.2 Ford Meter Box FC1

.3 Robar 1408

.4 Rockwell Type 411

.5 Viking Johnson Quick-Fit

.2 Flexible Couplings - Type IB

.1 Flanged flexible sleeve type couplings: flanged cylindrical centre ring, a companion flange, one follower ring, one resilient gasket, and connecting bolts.

.2 Acceptable Products are:

.1 Dresser Style 128

.2 Ford Meter Box FCA

.3 Robar 7808

.4 Rockwell Type 913

.5 Viking Johnson Quickfit Flange Adapter

.3 Flexible Couplings - Type IC

.1 Transition flexible sleeve type couplings: cylindrical centre ring, two follower rings two resilient gaskets, and connecting bolts.

.2 Acceptable Products are:

.1 Dresser Style 62

.2 Robar 1408

**2.19 Flexible Couplings Type II**

.1 Flexible pipe couplings: progressive sealing, capable of two degrees angular deflection in all directions, leakproof

.2 Acceptable manufacturers:

.1 Straub

.2 Young Nam Company (YNC)

.3 Casing: 304 or 316 stainless steel.

.4 Lockparts: steel, shop coated for corrosion protection. 304 Stainless steel for buried or submerged services.

.5 Gaskets: fabricated of material suitable to the service conditions.

**2.20 Equipment Connections**

.1 Unless specified otherwise, comply with the Table at the end of this Section for the pipe connection requirements for various types of equipment ends.

## 3. EXECUTION

### 3.1 Mild Steel Welding

.1 Refer to Section 11050 for mild steel welding requirements.

### 3.2 Stainless Steel Welding

.1 Refer to Section 11050 for stainless steel welding requirements.

### 3.3 Threaded Joints

.1 Conform to the requirement of ANSI B31.3 Process Piping Code.

.2 Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

.3 Clean out pipe and repair linings and coatings prior to joining.

.4 Apply Teflon tape to male threads and join pipe. Use both Teflon tape and Teflon sealing compound on stainless steel pipe threads. Do not use extra tape to make up for slack in the joint.

.5 Provide joints at spacings noted in Section 11055 to allow for pipe disassembly.

### 3.4 Flanged Joints

.1 Clean flanges and gaskets prior to connection.

.2 Lubricate gaskets with soapy water and apply anti-seize compound to the bolts.

.3 Bring flanges into close parallel and lateral alignment.

.4 Tighten bolts progressively. Proceed from side to side of the flange.

.5 Washers may not be used to take up excess bolt length.

.6 Provide approximately two full threads bolt projection beyond nuts.

.7 When joining steel to cast iron flanges, take care to avoid damage to the cast iron flange. Ensure both flanges are flat-faced and use full face gaskets.

.8 Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place undue strain on the equipment.

.9 Provide flanges at spacings noted in the Drawings and in Section 11055 to allow for pipe disassembly.

.10 Allow a minimum of 150 mm to face or 200 mm to edge of flange from wall, floor or ceiling unless otherwise shown on the Drawings.

.11 On gauge stainless steel piping, consider the flange assembly weight in the design of the piping supports.

## 3.5 Grooved Pipe Joints

.1 Groove all pipes to be joined by this method in accordance with the manufacturer's recommendations.

.2 Repair linings and coatings after grooving.

.3 Where connecting grooved joint pipe to flanged equipment or valves, use a transition coupling a minimum of 150 mm in length with a Class 125 FF flange at one end and a grooved joint at the other, unless otherwise specified or shown.

.4 Alternately, use split flanges fabricated specifically for grooved joint pipe to connect to flanged equipment, valves, meters, or sensing devices. Provide restraint on joints to prevent valve body rotation when the operator is torqued.

.5 Provide joints at spacing noted in Section 11055 to allow for pipe disassembly.

.6 Allow a minimum of 150 mm to face or edge of grooved joint coupling from wall, floor or ceiling unless otherwise shown.

.7 On epoxy lined piping systems and in accordance with the coupling manufacturer's recommendations, continue the epoxy lining around the ends of each pipe to the edge of the cut groove; provide the same on each fitting.

.8 On glass lined piping systems and in accordance with the coupling manufacturer's recommendations, continue the lining around the ends of each pipe to the edge of the cut groove; provide the same on each fitting. Alternately a glass lining patch kit or mastic similar to Sikaflex 1A is acceptable on the glass lined pipe ends to the outside groove.

**END OF SECTION**

**PROCESS PIPE JOINTS AND EQUIPMENT CONNECTIONS**

**Table - Pipe Connections for Various Equipment End Types**

| Piping Material | Pipe Type | Diameter Range (mm) | Equipment End | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tubing/Various | Brass or Bronze Female Thread | Cast Iron or Steel Female Thread | Cast Iron Flanged | Steel/Stainless Flanged | Steel/Stainless Plain End | Steel or Stainless Welding End | Fibreglass Flanged | PVC Female Thread |
| Stainless Steel | Tubing | 6 to 25 | Nut and Double Ferrule Type Connectors or Adapters as required Rating: Class 1000 | 150mm SS Threaded Nipple and Union Rating: Class 250 | 150mm SS Threaded Nipple and Union Rating: Class 250 | | | | | | 150mm SS Threaded Nipple and Union Rating: Class 250 |
| | Gauge & Schedule 10S | 10 to 65 | | 150mm SS Threaded Nipple and Union Rating: Class 250 | 150mm SS Threaded Nipple and Union Rating: Class 250 | | | Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF | | | 150mm SS Threaded Nipple and Union Rating: Class 250 |
| | | Greater than 65 | | | | Rolled Angle Van Stone Flange Rating: Class 125 FF | Rolled Angle Van Stone Flange Rating: Class 150 RF | Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF | Butt Welded (SS Equip. End) | Rolled Angle Van Stone Flange Rating: Class 150 RF | |
| | Schedule 40S | 10 to 65 | | Socket Weld Nipple and Union Rating: Class 250 | Socket Weld Nipple and Union Rating: Class 250 | | | Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF | | | Socket Weld Nipple and Union Rating: Class 250 |
| | | Greater than 65 | | | | Rolled Angle Van Stone Flange Rating: Class 125 FF | Rolled Angle Van Stone Flange Rating: Class 150 RF | Flexible Joint Flanged One End Rating: Class 150 RF or Flange Adaptor and Van Stone Flange Rating: Class 150 RF | Butt Welded (SS Equip. End) | | |
| Steel | Standard Wt. & Schedule 40 | 10 to 65 | | 150mm Galvanized Threaded Nipple and Union Rating: Class 250 | 150mm Galvanized Threaded Nipple and Union Rating: Class 250 | Threaded Steel Flange Rating: Class 125 FF | Threaded Steel Flange Rating: Class 150 RF | Flexible Joint Flanged One End Rating: Class 150 RF | | | 150mm galv. Threaded Nipple and Union Rating: Class 250 |
| | | Greater than 65 | | | | Steel Flange Rating: Class 125 FF | Steel Flange Rating: Class 150 RF | Flexible Joint Flanged One End Rating: Class 150 RF | Butt Welded (Steel Equip. End) | | |
| | Schedule 80 | 10 to 65 | | Threaded Nipple and Union Rating: 3000 kPa | Threaded Nipple and Union Rating: 3000 kPa | Threaded Steel Flange Rating: Class 125 FF | Threaded Steel Flange Rating: Class 150 RF | Flexible Joint Flanged One End Rating: Class 150 RF | | | Threaded Nipple and Union Rating: 3000 kPa |
| | | Greater than 65 | | | | Steel Flange Rating: Class 125 FF | Steel Flange Rating: Class 150 RF | Flexible Joint Flanged One End Rating: Class 150 RF | Butt Welded (Steel Equip. End) | | |

**PROCESS PIPE JOINTS AND EQUIPMENT CONNECTIONS**

**Table - Pipe Connections for Various Equipment End Types (Continued)**

| Piping Material | Pipe Type | Diameter (mm) | Equipment End | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Tubing/ Various | Brass or Bronze Female Thread | Cast Iron or Steel Female Thread | Cast Iron .1 | Steel/Stainless Flanged | Steel/Stainless Plain End | Steel or Stainless Welding End | Fibreglass Flanged | PVC Female Thread |
| Ductile Iron | | Greater than 65 | | | | Grooved End to Flanged Adaptor Rating: Class 125 FF | Grooved End to Flanged Adaptor Rating: Class 150 RF | | | | |
| Cast Iron | | Greater than 65 | | | | Grooved End to Flanged Adaptor Rating: Class 125 FF | Grooved End to Flanged Adaptor Rating: Class 150 RF | | | | |
| Copper | | 10 to 65 | | 150mm Copper Threaded Nipple and Union Rating: Class 250 | 150mm Copper Threaded Nipple and Union Rating: Class 250 | Threaded Copper Flange Rating: Class 125 FF | Threaded Copper Flange Rating: Class 150 RF | | | | |
| PVC | Schedule 40 | 10 to 65 | | | | | | | | | 150mm PVC Nipple and Union Rating: Schedule 80 |
| | | Greater than 65 | | | | PVC Van Stone Flange Rating: Class 125 FF | PVC Van Stone Flange Rating: Class 150 RF | | | | |
| | Schedule 80 | 10 to 65 | | 150mm PVC Nipple and Union Rating: Schedule 80 | 150mm PVC Nipple and Union Rating: Schedule 80 | | | | | | 150mm PVC Nipple and Union Rating: Schedule 80 |
| | | Greater than 65 | | | | PVC Flange (Sch.80) Rating: Class 125 FF | PVC Flange (Sch.80) Rating: Class 150 RF | | | | |
| HDPE | | 10 to 65 | | 150mm Galvanized Steel Nipple and Grooved Joint, Transition Coupling | 150mm Galvanized Steel Nipple and Grooved Joint, Transition Coupling | | | | | | |
| | | Greater than 65 | | | | Stub End and Ductile Iron Backup Ring Rating: Class 125 FF | Stub End and Steel Backup Ring Rating: Class 150 RF | | | | |

**END OF SECTION**

# PROCESS PIPE GUIDES AND ANCHORS

## 1. GENERAL

### 1.1 Description

.1 This Section describes process pipeline guides and anchors to be installed integrally with the piping. These items are an integral component of the piping support system for which other requirements are described in Section 11050.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this Section and Section 11050 integrally with the more specific requirements listed in Section 11055.

### 1.2 Submittals

.1 Provide Shop Drawings, signed and sealed by a Professional Engineer registered in the Province of Manitoba, for each type of pipeline support and anchor in accordance with the requirements of Section 01300 and 11050.

.2 Show the materials of construction and illustrations of the method of installation.

.3 Refer to Section 11050 for requirements for submittals for the support system that incorporates the pipe guides and anchors.

.4 Provide evidence that the manufacturer has at least five installations of similar size and type in satisfactory service for a period of not less than five years.

### 1.3 Coordination

.1 Coordinate the guides and supports with the pipe support system. Ensure that the guides and supports are mounted in locations suitable for their intended function.

### 1.4 Quality Assurance

.1 Welding Requirements: refer to Section 11050 for welding quality assurance requirements.

.2 Alignment: for large diameter (500 mm and larger), thin walled (6.4 mm and less) stainless steel piping supports laser align such that lateral and vertical misalignments between three consecutive supports do not exceed the wall thickness.

### 1.5 Process Air Pipe Anchors and Guides

.1 The process air pipe anchor and guide manufacturer will be regularly engaged in the business of designing and fabricating pipe anchors and guides of the size and type specified and shown on the Drawings.

### 1.6 Shipment, Protection, and Storage

.1 Refer to Section 01600 and Section 11050.

## 2. PRODUCTS

### 2.1 Function

.1 Provide the pipe guides and anchors as described below, for the piping systems shown.

### 2.2 Pipe Guides and Anchors

.1 Pipe guides:

.1 Unless otherwise shown or specified, provide spider type. After fabrication hot dips galvanize. Provide AISI 316 stainless steel for submerged locations. Refer to the following pages and the Drawings for location.

.2 Acceptable Manufacturers:

.1 Grinnell Fig. 256

.2 B-Line Series B3281

.2 Anchors:

.1 Unless otherwise shown or specified, provide steel to Section 05120, hot dip galvanized to Section 05120; concrete to Section 03300, reinforcement to Section 03200; and anchor bolts to Section 05120.

.2 Provide AISI type 316 stainless steel materials in submerged locations.

.3 In submerged applications, provide AISI Type 316 stainless steel nuts, bolts, and washers.

.4 In applications other than submerged, provide AISI Type 304 stainless steel nuts, bolts, and washers.

### 2.3 Process Air Pipe Guides and Anchors

.1 Provide PTFE lower bearing surfaces not less than 2.4 mm thick of 100 percent virgin material in accordance with ASTM D1457 and with a 25 percent content of glass fiber filling.

.2 Provide PTFE lower bearing surfaces mechanically secured and bonded to a substrate made of 10 gauge or 3.2 mm thick type 304 stainless steel with a 6.4 mm welding lip all around.

.3 Provide PTFE with minimum 20 MPa tensile strength, tested in accordance with ASTM D638; 200 percent elongation minimum, tested in accordance with ASTM D638; and 216 ± 0.03 relative density, tested in accordance with ASTM D792.

.4 Provide stainless steel components to ASTM A167; type 304. For submerged applications, provide Type 316 stainless steel.

.5 Provide stainless steel upper bearing surfaces with an annealed mirror finish in accordance with ASTM A480 and having a maximum surface roughness of 0.15 microns.

.6 Provide these filled Teflon to stainless steel slide bearings as manufactured by Amscot Structural Products, Piping Technology and Products, or approved equal, and with the dimensions shown on the Drawings.

.7 Use welding procedures which minimize distortion of the pipe guides and anchors, and avoid damage to the finished work or bonded materials. Stitch weld thin stainless steel.

.8 Finish members true to line, free from twists, bends, open joints, sharp corners and sharp edges.

.9 Provide fabrication tolerances as follows:

.1 Overall dimensions to within 3 mm

.2 Machined surfaces to within 0.4 mm

.3 Backing plates for sliding surfaces to within 0.8 mm

.4 Deviation from flatness of PTFE surfaces to 0.2 mm maximum

.5 Deviation from flatness of stainless steel surfaces intended for contact with PTFE to 0.0003 LH maximum

.6 PTFE thickness to ±10 percent of the specified thickness

.7 Parallelism of one sliding surface with respect to the mating sliding surface, as datum, to 0.2 percent of the longer side, maximum

.8 Matching holes for bolts to register so that a gauge 2 mm smaller in diameter than the holes will pass freely through the assembled members at right angles to such members

.9 Finished bolt holes to not more than 2 mm in diameter larger than the bolt diameter.

.10 Center-to-center distances between bolt holes to within 1 mm of the dimensioned distance.

.10 Drill or ream bolt holes.

.11 Provide vibration resistant type fasteners.

.12 Provide stainless steel sliding surfaces intended for contact with PTFE of one piece continuously welded around the perimeter to the back plate to prevent ingress of moisture. Provide the weld clean, sound, smooth, uniform, without overlaps, properly fused, and located outside the area of contact with PTFE.

.13 Machine or fine grind metal-to-metal contact surfaces. Machine sliding metal contact surfaces in the principal direction of movement. Machine after welding whenever possible.

.14 Provide metal surfaces in contact with PTFE with no openings or discontinuities, and a maximum surface roughness of three microns.

.15 Remove abrasive materials from finished surfaces and clean with a degreasing agent.

.16 Protect finished surfaces from contamination and mechanical damage.

## 3. EXECUTION

### 3.1 Process Air Pipe Guides and Anchors

.1 Unless written permission has been obtained from the manufacturer and from the Contract Administrator, do not dismantle the pipe guides after they have left the manufacturer's shop, in order to prevent contamination of the sliding surfaces.

.2 Use stainless steel shims to laser-align supports before installing the piping. Tighten J-bolts and grout using liquid, non-shrink, epoxy grout. Prevent ingress of grout into the annular space between the J-bolts and their pipe casing (the use of flexible sealant is allowed). Concrete base foundations for anchors and sliding supports shall be built with the top surface approximately 25 mm below aligned bottom of support plate. Allow for this much epoxy grout at each location. Preparation and grouting to be done according to Specifications in Division 3.

.3 Construct of fabricate as indicated in the Drawings or use approved commercial systems as indicated above.

**END OF SECTION**

# EXPANSION JOINTS

## 1. GENERAL

### 1.1 Description

.1 This Section describes expansion joint supply and methods for installation.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this Section and Section 11050 integrally with the more specific requirements listed in Section 11055.

.3 The number and location of expansion joints detailed on Drawings is indicative only. Contractor to provide a complete piping system design as described in Section 11050.

### 1.2 Submittals

.1 With the submittals required in Section 11050, provide a listing of the expansion joints used in the performance of the Work.

### 1.3 Coordination

.1 Coordinate the expansion joints with the piping requirements and ensure that the connection techniques match.

### 1.4 Quality Assurance

.1 Comply with the requirements of EJMA.

### 1.5 Shipment, Protection and Storage

.1 Refer to Section 01600 and Section 11050.

## 2. PRODUCTS

### 2.1 Function

.1 Expansion joints are used to compensate for thermal expansion and contraction in the piping system; to isolate equipment from stresses and vibration transmitted from the piping system; and to allow for seismic or long term settlement which could cause differential movement in adjacent piping or equipment.

### 2.2 Metal Clad Expansion Joints

.1 Design and fabricate expansion joints in accordance with EJMA standards and to meet the requirements of this Section.

.2 Provide expansion joints as necessary to allow for piping expansion and contraction. Unless otherwise specified, provide elastomer spool type expansion joints.

.3 Ensure corrugated type expansion joints are capable of a minimum 10,000 pressure, temperature, and deflection cycles, not concurrent.

.4 For metal expansion joints of the metal bellows type, in systems handling gases, air, water or other liquids, provide liners to produce a smooth flow path, reduce vibration and reduce noise through the expansion joint.

.5 Provide sufficient bends and expansion joints to allow for thermal movement of piping from -40°C to maximum service temperature.

.6 Provide factory precompressed expansion joints where required to suit installation temperature.

.7 For methanol piping provide CSA and ULC approved OPW stainless steel flexible connectors with convoluted stainless steel hose with 304 stainless steel wire braid.

.8 Formed Bellows Type, Low Temperature

.1 For up to 150°C

.2 Fabricate with 321 stainless steel corrugations, rated for the design pressure and temperature. Factory pressure and leak test at the design temperature.

.3 Design expansion joint to meet the requirements of movement specified (axial, lateral, and angular). Utilize a minimum safety factor of 1.35 for movement in anchor to anchor pipe run length over entire temperature range.

.4 For expansion joints with specified lateral movements greater than 3.0mm, except for the Process Air piping system, provide expansion joints with control rings and control rods or alternate method to equally distribute lateral movement among each corrugation and prevent squirm or buckling of the corrugations. Control rings shall be nickel-iron rated for 1000 kPa at 150°C.

.5 Provide limit rods which are full load rated in the event of anchor failure and to protect expansion joint from excessive axial movement. Process Air piping system expansion joints do not require limit rods unless they are to accommodate movement of the supporting structures.

.6 Unless otherwise specified, provide Van Stone flanges with galvanized steel backing flanges drilled to ANSI B16.5 for all expansion joints without limit rods.

.7 Provide fixed forged steel flanges on expansion joints requiring limit rods.

.8 Acceptable manufacturers are:

.1 American BOA

.2 Senior Flexonics

.3 Hyspan Precision Products

.9 Formed Bellows Type, Medium Temperature

.1 For up to 425°C

.2 Fabricate with 321 stainless steel corrugations, rated for the design pressure and temperature. Factory pressure and leak test at the design temperature.

.3 Design expansion joint to meet the requirements of movement specified (axial, lateral, angular).

.4 Provide expansion joints with control rings, control rods and limit rods as described above, for low temperature formed bellows type.

.5 Use flanged steel plate end connections, drilled to ANSI B16.5.

.6 Acceptable manufacturers are:

.1 American BOA

.2 Senior Flexonics

.3 Hyspan Precision Products

.10 Formed Bellows Type, High Temperature

.1 For up to 700°C

.2 Fabricate with 321 stainless steel corrugations rated for the design pressure and temperature. Factory pressure and leak test at the design temperature.

.3 Design expansion joint to meet the requirements of movement specified (axial, lateral and angular). Provide expansion joints with control rings, control rods and limit rods as described above for low temperature formed bellows type.

.4 Use flanged stainless steel plate end connections, the same as the bellows, drilled to ANSI B16.5.

.5 Acceptable manufacturers are:

.1 American BOA

.2 Senior Flexonics

.3 Hyspan Precision Products

.11 Steel Expansion Compensator Type

.1 Provide steel compensator type expansion joints in steel pipe systems of 65mm diameter and less for CWR, CWS, DHF, GLR, GLS, HRR and HRS systems only.

.2 Use 2-ply stainless steel bellows with carbon steel shroud and end fittings. Compensators to be rated for 1.2 MPa maximum working pressure and 400°C.

.3 Acceptable products are:

.4 Senior Flexonics Model H

.5 Hyspan Series 8500

.6 Keflex 7Q

.12 Bronze Expansion Compensator Type

.1 Provide bronze compensator type expansion joints in copper pipe systems of 50mm diameter and less for DHF, DHR, RFH, RFL and RFS systems only.

.2 Use multi-ply phosphor bronze or stainless steel bellows with copper tube end fittings. Compensators to be rated for 1.0 MPa and 205°C.

.3 Acceptable products are:

.1 American BOA

.2 Senior Flexonics Model HB

.3 Hyspan Series 8500

.4 Keflex 7Q

.13 Tied Universal Expansion Joint

.1 Provide steel tied universal assembly type expansion joints in steel pipe systems for HRR and HRS pipe systems.

.2 Use a dual stainless steel bellows arrangement with a minimum of three tie rods.

.3 The tie rods must contain the pressure thrust force and limit the joint motion axially and laterally. A minimum of 10,000 cycles is required for the lateral offset movement.

.4 Expansion joints to be rated for 1034 kPa maximum working pressure and 400°C.

.5 Acceptable manufacturers are:

.1 American BOA

.2 Hyspan Precision Products - Series 1512R

.3 Senior Flexonics

.14 Dual Expansion Joint

.1 Provide steel externally pressurized dual expansion joint type in steel pipe systems for HRR and HRS pipe systems.

.2 Use 304 stainless steel, 3-ply laminated bellows attached to internal and external guide rings.

.3 Use 304 stainless steel collar rings slipped over and welded to the bellows neck.

.4 Vent internal guide ring to minimize the effects of flashing.

.5 A minimum of 10,000 cycles is required at full compression.

.6 Provide drain port, flanged ends, and lifting lug.

.7 Expansion joints to be rated for 1034 kPa maximum working pressure and 400°C.

.8 Acceptable manufacturers are:

.1 American BOA

.2 Hyspan Precision Products - Series 3500

.3 Senior Flexonics

## 2.3 Elastomer Expansion Joints

.1 Select materials suitable for service commodity, temperature and pressure. Conform to the requirements of the Fluid Sealing Association, Rubber Expansion Joint Division.

.2 Provide control rods on expansion joint connectors to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Manufacturer to determine number and sizes of control rods.

.3 Provide elastomer cover of the same material as the elastomer tube liner.

.1 For service temperatures between 80°C and 120°C, use chlorobutyl or EPDM for the elastomer tube.

.2 For temperatures below 80°C, use EPDM, Neoprene or Buna-N tube elastomer.

.4 For single arch or single spherical rubber expansion joints in piping up to and including 200 mm diameter, make expansion joint face-to-face dimension 150 mm, nominal. For pipe

greater than 200 mm and less than or equal to 300 mm, make expansion joint face-to-face dimension 200 mm, nominal.

.5 Elastomer, Spool Type

.1 Unless otherwise specified, provide spool, resilient arch type expansion joints.

.2 Construct of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body.

.3 Provide backup or retaining rings of galvanized steel construction. Make retaining rings a nominal 10 mm thick, split type.

.4 Use filled arch type expansion joints on all piping systems conveying fluids containing solids.

.5 Acceptable manufacturers are:

.1 Senior Flexonics

.2 Garlock

.3 Mercer

.4 Techniquip

.6 Elastomer, Spherical Moulded Type

.1 Construct of multiple plies of nylon tire cord fabric and elastomer suitable for specified commodity, temperature and pressure.

.2 Provide steel floating flanges, such that no metal parts come in contact with the fluid.

.3 Acceptable Manufacturers:

.1 Senior Flexonics

.2 Garlock

.3 Mercer

.4 Techniquip

.5 Proco

## 2.4 Sliding Joints - Liquid Service

.1 Provide single end type sliding expansion joints able to allow longitudinal movement and radial stresses while maintaining pipe alignment. Provide through rods where necessary to maintain alignment.

.2 Limit longitudinal separation of the two pipe sections to 50 percent of the manufacturer's recommended maximum by a restraining flange affixed to the slip pipe with the bolts extending through this flange.

.3 Use packing material suitable for the service conditions.

.4 Acceptable products are:

.1 Dresser Style 63

.2 Ford Meter Box FEJ

.3 Robar 8808-1

.4 Rockwell 611

## 2.5 Flexible Hose Connectors

.1 Where other types of flexible expansion joints are not shown or specified, provide flexible hose connectors within 2 m pipe length of rotating equipment suction, discharge and ancillary service connection. Do not provide flexible connectors on sump pump connection piping.

.2 Provide flexible hose connectors with live lengths suitable for a line pressure equal to the test pressure of the pipe and for 12.5 mm lateral movement each side of the pipe centerline.

.3 Provide one union for pipe diameters ≤65 mm or floating flange for pipe diameter >65 mm, per flexible connector as appropriate to minimize the possibility of torque damage during installation.

.4 Provide flexible hose connectors capable of minimum of 10,000 cycles at the manufacturer's published minimum intermittent centreline bend radius and maximum working pressure.

.5 The design standard for flexible hose connectors on piping systems up to and including 50 mm diameter is Senior Flexonics Type 461 helically corrugated hose connectors.

.6 Acceptable manufacturers for flexible hose connectors on piping systems up to and including 50 mm diameter are:

.1 American BOA

.2 Flex-Weld

.3 Senior Flexonics

.7 The design standard for flexible hose connectors on piping systems larger than 50 mm diameter is Senior Flexonics Type 401 M corrugated flexible metal hose connectors.

.8 Acceptable manufacturers for flexible connectors on piping systems larger than 50 mm diameter are:

.1 American BOA

.2 Flex-Weld

.3 Senior Flexonics

## 3. EXECUTION

### 3.1 Expansion Joints

.1 Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping.

.2 Align and install each expansion joint in accordance with EJMA standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator type expansion joints.

.3 On rubber expansion joints, check bolt tightness, and tighten where necessary one week after commissioning.

### 3.2 Flexible Hose Connectors

.1 Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign or offset the connectors.

.2 Align and install each flexible connector in accordance with the manufacturer's instructions.

.3 Support, anchor and guide the piping so that the flexible connectors are not required to absorb any axial compression or elongation.

.4 Do not torque or twist the flexible connectors.

.5 Check bolt tightness and tighten where necessary, a maximum of one week after commissioning and periodically thereafter.

**END OF SECTION**

**DETAILED PIPING SPECIFICATION**

## 1. GENERAL

### 1.1 Work Included

.1 The piping specification sheets on the following pages detail the requirements for each type of process pipe included in the Work.

.2 The piping materials are listed on the specification sheets.

### 1.2 Process Piping Commodity Summary

| | | |
|---|---|---|
| CE | Centrate | Ductile Iron Glass-Lined (except sample lines) |
| PV | Process Vent | FRP |
| FW | Flushing Water | Copper (L Hard), Galvan'd or Mild Steel, (ERW or Seamless), PVC |
| MET | Methanol | 304L Stainless Steel (316 submerged) |
| ML | Mixed Liquor | Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304) |
| AIR | Process Air | 304L Stainless Steel (316 submerged) |
| N2 | Nitrogen Gas | 304L Stainless Steel (316 submerged) |
| PD | Process Waste Drain | PVC (Sch80) |
| RAS | Return Activated Sludge | Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304) |
| SA | Soda Ash | PVC Sch80 (Silo); Ductile Iron Glass-Lined (between silo and SBR) |
| TCE | Treated Centrate | Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304) |
| WAS | Waste Activated Sludge | Mild Steel, (CW, ERW or Seamless); Stainless Steel, Std Wt (304) |

## 2. PRODUCTS

### 2.1 Schedule

.1 Pages 3 to 24 following.

.2 Piping located in the SBR headspace is defined as "submerged"

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# DETAILED PIPING SPECIFICATION

## CE / SA

**GENERAL**

| PROCESS FLUID | SYMBOL | OPERATING LIMITS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Centrate<br>Soda Ash (outside silo) | **CEN** | 0-750 | 5-30 | 1200 | 120 minutes |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Ductile Iron, Seamless | Std. Wt. | ANSI A21.51 Class 53, AWWA C151 | |
| Exposed, Aboveground | ≥75 | Ductile Iron, Seamless | Std. Wt. | ANSI A21.51 Class 53, AWWA C151 | |
| Underground | ≥75 | Ductile Iron, Seamless | Std. Wt. | ANSI A21.51 Class 53, AWWA C151 | Note 6 |
| Below Structures | ≥75 | Ductile Iron, Seamless | Std. Wt. | ANSI A21.51 Class 53, AWWA C151 | |
| Submerged | ≥75 | Ductile Iron, Seamless | Std. Wt. | ANSI A21.51 Class 53, AWWA C151 | |
| Sample Lines | 25-75 | PVC | Schedule 80 | ASTM D1785, CSA 137.3 | |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Paint – E1 | | |
| Exposed, Aboveground | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Underground | ≥75 | Yellow Jacket | | |
| Below Structures | ≥75 | Concrete Surround | | Note 1 |
| Submerged | ≥75 | Liquid Epoxy | AWWA C210 | |
| Sample Lines | 25-75 | N/A | | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Glass Lining | | Note 2 |
| Exposed, Aboveground | ≥75 | Glass Lining | | Note 2 |
| Underground | ≥75 | Glass Lining | | Note 2 |
| Below Structures | ≥75 | Glass Lining | | Note 1, 2 |
| Submerged | ≥75 | Glass Lining | | Note 2 |
| Sample Lines | 25-75 | N/A | | |

## DETAILED PIPING SPECIFICATION

### CE / SA (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Grooved Joint | N/A | AWWA C110<br>Dimensions: AWWA C606 | |
| Exposed, Aboveground | ≥75 | Grooved Joint | N/A | AWWA C110<br>Dimensions: AWWA C606 | |
| Underground | ≥75 | Grooved Joint | N/A | AWWA C110<br>Dimensions: AWWA C606 | |
| Below Structures | ≥75 | Grooved Joint | N/A | AWWA C110<br>Dimensions: AWWA C606 | |
| Submerged | ≥75 | Grooved Joint | N/A | AWWA C110<br>Dimensions: AWWA C606 | |
| Sample Lines | 25-75 | N/A | | | |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Flanges, FF | ≥75 | Ductile Iron | Class 125 | Material: ANSI A21.51 Class 53<br>Dimensions:ANSI B16.1<br>AWWA C110 | |
| ELL - Short Radius<br>ELL - Long Radius,<br>Tees, Reducers,<br>Reducing Outlets, Laterals | ≥75 | Ductile Iron, Seamless | Same as Pipe | Material: ANSI A21.51Class 53<br>ASTM A536<br>Dimensions: AWWA C606<br>AWWA C110 | |
| 3 Piece ELL | >350 | Ductile Iron | Same as Pipe | Material: Same as Pipe<br>Dimensions: AWWA C110 | |
| Plug | ≥75 | Ductile Iron | Class 125<br>Blind Flange | Material: Same as Pipe<br>Dimensions:ANSI B16.1 | |
| Cap, Grooved | ≥75 | Ductile Iron | Class 125 | Material: Same as Pipe<br>Dimensions: AWWA C606 | |
| Sockolet | | | | | |
| Threadolet | | | | | |
| Flange Adaptors | ≥75 | Same as Pipe | Same as Pipe | Flange: ANSI B16.1<br>Grooved End: AWWA C606 | |
| Flanged Gaskets | | Bl. Neoprene | | | |
| Grooved Joint Gaskets | ≥75 | | | AWWA C606 | Note 3 |

# DETAILED PIPING SPECIFICATION

## CE / SA (continued)

**VALVES**

| TYPE | SIZE (mm) | VALVE SPECIFICATION (SECTION 11105) | REMARKS |
|---|---|---|---|
| Butterfly | N/A | - | |
| Ball | <75 | BV06 | |
| Check | <75 | CV03 | |
| Globe | N/A | - | |
| Gate | N/A | - | |
| Knife | N/A | - | |
| Mud | N/A | - | |
| Plug | ≥75 | PV01 | Note 5 |
| Needle | N/A | | |

**NOTES**

1. For Concrete Surround linings, refer to Division 2 and 3 specifications and drawings.
2. Glass Lining shall be Vitco SG-14, 0.25 mm thickness minimum, or equivalent.
3. Comply with the manufacturer's recommendations for grooved joint gaskets.
4. Follow manufacturer's recommendations for procedures and repair of glass lining for any field cuts or field taps.
5. Glass lined valves are required.
6. Refer to civil drawings for concrete pipes greater than 1000 mm.

## DETAILED PIPING SPECIFICATION

### PV

**GENERAL**

| PROCESS FLUID | SYMBOL | MAXIMUM CONDITIONS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | DURATION |
| Process Vent – Suction | **PV** | -2 to 0 | -40 to +65 | 140 | 120 minutes |
| Process Ventr – Discharge | **PV** | 0 to 5 | -40 to +65 | 140 | 120 minutes |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≤600 mm<br>>600 mm | FRP | Green Thread<br>F-Chem –V-75 | ASTM D2996, ASTM D2992, ASTM D1599, ASTM 2310 | Note 1 |
| Exposed, Aboveground | ≤600 mm<br>>600 mm | FRP | Green Thread<br>F-Chem –V-75 | ASTM D2996, ASTM D2992, ASTM D1599, ASTM 2310 | Note 1 |
| Underground | ≤600 mm<br>>600 mm | FRP | Green Thread<br>F-Chem –V-75 | ASTM D2996, ASTM D2992, ASTM D1599, ASTM 2310 | Note 1 |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≤600 mm<br>>600 mm | N/A | | |
| Exposed, Aboveground | ≤600 mm<br>>600 mm | Provide a UV resistant barrier or gelcoat to provide protection against UV degradation. | | |
| Underground | ≤600 mm<br>>600 mm | N/A | | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≤600 mm<br>>600 mm | 30 mil minimum liner thickness<br>20 mil minimum liner thickness | Resin rich liner | |
| Exposed, Aboveground | ≤600 mm<br>>600 mm | 30 mil minimum liner thickness<br>20 mil minimum liner thickness | Resin rich liner | |
| Underground | ≤600 mm<br>>600 mm | 30 mil minimum liner thickness<br>20 mil minimum liner thickness | Resin rich liner | |

## DETAILED PIPING SPECIFICATION

### PV (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≤600 mm<br><br><br>>600 mm | Adhesive Bonded Socket or Bell and Spigot<br>Flanged<br>Plain end/Butt wrapped<br>Flanged | N/A | Per FRP Manufacturer | |
| Exposed, Aboveground | ≤600 mm<br><br><br>>600 mm | Adhesive Bonded Socket or Bell and Spigot<br>Flanged<br>Plain end/Butt wrapped<br>Flanged | N/A<br><br>24 m | Per FRP Manufacturer | |
| Underground | ≤600 mm<br><br><br>>600 mm | Adhesive Bonded Socket or Bell and Spigot<br>Flanged<br>Plain end/Butt wrapped | N/A<br><br>N/A | Per FRP Manufacturer | |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Flanges: Slip on, Lap-Joint or Welding Neck Type, FF | ≥100 | Same as pipe, FRP flanges | Class 150 | Dimensions: ANSI B16.5 | |
| Ell - Short Radius<br>Ell - Long Radius, Tees, Reducers, Reducing Outlets, Laterals, Caps | ≥100 | Same as Pipe | Same as Pipe | Dimensions: ANSI B16.9 | |
| 3 piece ELL | 450 - 600 | Same as Pipe | Same as Pipe | Dimensions: ANSI B16.9 | |
| Sockolet | | | | | |
| Threadolet | 10 - 40 | Same as Pipe | | | Note 2 |
| Flex Connections | ≥50 | EPDM | Same as Pipe | | |
| Expansion Couplings | ≥50 | Teflon coated fabric with U-belts for flanged connection. | Same as Pipe | Refer to Section 11053 | Min. 50 mm axial movement. See Note 11. |
| Flange Gaskets | 100 - 250<br><br>300 - 450 | Compressed Kevlar with Neoprene Binder | 1.6 mm thick<br><br>3.2 mm thick | | |

## DETAILED PIPING SPECIFICATION

### PV (continued)

**VALVES**

| TYPE | SIZE (mm) | VALVE SPECIFICATION (SECTION 11105) | REMARKS |
|---|---|---|---|
| Butterfly | N/A | - | |
| Ball | <75 | BV06 | |
| Check | N/A | - | |
| Globe | N/A | - | |
| Gate | N/A | - | |
| Circular balancing damper | ≥75 | FRP construction. Rating is same as pipe. Flanged connections. Acceptable Manufacturers are Swartwout and Ershigs. | |
| Needle | N/A | - | |

**NOTES**

1. Support spacing for FRP piping less than 600 mm diameter is based on GreenThread Pipe manufactured by Smith Fibercast. Refer to Section 11052. Support spacing for FRP piping larger than 600 mm diameter is based on F-Chem-V-75 by Smith Fibrecast.
2. Contractor to provide engineered stamped shop drawings showing similar thermal expansion and adequate support, guide and anchor systems for acceptable manufacturers.
3. Slope pipe a minimum of 1% towards drain points as shown on the drawings.
4. Not used
5. Test fitting according to ASTM D1599 with a 3:1 safety factor. Provide ASTM D2992 data for pipe and ASTM D1599 data for pipe and fittings.
6. The supports, guide and anchor locations are based on a continuous beam pipe support for normal self weight and a multiplier of 1.4 to account for the specific gravity of gas/air as the process fluid. Refer to Section 11058 for support spacing.
7. Contractor to install the piping at temperature greater than -10 deg C.
8. Not used
9. FOA piping less than and equal to 600 mm is to be designed for -4.5 kPa @ 35 deg C.
10. Provide a UV resistant barrier or gelcoat to protect outdoors and exposed piping from UV degradation
11. For > 600 provide a minimum of 100 mm of axial movement or 50 mm on either side of the centre of the expansion joint.

## DETAILED PIPING SPECIFICATION

### FW

**GENERAL**

| PROCESS FLUID | SYMBOL | OPERATING LIMITS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Flushing Water | **FW** | 0-750 | 5-30 | 1200 | 120 minutes |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | <75 | Copper | Type L. Hard | ASTM B88 | Note 1. |
| | | PVC | Sch. 80 | CSA 137.3, ASTM D1785 | |
| | ≥75 | Mild Steel, ERW or Seamless | Std. Wt. | ASTM A53, Grade B | |
| Exposed, Aboveground | <75 | Galvanized Steel, ERW or Seamless | Std. Wt. | ASTM A53, Grade B | |
| | ≥75 | Mild Steel, ERW or Seamless | Std. Wt. | ASTM A53, Grade B | |
| Underground | <75 | Copper | Type K. Soft | ASTM B88 | |
| | ≥75 | PVC | | AWWA C-900 | Note 1. |
| Below, Structures | ≥75 | Mild Steel, ERW or Seamless | Std. Wt. | ASTM A53, Grade B | |
| Submerged | <75 | 304L SS | Sch 10 Pipe or Gauge 12 Tube | | Note 2. |
| | ≥75 | 304L SS | Std. Wt. | | |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Paint – E1 | | |
| Exposed, Aboveground | <75 | Galvanizing | | |
| | ≥75 | Paint | | |
| Underground | <75 | N/A | | |
| | ≥75 | N/A | | |
| Below Structures | ≥75 | Concrete Surround | | |
| Submerged | <75 | N/A | | |
| | ≥75 | N/A | | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | <75 | N/A | | |
| | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Exposed, Aboveground | <75 | Galvanizing | | |
| | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Underground | <75 | N/A | | |
| | ≥75 | N/A | | |
| Below Structures | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Submerged | <75 | N/A | | |
| | ≥75 | N/A | | |

## DETAILED PIPING SPECIFICATION

### FW (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | <75<br><br>≥75 | Soldered Couplings<br>Unions<br>Grooved Joint<br>Butt Welded | N/A<br>12 m<br>N/A | ANSI B16.22<br>ASTM D2467<br>AWWA C606 | |
| Exposed, Aboveground | <75<br>≥75 | Threaded Couplings<br>Grooved Joint<br>Butt Welded | N/A<br>N/A | ASTM A197, ANSI B16.3<br>AWWA C606 | |
| Underground | <75<br><br>≥75 | Soldered Couplings<br>Unions<br>Bell & Spigot | N/A<br>12 m<br>N/A | ANSI B16.22<br><br>AWWA C900 | |
| Below Structures | ≥75 | Grooved Joint<br>Butt Welded | N/A | AWWA C606 | |
| Submerged | <75<br><br>≥75 | Socket Welding<br><br>Grooved Joint | N/A<br><br>12 m | <br><br>ASTM D2467 | |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Flanges, FF or RF | ≥75 | Mild Steel | Class 150 | Material: ASTM A181, Gr.1 Dimensions: ANSI B16.5 | |
| ELL - Short Radius,<br>ELL - Long Radius,<br>Tees, Reducers,<br>Reducing Outlets, Laterals and Caps | 10 - 65<br><br>≥75 | Bronze, Socket Welded PVC<br><br>Mild Steel, Seamless | Class 250<br>Sch. 80<br>Same as Pipe | ANSI B16.22<br>ASTM D2467, Solvent Weld<br>Material: ASTM A234, WPB Dimensions: ANSI B16.9 | |
| Plug | ≥75 | Mild Steel | Class 150<br>Blind Flange | Material: ASTM A181, Gr.1 Dimensions: ANSI B16.9 | |
| Flanged Adaptors | ≥75 | Same as Pipe | Same as Pipe | Flange: ANSI B16.5 | |
| Expansion Couplings | | | | | |
| Flange Gaskets | ≥75 | Bl. Neoprene | | | |
| Grooved Joint Gaskets | ≥75 | | | AWWA C606 | |
| Solder | <75 | Lead Free | | ASTM B32 | |
| Spray Nozzles | 13 | Brass | | John Brooks: FullJet Square spray nozzle, ½ QJJA body, QHA18SQ tip | |

## DETAILED PIPING SPECIFICATION

### FW (continued)

**VALVES**

| TYPE | SIZE (mm) | VALVE SPECIFICATION (SECTION 11105) | REMARKS |
|---|---|---|---|
| Butterfly | ≥75 | BF02 | Default isolation valve, ≥75 |
| Ball | <75<br>≥75 | BV01<br>BV03, BV05 (Note 3) | Default isolation valve, <75 |
| Check | <75<br>≥75 | CV01<br>CV02 | |
| Globe | <75<br>≥75 | GL01<br>GL01 | |
| Gate | <75<br>≥75 | GV01<br>KV01 | Do not use except with Contract Administrator's permission. |
| Needle | <75 | NV01 | |
| Three Way | <75 | TW01 | |

**NOTES**

1. See civil yard piping details for construction beyond 0.45m outside building limits and connection to PVC pipe. Tapewrap all metallic pipe outside building and provide appropriate pipe end (flange, plain end, as required).
2. Tubing or piping located in the headspace of tanks is considered "submerged".

## DETAILED PIPING SPECIFICATION

### MET / N2

**GENERAL**

| PROCESS FLUID | SYMBOL | OPERATING LIMITS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Methanol | **MET** | 0-750 | 5-30 | 1200 | 120 minutes |
| Nitrogen Gas | **N2** | 0-750 | 5-30 | 1200 | 120 minutes |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | WALL THICKNESS | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | <100 | 304L Stainless Steel | 2.03 mm | ASTM A240 | Note 1 |
| | 100 - 200 | 304L Stainless Steel | 14 Gauge | ASTM A778 with scale | Note 7 |
| | 250 - 300 | 304L Stainless Steel | 12 Gauge | removed or ASTM 312 | |
| | 350 - 450 | 304L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 304L Stainless Steel | 10 Gauge | | |
| Exposed, Aboveground | <100 | 304L Stainless Steel | 2.03 mm | | |
| | 100 - 200 | 304L Stainless Steel | 14 Gauge | | |
| | 250 - 300 | 304L Stainless Steel | 12 Gauge | | |
| | 350 - 450 | 304L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 304L Stainless Steel | 10 Gauge | | |
| Underground | <100 | 304L Stainless Steel | 2.03 mm | | |
| | 100 - 200 | 304L Stainless Steel | 14 Gauge | | |
| | 250 - 300 | 304L Stainless Steel | 12 Gauge | | |
| | 350 - 450 | 304L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 304L Stainless Steel | 10 Gauge | | |
| Submerged | <100 | 316L Stainless Steel | 2.03 mm | | |
| | 100 - 200 | 316L Stainless Steel | 14 Gauge | | |
| | 250 - 300 | 316L Stainless Steel | 12 Gauge | | |
| | 350 - 450 | 316L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 316L Stainless Steel | 10 Gauge | | |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | >25 | Insulation and Recovering | See drawings | Note 2 |
| Exposed, Aboveground | >25 | | See drawings | |
| Underground | >25 | N/A | See drawings | |
| Submerged | >25 | N/A | See drawings | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | >25 | N/A | | |
| Exposed, Aboveground | >25 | N/A | | |
| Underground | >25 | N/A | | |
| Submerged | >25 | N/A | | |

## DETAILED PIPING SPECIFICATION

### MET / N2 (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | >25 | Butt Welded<br>Flanged | N/A<br>24 m | ANSI B16.9<br>ASTM 351, ASTM 403 or ASTM A774 with scale removed. | Note 7 |
| Exposed, Aboveground | >25 | Butt Welded<br>Flanged | N/A<br>At anchors | | |
| Underground | >25 | Butt Welded | N/A | | |
| Submerged | >25 | Butt Welded | N/A | | |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Van Stone Flanges, Rolled Angle, | >50 | Same as pipe, with Galvanized Steel Back-Up Ring | Class 150 | Pipe Material: ASTM A240<br>Flanges: ASTM 285<br>Fabrication: ASTM A351, A403 or A774 with scale removed<br>Pattern: ANSI B16.9 | Note 7 |
| Ell – Short Radius<br>ELL - Long Radius,<br>Tees, Reducers,<br>Reducing Outlets, Laterals and Caps | >50<br><450 | Same as Pipe | Same as Pipe | General: MSS SP 43<br>Material: ASTM A351, A403 or A774 with scale removed<br>Dimensions: MSS SP43 | Note 3<br>Note 7 |
| 5 piece ELL | 450 - 1200 | Same as Pipe | Same as Pipe | Material: ASTM A351, A403 or A774 with scale removed<br>Dimensions: ANSI B16.9 | Note 7 |
| Cap | ≥50 | Same as Pipe | Same as Pipe | Material: ASTM A351, A403 or A774 with scale removed.<br>Dimensions: MSS SP43 | |
| Plug | | | | | |
| Sockolet | | | | | |
| Threadolet | 10 - 40 | Same as Pipe | | | |
| Expansion Joints | >50 | EPDM<br>Flange, with Galvanized Steel Back-Up Ring | Same as Pipe | | Note 4 |
| Expansion Couplings | N/A | N/A | N/A | N/A | Not Acceptable |
| Flange Gaskets | | Compressed Kevlar<br>With Neoprene<br>Binder Free of Carbon Black | | | Full face gaskets are allowed for Van Stone & raised face flanges over 100 mm ND. |

## DETAILED PIPING SPECIFICATION

### MET / N2 continued

**VALVES**

| TYPE | SIZE (mm) | SPECIFICATIONS | REMARKS |
|---|---|---|---|
| Butterfly | ≥75 | BF04, BF02 | |
| Ball | <75<br>≥75 | BV02<br>BV03 | |
| Check | ≥75 | CV04 | |

**NOTES**

1 All structural penetrations shall consist of a type 304L stainless steel schedule 10s thimble.

2. Insulation shall be a minimum 50 mm thickness and as required for personnel protection at the design temperature of the pipe, ensuring the surface temperature is below 40°C. Also, ensuring the pipe surface does not sweat. Refer to Section 11059 for pipe insulation and recovering.

3. Fabricate mitered elbows from pipe sections, except as indicated in Section 11050.

4. Where the exposure is buried or submerged and when shown in the drawings, use stainless steel bellows type expansion joints.

5. Not used

6. Test pressure shall be applied and sustained for 120 min, then all joints shall be tested with soapy water.

7. Thoroughly remove all internal and external scale or other surface deposits from pipe and fittings before welding.

8. Piping located in the headspace of the tank is considered "submerged"

9. Gaskets and solvent material to be compatible with designated chemical solution.

## DETAILED PIPING SPECIFICATION

### ML / RAS / WAS

**GENERAL**

| PROCESS FLUID | SYMBOL | OPERATING LIMITS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Mixed Liquor<br>Recycle Activated Sludge<br>Waste Activated Sludge | **ML**<br>**RAS**<br>**WAS** | 0-750 | 5-30 | 1200 | 120 minutes |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Mild Steel (CW or ERW)<br>or<br>Stainless Steel 316L | Std. Wt.<br><br>Std. Wt. | ASTM A53, Grade B<br><br>ASTM A312 | |
| Underground | ≥75 | Mild Steel (CW or ERW)<br>or<br>Stainless Steel 316L | Std. Wt.<br><br>Std. Wt. | ASTM A53, Grade B<br><br>ASTM A312 | |
| Below Structures | ≥75 | Mild Steel (CW or ERW)<br>or<br>Stainless Steel 316L | Std. Wt.<br><br>Std. Wt. | ASTM A53, Grade B<br><br>ASTM A312 | |
| Submerged | ≥75 | Stainless Steel 316L | Std. Wt. | ASTM A312 | Note 1. |
| Sample Lines | 25-75 | PVC | Schedule 80 | ASTM D1785, CSA 137.3 | Note 3. |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 (Steel)<br>≥75 (316L SS) | Paint – E1<br>N/A | | Note 2. |
| Underground | ≥75 (Steel)<br>≥75 (316L SS) | Yellow Jacket<br>N/A | | |
| Below Structures | ≥75 (Steel)<br>≥75 (316L SS) | Concrete Surround<br>Concrete Surround | | |
| Submerged | ≥75 (316L SS) | N/A | | |
| Sample Lines | 25 – 75 | N/A | | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 (Steel)<br>≥75 (316L SS) | Liquid Epoxy – E2a<br>N/A | AWWA C210 | Note 2. |
| Underground | ≥75 (Steel)<br>≥75 (316L SS) | Liquid Epoxy – E2a<br>N/A | AWWA C210 | |
| Below Structures | ≥75 (Steel)<br>≥75 (316L SS) | Liquid Epoxy – E2a<br>N/A | AWWA C210 | |
| Submerged | ≥75 (316L SS) | N/A | | |
| Sample Lines | 25-75 | N/A | | |

## DETAILED PIPING SPECIFICATION

### ML / RAS / WAS (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | 75 – 600<br><br>>600 | Butt Weld<br>Grooved Joint<br>Grooved Joint Flanged | N/A<br>20 m<br>20 m | <br>AWWA C606<br>AWWA C606 | |
| Underground | ≥75 | Butt Weld | N/A | | |
| Below Structures | ≥75 | Butt Weld | N/A | | |
| Submerged | ≥75 | Butt Weld<br>Grooved Joint | N/A<br>20 m | <br>AWWA C606 | |
| Sample Lines | 25-75 | Solvent Weld / Unions | N/A / 12 m | ASTMD2467, D2564 | Note 4. |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Flanges, FF or RF<br><br><br>Sample Lines | ≥75<br><br><br>25-75 | Mild Steel or<br>316L Stainless Steel<br><br>PVC | Class 150<br><br><br>Schedule 80 | Material: ASTM A181, Gr. 1<br>Dimensions: ANSI B16.5<br>ANSI B16.9 | |
| ELL – Short Radius<br>ELL – Long Radius,<br>Tees, Reducers,<br>Reducing Outlets, Laterals and Caps<br>Sample Lines | ≥75<br><br><br><br><br>25-75 | Mild Steel, Seamless or<br>316L Stainless Steel<br><br><br><br>PVC | Same as Pipe<br><br><br><br><br>Schedule 80 | Material: ASTM A234, WPB<br>Dimensions: ANSI B16.9 | |
| 3 Piece ELL | 350 | Mild Steel or<br>316L Stainless Steel | Same as Pipe | Material: Same as Pipe<br>Dimensions: AWWA C208 | |
| 4 Pce ELL, Tees, Reducers, Crosses, Laterals | >600 | Mild Steel or<br>316L Stainless Steel | Same as Pipe | Material: Same as Pipe<br>Dimensions: AWWA C208 | |
| Plug<br><br>Sample Lines | ≥75<br><br>25-75 | Mild Steel or<br>316L Stainless Steel | Class 150<br>Blind Flange<br>Schedule 80 | Material: ASTM A181, Gr. 1<br>Dimensions: ANSI B16.5<br>ASTM D2467, Solvent Weld | |
| Flanged Adaptors | ≥75 | Same as Pipe | Same as Pipe | Flange: ANSI B16.5 | |
| Flanged Gaskets<br>Sample Lines | | Bl. Neoprene<br>Bl. Neoprene, Viton | | <br>ASTM F477 | <br>Note 6 |
| Grooved Joint Gaskets | ≥75 | | | AWWA C606 | |
| Sample Lines PVC Solvent | | | | ASTM D2564 | Note 6 |

## DETAILED PIPING SPECIFICATION

### ML / RAS / WAS (continued)

**VALVES**

| TYPE | SIZE (mm) | SPECIFICATIONS | REMARKS |
|---|---|---|---|
| Butterfly | N/A | - | |
| Ball | <75<br>≥75 | BV06<br>BV05 | |
| Check | ≥75 | CV07 | |
| Globe | N/A | - | |
| Gate | N/A | - | |
| Needle | N/A | - | |

**NOTES**

1. Piping located in the headspace of tanks is considered "submerged".
2. Refer to Section 09905.
3. Not Applicable.
4. Provide unions or flanges to allow for pipe disassembly.
5. Where pipe crosses a structural joint, install at the joint location an EPDM lined elastomer spherical moulded type expansion joint capable of 0.25 degrees angular movement and ±20 mm axial movement.
6. Gaskets and solvent material to be compatible with designated chemical solution.

## DETAILED PIPING SPECIFICATION

# AIR

**GENERAL**

| PROCESS FLUID | SYMBOL | OPERATING LIMITS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Process Air | **AIR** | 0-115 | -40 to 150 | 175 | 120 minuted<br>See Note 6 |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | WALL THICKNESS | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | <100 | 304L Stainless Steel | 2.03 mm | ASTM A240 | Note 1 |
| | 100 - 200 | 304L Stainless Steel | 14 Gauge | ASTM A778 with scale | Note 7 |
| | 250 - 300 | 304L Stainless Steel | 12 Gauge | removed or ASTM 312 | |
| | 350 - 450 | 304L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 304L Stainless Steel | 10 Gauge | | |
| Exposed, Aboveground | <100 | 304L Stainless Steel | 2.03 mm | | |
| | 100 - 200 | 304L Stainless Steel | 14 Gauge | | |
| | 250 - 300 | 304L Stainless Steel | 12 Gauge | | |
| | 350 - 450 | 304L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 304L Stainless Steel | 10 Gauge | | |
| Underground | <100 | 304L Stainless Steel | 2.03 mm | | |
| | 100 - 200 | 304L Stainless Steel | 14 Gauge | | |
| | 250 - 300 | 304L Stainless Steel | 12 Gauge | | |
| | 350 - 450 | 304L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 304L Stainless Steel | 10 Gauge | | |
| Submerged | <100 | 316L Stainless Steel | 2.03 mm | | |
| | 100 - 200 | 316L Stainless Steel | 14 Gauge | | |
| | 250 - 300 | 316L Stainless Steel | 12 Gauge | | |
| | 350 - 450 | 316L Stainless Steel | 11 Gauge | | |
| | 500 - 1200 | 316L Stainless Steel | 10 Gauge | | |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | >25 | Insulation and Recovering | See drawings | Note 2 |
| Exposed, Aboveground | >25 | | See drawings | Note 8 |
| Underground | >25 | N/A | See drawings | |
| Submerged | >25 | N/A | See drawings | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | >25 | N/A | | |
| Exposed, Aboveground | >25 | N/A | | |
| Underground | >25 | N/A | | |
| Submerged | >25 | N/A | | |

**DETAILED PIPING SPECIFICATION**

## AIR (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | >25 | Butt Welded<br>Flanged | N/A<br>24 m | ANSI B16.9<br>ASTM 351, ASTM 403 or ASTM A774 with scale removed. | Note 7 |
| Exposed, Aboveground | >25 | Butt Welded<br>Flanged | N/A<br>At anchors | | |
| Underground | >25 | Butt Welded | N/A | | |
| Submerged | >25 | Butt Welded | N/A | | |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Van Stone Flanges, Rolled Angle, | >50 | Same as pipe, with Galvanized Steel Back-Up Ring | Class 150 | Pipe Material: ASTM A240<br>Flanges: ASTM 285<br>Fabrication: ASTM A351, A403 or A774 with scale removed<br>Pattern: ANSI B16.9 | Note 7 |
| Ell – Short Radius<br>ELL - Long Radius,<br>Tees, Reducers,<br>Reducing Outlets, Laterals and Caps | >50<br><450 | Same as Pipe | Same as Pipe | General: MSS SP 43<br>Material: ASTM A351, A403 or A774 with scale removed<br>Dimensions: MSS SP43 | Note 3<br>Note 7 |
| 5 piece ELL | 450 - 1200 | Same as Pipe | Same as Pipe | Material: ASTM A351, A403 or A774 with scale removed<br>Dimensions: ANSI B16.9 | Note 7 |
| Cap | ≥50 | Same as Pipe | Same as Pipe | Material: ASTM A351, A403 or A774 with scale removed.<br>Dimensions: MSS SP43 | |
| Plug | | | | | |
| Sockolet | | | | | |
| Threadolet | 10 - 40 | Same as Pipe | | | |
| Expansion Joints | >50 | EPDM<br>Flange, with Galvanized Steel Back-Up Ring | Same as Pipe | | Note 4 |
| Expansion Couplings | N/A | N/A | N/A | N/A | Not Acceptable |
| Flange Gaskets | | Compressed Kevlar<br>With Neoprene<br>Binder Free of Carbon Black | | | Full face gaskets are allowed for Van Stone & raised face flanges over 100 mm ND. |

# DETAILED PIPING SPECIFICATION

## AIR (continued)

**VALVES**

| TYPE | SIZE (mm) | VALVE SPECIFICATION (SECTION 11105) | REMARKS |
|---|---|---|---|
| Butterfly | ≥75 | BF10 | |
| Ball | <75 | N/A | |
| Check | ≥75 | CV04 | |
| Globe | - | N/A | |
| Gate | - | N/A | |
| Mud | - | N/A | |
| Needle | <75 | N/A | |
| Vee Ball | - | N/A | |

**NOTES**

1. All structural penetrations shall consist of a type 304L stainless steel schedule 10s thimble.
2. Insulation shall be a minimum 50 mm thickness and as required for personnel protection at the design temperature of the pipe, ensuring the surface temperature is below 40°C. Also, ensuring the pipe surface does not sweat. Refer to Section 11059 for pipe insulation and recovering.
3. Fabricate mitered elbows from pipe sections, except as indicated in Section 11050.
4. Where the exposure is buried or submerged and when shown in the drawings, use stainless steel bellows type expansion joints.
5. Not used
6. Test pressure shall be applied and sustained for 120 min, then all joints shall be tested with soapy water.
10. Thoroughly remove all internal and external scale or other surface deposits from pipe and fittings before welding.
11. Provide stenciled warning on outdoor piping as follows: "WARNING – EXTREMELY HOT".

## DETAILED PIPING SPECIFICATION

### TCE

**GENERAL**

| PROCESS FLUID | SYMBOL | OPERATING LIMITS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Treated Centrate | **TCE** | 0-750 | 5-30 | 1200 | 120 |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Mild Steel, ERW or Seamless | Sch. 80<br>Std. Wt. | CSA 137.3, ASTM D1785<br>ASTM A53, Grade B | Note 1. |
| Exposed, Aboveground | ≥75 | Mild Steel, ERW or Seamless | Std. Wt. | ASTM A53, Grade B | |
| Underground | ≥75 | PVC | | AWWA C-900 | Note 1. |
| Below, Structures | ≥75 | Mild Steel, ERW or Seamless | Std. Wt. | ASTM A53, Grade B | |
| Submerged | ≥75 | 316L SS | Std. Wt. | | Note 2. |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Paint – E1 | | |
| Exposed, Aboveground | ≥75 | Paint | | |
| Underground | ≥75 | N/A | | |
| Below Structures | ≥75 | Concrete Surround | | |
| Submerged | ≥75 | N/A | | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Exposed, Aboveground | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Underground | ≥75 | N/A | | |
| Below Structures | ≥75 | Liquid Epoxy – E2a | AWWA C210 | |
| Submerged | ≥75 | N/A | | |

# DETAILED PIPING SPECIFICATION

## TCE (continued)

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Tunnels, Pumphouses, and Buildings | ≥75 | Grooved Joint<br>Butt Welded | N/A | AWWA C606 | |
| Exposed, Aboveground | ≥75 | Grooved Joint<br>Butt Welded | N/A | AWWA C606 | |
| Underground | ≥75 | Bell & Spigot | N/A | AWWA C900 | |
| Below Structures | ≥75 | Grooved Joint<br>Butt Welded | N/A | AWWA C606 | |
| Submerged | ≥75 | Grooved Joint | 12 m | ASTM D2467 | |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Flanges, FF or RF | ≥75 | Mild Steel | Class 150 | Material: ASTM A181, Gr.1 Dimensions: ANSI B16.5 | |
| ELL - Short Radius,<br>ELL - Long Radius,<br>Tees, Reducers,<br>Reducing Outlets, Laterals and Caps | 10 - 65<br><br>≥75 | Bronze, Socket Welded PVC<br>Mild Steel, Seamless | Class 250<br>Sch. 80<br>Same as Pipe | ANSI B16.22<br>ASTM D2467, Solvent Weld<br>Material: ASTM A234, WPB Dimensions: ANSI B16.9 | |
| Plug | ≥75 | Mild Steel | Class 150<br>Blind Flange | Material: ASTM A181, Gr.1 Dimensions: ANSI B16.9 | |
| Flanged Adaptors | ≥75 | Same as Pipe | Same as Pipe | Flange: ANSI B16.5 | |
| Expansion Couplings | | | | | |
| Flange Gaskets | ≥75 | Bl. Neoprene | | | |
| Grooved Joint Gaskets | ≥75 | | | AWWA C606 | |

**VALVES**

| TYPE | SIZE (mm) | SPECIFICATIONS | REMARKS |
|---|---|---|---|
| Butterfly | N/A | - | |
| Ball | <75<br>≥75 | BV06<br>BV05 | |
| Check | ≥75 | CV07 | |
| Globe | N/A | - | |
| Gate | N/A | - | |
| Needle | N/A | - | |

**NOTES**

3. See civil yard piping details for construction beyond 0.45m outside building limits and connection to PVC pipe. Tapewrap all metallic pipe outside building and provide appropriate pipe end (flange, plain end, as required).
4. Tubing or piping located in the headspace of tanks is considered "submerged".

## DETAILED PIPING SPECIFICATION

### PD / SA

**GENERAL**

| PROCESS FLUID | SYMBOL | MAXIMUM CONDITIONS | | TEST CONDITIONS | |
|---|---|---|---|---|---|
| | | PRESSURE (kPa) | TEMP. (°C) | PRESSURE (kPa) | DURATION |
| Process Drain | **PD** | 750 | 30 | 1000 | |
| Soda Ash (in Silo) | **SA** | | | | 120 minutes |

**PIPE**

| LOCATION | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| All | 10 – 200 | PVC | Schedule 80 | ASTM D1785, CSA 137.3 | |

**COATINGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| All | 10 – 200 | N/A | | |

**LININGS**

| LOCATION | SIZE (mm) | MATERIAL | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|
| All | 10 – 200 | N/A | | |

**JOINTS**

| LOCATION | SIZE (mm) | TYPE | MAXIMUM SPACING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| All | 10 – 65 | Solvent Weld | N/A | ASTM D2467, D2564 | |
| | 10 – 65 | Unions | 12 m | ASTM D2467 | Note 1 |
| | ≥75 | Solvent Weld | N/A | ASTM D2467, D2564 | |
| | ≥75 | Flanges | 12m | ASTM D2467 | Note 1 |

**FITTINGS AND APPURTENANCES**

| ITEM | SIZE (mm) | MATERIAL | RATING | SPECIFICATIONS | REMARKS |
|---|---|---|---|---|---|
| Flanges | 10 – 200 | PVC | Schedule 80 | | |
| ELL - Short Radius<br>ELL - Long Radius,<br>Couplings, Tees,<br>Reducers,<br>Reducing Outlets and<br>Laterals | 10 – 200 | PVC | Schedule 80 | ASTM D2467, Solvent Weld | |
| Plug | 10 – 200 | PVC | Schedule 80 | ASTM D2467, Solvent Weld | |
| Cap | ≥75 | PVC | Blind Flange<br>Schedule 80 | | |
| Flange Gaskets | | Bl. Neoprene, Viton | | ASTM F477 | Note 3 |
| PVC Solvent | | | | ASTM D2564 | Note 3 |

## DETAILED PIPING SPECIFICATION

### PD / SA (continued)

**VALVES**

| TYPE | SIZE (mm) | VALVE SPECIFICATION (SECTION 11105) | REMARKS |
|---|---|---|---|
| Butterfly | - | N/A | |
| Ball | All | BV06 | |
| Check | All | CV06 | |
| Globe | - | N/A | |
| Gate | All | GV02 | |
| Needle | - | N/A | |
| Plug | - | N/A | |

**NOTES**

1. Provide Unions or flanges as shown on Drawings to allow for pipe disassembly.
2. Where pipe crosses a structural joint, install at the joint location an EPDM lined elastomer spherical moulded type expansion joint capable of 0.25 degrees angular movement and ±20 mm axial movement.
3. Gaskets and solvent material to be compatible with designated chemical solution.
4. Drains from Exhaust Air Fans to meet this detailed piping specification.

**END OF SECTION**

# PROCESS PIPELINE APPURTENANCES

## 1. GENERAL

### 1.1 Description

.1 This Section describes process pipeline appurtenances to be installed integrally with the piping.

.2 Refer to the general piping requirements of Section 11050. Use the general requirements specified in this Section and Section 11050 integrally with the more specific requirements listed in Section 11055.

### 1.2 Submittals

.1 Provide Shop Drawings for each type of pipeline appurtenance in accordance with the requirements of Section 01300 and 11050.

.2 Show the materials of construction, a cutout indicating the interior workings of the unit, and illustrations of the method of installation.

### 1.3 Coordination

.1 Coordinate the appurtenances with the piping layout and arrangement. Ensure that the appurtenances are mounted in locations suitable for their intended function and where they are accessible for maintenance personnel.

### 1.4 Quality Assurance

.1 Refer to Section 11050 for welding quality assurance requirements.

### 1.5 Shipment, Protection, and Storage

.1 Refer to Section 01600 and Section 11050.

## 2. PRODUCTS

### 2.1 Function

.1 Provide the pipe appurtenances as described below, for the piping systems shown.

### 2.2 Instrument Air Connections

.1 Provide instrument air connections to each instrument with a run of 12 mm stainless steel tubing from the nearest instrument air header to within close proximity of each device requiring instrument air.

.2 Terminate each tubing run with a 12 mm ball valve (stainless steel) within 1500 mm horizontal distance of the device and 1500 mm off the floor. Group multiple valves neatly together with a common orientation.

.3 Refer to Division 17 for connection from that termination to the device from the downstream side of the valve. A list of devices requiring instrument air is provided in the Instrument Specification Sheets.

.4 Provide a vertical riser connection at the header to avoid condensate entrainment. From the top of the riser, slope the tubing generally down to the device.

## 2.3 Strainers

.1 Air and Gas Strainers

.1 Provide strainers with Y-pattern, cast iron body, with 40 mesh Moel screens packed with Everdur wool. For copper piping, provide bronze bodies.

.2 Fit air line strainers with a brass blowoff cock.

.3 Acceptable Manufacturers are:

.1 Armstrong

.2 Mueller

.2 Steam and Water Strainers

.1 Provide steam and water strainers with Y-pattern unless otherwise specified.

.2 Provide carbon steel body for steam strainers, cast iron body for water strainers, and bronze bodies for copper piping systems.

.3 Provide 304 stainless steel screens and tapped and plugged blowoff connections. Screen perforations shall be 0.5 mm for steam service and 1.15 mm for water service.

.4 Acceptable Manufacturers are:

.1 Armstrong

.2 Mueller

## 2.4 Quick Disconnects

.1 Provide quick disconnects which are not disconnectable under pressure. Unless otherwise shown or specified, provide products listed below.

.2 For air service, acceptable products are:

.1 Dixon Air King

.2 Tomco, 12 mm diameter

.3 For water service, provide products to City standard; two lug, malleable iron, female NPT. Sizes as shown. Acceptable Products are: for water service, provide Products to City standard. Sizes as shown. Acceptable Products are:

.1 For hose 25 mm or less in diameter, two lug, malleable iron, female NPT: Dixon Air King

.2 For 38 mm and 50 mm diameter hose, two lug, malleable iron, female NPT: New Line

.3 For 75 mm and 100 mm diameter, quick-acting, dual clip: Rite-pro, Dixon.

.4 For sodium hypochlorite service, acceptable Products are:

.1 Bay Seal

.2 Dixon Boss Lock

.3 PT Couplings

**2.5 Flushing Connections**

.1 Provide flushing connections on all piping for the conveyance of sludge, scum, grit, or other liquid containing solids greater than 0.5 percent.

.2 Locate flushing connections adjacent to all isolation valves, on dead end branches, at tees and 90-degree elbows, and at intermediate locations, which limit the distance between flushing connections to less than 30 m.

.3 Show flushing connections on piping submittals.

**2.6 Purge Connections**

.1 Provide purge connections on all gas lines.

.2 Locate adjacent to both sides of all isolation valves and spectacle flanges, and at any other locations shown in the Drawings.

.3 Purge points shall be a minimum of 20 mm NPS pipe, fitted with a shut-off valve, which shall be capped.

**2.7 Mechanical Branch Connections**

.1 Provide mechanical branch connections as required for flushing connections and pipe tappings as shown in the Standard Details.

.2 Provide branch connection recommended by the Manufacturer for the service and pipe installed.

.3 Acceptable Products are:

.1 Gruvlock Clamp T

.2 Ford Service Saddles (F/FS)

.3 Victaulic Mechanical T

.4 Robar 2706 Service Saddles

**2.8 Hoses**

.1 Provide hoses rated for 600 kPa, complete with quick connect fittings as per standard details and as called for on the Drawings.

**3. EXECUTION**

**3.1 Pipeline Appurtenances**

.1 Provide manual air vents at the high points of each reach of pipeline and where shown, consisting of a ball valve and copper tubing return. Take air vents to the nearest floor with the valve mounted in a location accessible from floor level and no greater than 1200 mm above the floor. For piping systems conveying fluids containing solids, use 25 mm line with a non-lubricated ball valve fitted with quick disconnects. For a high point vent required on an extended run of constant elevation pipe, locate the vent at the downstream end of the run close to the downward elbow.

.2 Provide manual drains at the low point of each reach of pipeline and where shown. Pipe drains to a sump, gutter, floor drain, or other collection point with a valve mounted in a location accessible from floor level and no greater than 1200 mm above the floor. Provide threaded ball valves for drain valves of the size shown. When drains cannot be run to collection points, route them to a point of easy access and attach quick disconnects of the size specified. For pumps that do not come with integral drains, provide 25 mm drain connections with threaded manual ball valves inside pump isolation valves.

.3 Unless otherwise shown or specified, install gauge taps on the suction and discharge of all pumps, fans, blowers, compressors, and vacuum pumps. Attach gauge taps with a threaded nipple and valve, as shown, attached by a threaded nipple to the pipeline, duct, or equipment.

.4 Install flushing and purge connections as described in Part 2 and as shown. Install sample lines and connections as shown.

**3.2 Testing**

.1 Refer to 11050 3.10

**3.3 Pressure Testing of Liquid Lines**

.1 Refer to 11050 3.11

### 3.4 Pressure Testing of Gas, Air and Vapour Lines

.1 Refer to 11050 3.12

### 3.5 Cleaning and Flushing

.1 Refer to 11050 3.13

### 3.6 Disinfection

.1 Refer to 11050 3.14

**END OF SECTION**

**PROCESS PIPE HANGERS AND SUPPORTS**

## 1. GENERAL

### 1.1 Work Included

.1 Supply and installation of hangers and supports for all process piping systems specified in Section 11050. This Section does not include pipe support for plumbing systems, HVAC systems, fire sprinkling systems, pipe anchors, guides, or seismic restraints.

.2 Engage a Professional Engineer to be responsible for the final aspects of the piping support system design, including details and spacing of all supports. The support system will ensure that the weight of the pipework and the need for lateral and vertical support are considered fully. Contractor to provide a complete piping system design as described in Section 11050.

### 1.2 Submissions

.1 Submit the following for information in accordance with Section 01300:

.1 In piping layout drawings specified in Section 11050, indicate hanger and support locations and provide legend summarizing load information and hanger and support component selection at each location.

### 1.3 Service Conditions

.1 The intent of the Drawings has been to indicate general arrangements and typical spacings for pipe systems, but does not relieve the Contractor of the responsibility for the design and supply of a complete and adequate support system.

.2 Provide hangers and supports specified in this Section to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this Section established pipe support classifications based on the operating temperature of the piping contents.

.3 Pipe support classifications:

.1 Hot Systems:

.1 A-1: 40°C - 230°C

.2 A-2: 230°C - 400°C

.3 A-3: Over 400°C

.2 Ambient systems:

.1 B-1: 15°C - 49°C

.3 Cold systems:

.1 C-1: 0.5°C - 15°C

.2 C-2: -40°C - 0°C

## 1.4 Hanger and Support Selection

.1 Piping supports are generally not shown on the process mechanical layout Drawings. Therefore, select pipe hangers and supports as specified in this Section. Typical support details and structural attachments shown on the Drawings indicate the level of quality that will be considered acceptable. Where specific supports are illustrated on the process mechanical or structural Drawings or where a specific standard detail is noted on the Drawings, provide that type of support for that particular pipeline.

.2 Piping insulation thickness is specified in Section 11059.

.3 Review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

.4 Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to following conditions:

.1 Weights of pipe, valves, fitting, insulating materials, suspended hanger components, and normal fluid contents

.2 Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter

.3 Reaction forces due to the operation of safety or relief valves

.4 Wind, snow, or ice loadings on outdoor piping

.5 Size hangers and supports to fit the outside diameter of pipe, tubing, or where specified, the outside diameter of insulation.

.6 Where negligible movement occurs at hanger locations, use rod hangers for suspended lines, whenever practical. Use bases, brackets, or structural cross members for piping supported from below.

.7 Hangers for the suspension of pipe and tubing sizes, 65 mm and larger, shall be capable of vertical hanger component adjustment under load.

.8 Provide the supporting systems to allow for free or intended movement of the piping including its movement in relation to that of connected equipment.

.9 Design the system to support the operating loads with a safety factor of 4.0.

.10 Where there is horizontal movement at a suspended type hanger location, select hanger components to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4°.

.11 No contact is allowed between a pipe and hanger or support components of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing with copper-plated, rubber, plastic, or vinyl coated, or stainless steel hanger and support components.

.12 Do not support piping from masonry wall construction.

.13 Do not use existing pipes and supports to support new piping unless otherwise specified.

.14 Do not attach pipe support components to equipment or pressure vessels unless otherwise specified.

.15 Use stock hanger and support components wherever practical.

.16 Provide supplementary structural members, where structural bearings are not in suitable locations.

.1 Make provision for expansion, contraction, slope, and anchorage.

.2 Where necessary, pipe support systems shall withstand the additional load of electrical or instrumentation trays. Coordinate with other divisions. Design and provide support system accordingly.

## 2. PRODUCTS

### 2.1 Acceptable Manufacturers

.1 The following Manufacturers' Products to provide the specified features and to meet specified operating conditions:

.1 B-Line

.2 Grinnell

.3 Powerstrut

.4 Superstrut

.5 Unistrut

## 2.2 Support Spacing

.1 Maximum support spacing shall be as listed in the following table:

| Pipe Size Nominal (mm) | Maximum Spacing (m) | | |
|---|---|---|---|
| | Iron | PVC | Steel or Stainless Steel |
| 30 and under | 2.1 | 1.4 | 2.1 |
| 30 to 40 | 2.7 | 1.5 | 2.1 |
| 40 to 50 | 3.0 | 1.6 | 2.1 |
| 60 to 75 | 3.6 | 1.8 | 3.0 |
| 100 | 4.2 | 2.5 | 3.7 |
| 150 | 5.2 | 3.0 | 4.3 |
| 200 | 5.8 | 3.5 | 4.6 |
| 250 | 6.4 | 4.0 | 4.9 |
| 300 | 6.7 | 4.2 | 5.2 |
| 350 | 6.7 | - | 5.8 |
| 400 | 6.7 | - | 6.1 |
| 500 | 6.7 | - | 6.7 |
| 600 and greater | 6.7 | - | 6.7 |

.2 Provide additional supports at any valves or other heavy piping element.

## 2.3 Materials

.1 Non-Corrosive Environments (Tunnels and Buildings):

.1 Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories are hot-dipped galvanized after fabrication.

.2 Provide cadmium plated hardware (nuts, bolts, washers, threaded rods).

.3 Touch up cadmium and galvanized material with zinc rich coating where the material has been cut. Exposed bare steel is not acceptable.

.2 Exterior, Submerged, or Corrosive Environments:

.1 Pipe hangers, supports, structural attachments, fittings, accessories, and hardware are all stainless steel.

.2 Any areas that may be considered corrosive and are in question should be reviewed with the Contract Administrator in advance of securing the materials.

.3 The fluid in the SBRs and Equalization Tank has an average chloride concentration of 550 mg/L. Provide 316 Stainless Steel for submerged locations.

.3 Provide AISI, Type 304 stainless steel concrete inserts.

## 2.4 Pipe Hangers and Supports

.1 Type 1 - Clevis Pipe Hanger: provide carbon steel clevis hangers with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3100, Grinnell Figure 260, Superstrut C-710 or Unistrut No. 24 with insulation shield

.2 Steel pipe (un-insulated) - B-Line B3100, Grinnell Figure 260, Superstrut C-710 or Unistrut No. 24

.3 Cast and ductile iron pipe - B-Line B3102, Grinnell Figure 590, Superstrut C-710 or Unistrut No. 24

.4 Copper pipe (un-insulated) - shall be B-Line B3104 CT, Grinnell Figure CT-65, Superstrut C-710 or Unistrut No. 51

.5 Copper pipe (insulated) - B-Line B3100, Grinnell Figure 260, Superstrut C-710 or Unistrut No. 24, with insulation shield

.6 Plastic pipe - B-Line B3100, Grinnell Figure 260 or Unistrut No. 56

.2 Type 2 - "J" Pipe Hanger: provide carbon steel hangers with configuration and components equivalent to MSS Type 5. Use only on uninsulated pipe, with configuration and components as follows:

.1 Steel pipe - B-Line B3690, Grinnell Figure 67, Superstrut C-711 or Unistrut J1205-J1280 Series

.2 Copper and plastic pipe - B-Line B3690 (Plasticoat) Grinnell Figure 67 (plastic coated), Superstrut C-711P or Unistrut J 1205N-J1280N series

.3 Type 3 - Double Bolt Pipe Clamp: provide carbon steel pipe clamps, with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3144 or Grinnell Figure 295, with insulation shield. Insulation shield is optional for hot and ambient systems

.2 Steel pipe (un-insulated) - B-Line B3144 or Grinnell Figure 295

.3 Copper pipe (insulated only) - B-Line 3144 or Grinnell Figure 295, with insulation shield

.4 Type 4 - Adjustable Roller Hanger: provide cast iron rollers, carbon steel yoke and cross bolt with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3110, Grinnell Figure 181 or Superstrut C-729, with insulation shield

.2 Steel pipe (un-insulated) - B-Line B3110, Grinnell Figure 181 or Superstrut C-729

.3 Copper pipe (insulated only) - B-Line B3110, Grinnell Figure 181 or Superstrut C-729, with insulation shield

.4 Plastic pipe - B-Line B3110, Grinnell Figure 181 or Superstrut C-729

.5 Type 5 - Single Pipe Roll: provide cast iron rollers and sockets, and steel cross rods with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3114, Grinnell Figure 171 with insulation shield

.2 Steel pipe (un-insulated) - B-Line B3114, Grinnell Figure 171

.3 Plastic pipe - B-Line B3114, Grinnell Figure 171

.6 Type 6 - Framing Channel Pipe Clamp: provide steel pipe clamps with hot dipped galvanized finish and material thickness as listed below:

.1 Steel pipe (un-insulated) - B-Line 2007, Powerstrut PS1100, or Unistrut P1009 Series:

| Pipe Diameter mm | Thickness mm |
|---|---|
| 10 and 12 | 1.6 |
| 20 to 32 | 2.0 |
| 38 to 75 | 2.8 |
| 90 to 125 | 3.2 |
| 150 to 200 | 3.6 |

.2 Steel pipe (insulated): as per 2.4.6.1 with insulation shield

.3 Copper (un-insulated) and plastic pipe, B-Line B2033 Series, Powerstrut PS1200 or Unistrut P2024C and P2024PC Series B-Line. Provide a copper-plated, plastic coated or lined with a dielectric material on pipe clamps.

| Pipe Diameter mm | Thickness mm |
|---|---|
| 10 to 25 | 1.6 |
| 32 and 38 | 2.0 |
| 50 to 75 | 2.8 |
| 100 | 3.2 |

.4 Copper (insulated); as per 2.4.6.3 with insulation shield

.7 Type 7 - U-Bolt: Provide carbon steel U-bolts with configuration as follows:

.1 Steel pipe (uninsulated) - Grinnell Figure B-Line B3188 or Superstrut H-115

.2 Steel pipe (insulated) - Grinnell Figure 137, B-Line B3188 or Superstrut H-115 with insulation shield

.3 Cast and ductile iron pipe - Grinnell Figure 137, B-Line B3188 or Superstrut H-115

.4 Copper pipe (un-insulated) - B-Line B3501 CT, Grinnell Figure 137C, Superstrut H-115 (with plastic coating) or Unistrut No. 13 (with plastic coating)

.5 Copper pipe (insulated) - Grinnell Figure 137 or B-Line B3188, Superstrut H-115 with insulation shield

.6 Plastic pipe - Grinnell Figure 137C, B-Line B3188 or Superstrut H-115 (with plastic coating)

.8 Type 8 - Adjustable Pipe Roll Support: provide cast iron rollers and sockets, and carbon steel cross rod and support rods with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3122 or Grinnell Figure 177 with insulation shield

.2 Steel pipe (un-insulated) - B-Line B3122 or Grinnell Figure 177

.3 Copper pipe (insulated only) - B-Line B3122 or Grinnell Figure 177 with insulation shield

.4 Plastic pipe - B-Line B3122 or Grinnell Figure 177

.9 Type 9 - Welded Pipe Stanchion: provide a carbon steel, standard schedule pipe stanchion, cut pipe to match contour of pipe elbow. Use only for ambient commodity systems.

.10 Type 10 - Pipe Stanchion saddle: provide carbon steel saddles and yokes as follows:

.1 Steel pipe (insulated) - B-Line B3900 or Grinnell Figure 259 with insulation shield.

.2 Steel pipe (un-insulated) - B-Line 3090 or Grinnell Figure 259.

.3 Cast and ductile iron pipe - B-Line 3090 NS or Grinnell Figure 259.

.4 Copper pipe (un-insulated) - B-Line B3090 or Grinnell Figure 259 with insulation shield or lined with dielectric material.

.5 Copper pipe (insulated) - B-Line B3090 or Grinnell Figure 259 with insulation shield

.6 Plastic pipe - B-Line B3090 or Grinnell Figure 259

.11 Type 11 - Offset Pipe Clamp: provide carbon steel pipe clamps with configuration and components as specified and to the most standard design manufactured by a pipe hanger component manufacturer:

.1 Steel pipe (insulated) - B-Line B3148 or Grinnell Figure 103 or with insulation shield

.2 Steel pipe (un-insulated) - B-Line B3148 or Grinnell Figure 103

.3 Cast and ductile iron pipe - B-Line B3148 NS or Grinnell Figure 103

.4 Copper pipe (insulated) - B-Line B3148 or Grinnell Figure 103 or with insulation shield

.5 Copper pipe (un-insulated) - B-Line B3148 or Grinnell Figure 103 lined with dielectric material

.6 Plastic pipe - B-Line B3148 or Grinnell Figure 103

.12 Type 12 - Riser Clamp: provide carbon steel riser clamps with configuration and components as follows:

.1 Steel pipe (insulated) - B-Line B3373 or Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82

.2 Steel pipe (uninsulated) - B-Line B3373 or Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82

.3 Cast and ductile iron pipe - B-Line B3373 or Grinnell Figure 261, Superstrut C-720 or Unistrut No. 8

.4 Copper pipe (insulated) - B-Line B3373 CT, Grinnell Figure 261, Superstrut C-720 or Unistrut No. 82

.5 Copper pipe (uninsulated) - B-Line B3373 CT, Grinnell Figure CT-261, Superstrut C-720 or Unistrut No. 84

.6 Plastic pipe - B-Line B3373, Grinnell Figure 261C, or Superstrut C-720 or Unistrut No. 82

.13 Type 13 - Framing Channel Pipe Strap: provide carbon steel pipe strap with configuration as follows:

.1 Steel pipe (un-insulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series

.2 Steel pipe (insulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series with insulation shield

.3 Copper pipe (un-insulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series with insulation shield

.4 Copper pipe (insulated) - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series with insulation shield

.5 Plastic pipe - B-Line B2400 Series, Powerstrut PS3126, Superstrut C-708-U or Unistrut P2008 Series

.14 Rack and Trapeze Supports:

.1 Unless otherwise specified, provide steel trapeze and pipe rack components having a minimum thickness of 2.8 mm with a maximum deflection 1/240 of the span. Framing channel as specified in 2.4.16.5.

.2 Type 20 - Trapeze Pipe Support: trapeze pipe support cross members as specified in 2.4.16.5. Provide 41 mm square carbon steel flat plate fittings of stranded design manufactured by framing channel manufacturer, B-Line B202-2, Powerstrut PS619 or Unistrut P1062 Series.

.3 Type 21 - Pipe Rack Support: post- and cross-member framing channels, as specified in 2.4.16.5. Provide carbon steel pipe rack fittings of standard design manufactured by framing channel manufacturer. Provide gusset type, 90-degree fittings, B-Line B844, Grinnell PS3373 or Unistrut P2484. Post base fittings as specified in 2.4.15.14.

.15 Structural Attachments:

.1 Type A - Malleable Iron Concrete Insert: provide malleable iron concrete inserts; B-Line B3014, Grinnell Figure 282, or Unistrut M2808.

.2 Type B - Side Beam Bracket: provide malleable iron bracket Grinnell Figure 202 or B-Line B3062.

.3 Type C - Malleable Beam Clamp with Extension Piece: provide malleable iron clamp and extension pieces with steel tie rods; Grinnell Figure 218 with Figure 157 extension piece or B-Line B3054.

.4 Type D - Steel Beam Clamp with Eye Nut: provide forged steel beam clamps and eye nuts; Grinnell Figure 292, B-Line B3291 series.

.5 Type E - Steel channel clamp: provide malleable iron clamp and heel plates, and steel bolts and nuts; Grinnell Figure 226.

.6 Type F - Welded Beam Attachment: provide carbon steel beam attachments; B-Line B3083 or Grinnell Figure 66.

.7 Type G - Adjustable Beam Attachment: provide carbon steel beam attachments, B-Line B3082, Unistrut P1737, or Powerstrut PS2648.

.8 Type H - Double Channel Bracket: provide single channel attachment as specified in 2.4.16.5. Provide a carbon steel, double-framing, channel, cantilever bracket assembly; B-Line B297-12 through B297-36, Powerstrut PS809 or Unistrut P2542 series.

.9 Type J - Single Channel Bracket: provide single channel attachment as specified in 2.4.16.5. Provide a carbon steel, single-framing channel, cantilever bracket assembly; B-Line B198-6 through B198-24, Powerstrut PS661, or Unistrut P2231 through P2234.

.10 Type K - Wall Mounted Channel: provide 41 mm x 62 mm carbon steel framing channel; B-Line B12 or Unistrut P5500.

.11 Type L - Pipe Stanchion Attachment: provide minimum 12 mm thick carbon steel baseplate. Anchor bolt holes: 1.6 mm larger than bolt diameter. Provide non-shrink grout between the baseplate and upstand.

.12 Type M - Welded Steel Bracket: provide carbon steel brackets which comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket; Grinnell Figure 195. Heavy welded bracket to comply with MSS Type 33 and FEDSPEC Type 34; Grinnell Figure 199.

.13 Type N - Cast Iron Bracket: provide cast iron brackets; Grinnell Figure 213.

.14 Type P - Framing Channel Post Base: provide carbon steel post bases of stranded design manufactured by framing channel manufacture. Single channel: Unistrut P2072A, B-Line B280 Powerstrut PS3025. Double channel: Unistrut P2073A, B-Line B281 or Powerstrut PS3064.

.15 Type Q - Continuous Concrete Inserts: provide 300 mm long carbon steel concrete inserts; Unistrut P3253.

.16 Accessories:

.1 Weldless Eye Nut: provide forged steel eye nuts and comply with MSS and FEDSPEC Type 17; Grinnell Figure 290 or B-Line B3200.

.2 Welded Eye Rod: provide carbon steel eye rods with eye welded closed. Inside diameter of eye to accommodate a bolt diameter 3.2 mm larger than the rod diameter; Grinnell Figure 278 or B-Line B3211.

.3 Turnbuckle: provide forged steel turnbuckles; Grinnell Figure 230 or B-Line B3202.

.4 Framing Channels: provide 41mm x 62mm roll formed carbon steel framed channel, having a thickness of 2.7 mm. Channel to have a continuous slot along one side with in-turned clamping ridges. Single Channel: Unistrut P5500. Double Channel: Unistrut P5501.

.5 Anchor bolts to Section 05500.

## 2.5 Hanger Rods

.1 Rod material shall conform to ASTM A307 as a minimum, and shall be cadmium plated in non-corrosive interior spaces, stainless steel in exterior, submerged, or corrosive applications, threaded on both ends or continuous threaded and sized as specified.

.2 Hanger rod sizing, as a minimum shall be as follows:

| Pipe Size Nominal (mm) | Hanger Rod Diameter (mm) |
|---|---|
| 50 | 10 |
| 75 | 12 |
| 100 | 16 |
| 150 | 20 |
| 200 | 22 |
| 250 | 25 |
| 300 | 25 |
| 400 | 29 |
| 500 | 38 |
| 600 | 44 |

## 2.6 Base Elbows

.1 Where elbows change the run of a horizontal pipe to a vertical direction, supports shall be secured to the elbow.

.2 Dimensions for the supports shall be as follows:

| Pipe Size Nominal (mm) | Support Pipe Diameter (mm) | Base Plate (mm x mm) |
|---|---|---|
| 100 | 50 Schedule 40 | 100 x 6 |
| 150 | 75 Schedule 40 | 125 x 6 |
| 200 | 100 Schedule 40 | 150 x 6 |
| 250 | 100 Schedule 40 | 150 x 6 |
| 300 | 150 Schedule 40 | 200 x 10 |
| 350 | 200 Schedule 40 | 250 x 10 |
| 400 | 200 Schedule 40 | 250 x 10 |
| 500 | 250 Standard Weight | 300 x 10 |
| 600 | 300 Standard Weight | 350 x 10 |
| 750 | 350 Standard Weight | 400 x 10 |
| 1050 | 350 Standard Weight | 400 x 10 |

.3 Gauge piping: in general, support elbow stanchions for gauge stainless steel piping shall be of the same diameter as the pipe.

## 2.7 Thermal Pipe Hanger Shield

.1 Provide thermal shields at hanger, support and guide locations on pipe requiring insulation. The shield consists of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield is the same thickness as the piping system insulation. Use standard shield for hot systems and vapour barrier shield for cold systems. Use stainless steel band clamps to ensure against slippage between the pipe wall and the thermal shield.

.2 Standard Shield:

.1 Insulation:

.1 Hydrous calcium silicate, high density, waterproof

.2 Compressive strength: 700 kPa average

.3 Flexural strength: 500 kPa average

.4 R value: 2.16 at 37.8°C mean

.5 Temperature range: -7°C to 260°C

.6 Steel Jacket: galvanized steel, thickness as per Manufacturer's standards, supplied for the given pipe size

.7 Connection: provide butt connection shield to pipe insulation. Steel jacket and insulation to be flush with end.

.2 Vapour Barrier Shield:

.1 Insulation:

.1 Hydrous calcium silicate, high density, waterproof

.2 Compressive strength: 700 kPa average

.3 Flexural strength: 500 kPa average

.4 R value: 2.16 at 37.8°C mean

.5 Temperature range: -7°C to 260°C

.2 Steel Jacket: galvanized steel, thickness as per manufacturer's standards, supplied for the given pipe size

.3 Connection: provide butt connection shield to pipe insulation. Insulation to extend 25 mm each side of steel jacket for vapourtight connection to pipe insulation vapour barrier.

## 3. EXECUTION

### 3.1 Hanger and Support Location

.1 Locate hangers and supports as near as possible to concentrated loads such as valve, flanges, etc. Locate hangers, supports, and accessories within the maximum span lengths specified on Drawings to support continuous pipeline runs unaffected by concentrated loads.

.2 Provide hangers and/or base supports within 1000 mm of each change in direction on each leg, on one side of each valve, and on the first spool piece or fitting extending from a piece of equipment.

.3 Locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

.4 Ensure that where piping is connected to equipment, a valve, piping assembly, etc. that will require removal for maintenance, the piping will be supported in such a manner that temporary supports will not be necessary for this procedure.

.5 Support piping so that no pockets will be 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.

.6 Install spring hangers where required to offset expansion in horizontal runs which follow long vertical risers.

### 3.2 Installation

.1 Welded and bolted attachments to the building structural steel to be in accordance with the requirements of Section 05500. Unless otherwise specified, do not drill or burn holes in the building structural steel.

.2 Do not use hanger components for purposes other than for which they were designed. Do not use hanger components for rigging and erection purposes.

.3 Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

.4 Aluminum or galvanized steel clips shall be used to support piping from aluminum or steel structural members. Where metals of different type are to be connected, provide isolation to prevent galvanic corrosion.

.5 Use embedded anchor bolts instead of concrete inserts for support installation in areas below water surface or normally subjected to submerging.

.6 Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the tie of insulation installation in accordance with the Manufacturer's recommendation.

.7 All minor modifications to accommodate installed equipment and structural components are subject to review. Do not commence Work on related piping until written acceptance has been received.

.8 Include any piping support modifications on the Shop Drawings submitted prior to fabrication or installation.

.9 Prior to installation, inspect and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

.10 Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

.11 Rollers shall roll freely without binding.

.12 Finished floor beneath Type L structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of void of foreign material.

.13 Cut and drill baseplates to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

.14 Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 2100 mm above the floor.

.15 Review the Drawings prior to installation of piping, conduit, and fixtures by this or any other division. Identify any conflicts and confirm the routing of each section of pipe prior to commencement of installation. Advise of any conflicts with existing services. Where necessary, amend the routing of pipework to avoid conflict and provide Shop Drawings showing proposed routing.

## 3.3 Adjustment

.1 Adjust hangers and supports to obtain required pipe slope and elevation. Use shims made of material that is compatible with the piping material. Adjust stanchions prior to grouting of baseplates.

**END OF SECTION**

# PROCESS PIPING AND EQUIPMENT INSULATION

## 1. GENERAL

### 1.1 Scope

.1 Process piping and equipment insulation

.2 Adhesives, tie wires, tapes

.3 Recovering

### 1.2 Quality Assurance

.1 Install insulation employing skilled workers regularly engaged in this type of Work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

### 1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

### 1.4 Job Conditions

.1 Deliver material to Site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

## 2. PRODUCTS

### 2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives

.1 Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed rating when tested in accordance with CAN4-S102, NFPA 255 or ASTM E84.

.2 Provide insulating materials and accessories that withstand service temperatures without smouldering, glowing, smoking, or flaming when tested in accordance with ASTM C441.

.3 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labeled.

.4 Insulate fittings and valve bodies with preformed removable insulated fittings.

## 2.2 Materials

.1 Cold piping interior: semi-rigid, pre-formed fibreglass or formed rigid mineral fibre pipe insulation, with factory applied paintable canvas vapour barrier jacket, factory moulded to conform with piping, "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.2 Hot piping interior: semi-rigid, pre-formed fibreglass or rigid mineral fibre pipe insulation, with factory applied paintable canvas general purpose jacket, factory moulded to conform to piping, "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: up to 200°C.

.3 Cold piping exterior: foamglass insulation with factory applied aluminum vapour barrier jacket, factory moulded to conform with piping. "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.4 Hot piping exterior: foamglass insulation with factory applied aluminum vapour barrier jacket, factory moulded to conform with piping. "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: -40°C to 150°C.

.5 Hot equipment flat surfaces: rigid mineral fibre insulation with factory applied paintable canvas general purpose jacket, factory moulded to conform to equipment. "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: 20°C to 200°C.

.6 Hot equipment curved surfaces: mineral fibre blanket with factory applied paintable canvas general purpose jacket, factory moulded to conform to equipment. "K" value: maximum 0.035 W/m°C at 24°C. Service temperature: 20°C to 200°C.

.7 Recovery jackets: 0.9 mm smooth aluminum sheet or paintable canvas for all new insulated piping.

.8 Cold and hot water piping up to 115°C: as an alternate to formed fibreglass pipe insulation, rigid phenolic closed cell foam insulation equal to Kingspan Koolphen K CFC-free rigid phenolic insulation may be used. Product shall meet ASTM-E-84 and ASTM-C-585-90 and ULC burn and smoke spread rating for non-combustible installations (ULC-S102, S127).

## 2.3 Buried Piping

.1 Provide insulation for all buried piping with a soil cover of less than 2500 mm in grassed areas or less than 3000 mm below roads, walkways, and access pads

## 2.4 Above-ground Piping

.1 Provide insulation for all pipe and equipment with an operating surface temperature in excess of 50°C. Use a minimum thickness of 25 mm. Use greater thicknesses as required to lower the outer skin temperature to below 40°C.

.2 Provide insulation for all piping where heat retention is required, at the locations indicated on the drawings and for other piping systems where insulation is indicated on the process Drawings.

.3 Provide insulation at pipe hangers and supports with factory applied vapour jacket and a self-sealing lap, manufactured specifically for use at support locations. It shall be a minimum of 200 mm long and of the same thickness as adjacent pipe insulation.

.4 Provide a suitable bonding agent to joint the preformed sections.

.5 On exterior piping, provide aluminum jacketing with a minimum thickness of 0.9 mm, unless indicated otherwise.

.6 Provide aluminum banding, 12 mm wide by a minimum of 0.5 mm thick with matching seals.

.7 Provide polypropylene jacketing at elbows, tees or other changes of direction and where indicated. Use the heat-shrink type jacketing, with a minimal thickness of 0.1 mm.

.8 On interior piping, provide paintable canvas jacketing, ULC listed, 0.27 kg/$m^2$ minimum.

## 3. EXECUTION

### 3.1 Preparation

.1 Do not install insulation and recovering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

### 3.2 Installation

.1 Ensure insulation is continuous through inside walls and floor penetrations. Pack around pipes with fireproof, self-supporting insulation material, properly sealed.

.2 Insulate piping and fittings as noted in the schedule below. Insulate valves unless otherwise noted. Do not insulate unions, flanges (except on flanged valves if valve must be insulated), Victaulic couplings, strainers, (except on chilled water lines), flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Provide insulation on all process air pipes located in the building and tunnel areas. Use 50 mm thick fibreglass insulation over the entire length of the pipe run except over couplings, valves, and meters. Provide stainless steel bands over the insulation at a maximum of 300 mm centres.

.4 Unless indicated otherwise, do not insulate water body valves.

.5 Terminate insulation 100 mm on each side of all flanges and grooved joint couplings.

.6 Finish insulation neatly on hangers, supports, and other protrusions.

.7 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.8 Cover all insulated piping throughout with aluminum or paintable canvas recovery jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres, unless otherwise noted. Lap the joints a minimum of 75 mm. Align longitudinal seams in aluminum recovering to shed water. All bands and screws are to be accessible for service and removal.

.9 Cold piping: seal lap joints with 100 percent coverage of vapour barrier adhesive. Seal butt joints with 50 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.

.10 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100 mm centres.

.11 Hot piping: for fittings and valves, apply hydraulic insulating cement, or apply factory fabricated insulation half shells.

## 3.3 Process Pipe Insulation Installation Thickness Schedule

| Piping or Equipment | | Insulation Thickness (fibreglass) mm | Insulation Thickness (closed cell phenolic) mm | Recovery Jacket |
|---|---|---|---|---|
| Insulated Process Piping, as shown on drawings | 15 to 50<br>Over 50 | 25 *<br>50 * | 25 *<br>25 * | As noted in 2.2 |

* Unless stated otherwise elsewhere in Sections 11050, 11055, 11100 or 11105, or on drawings.

**END OF SECTION**

**PROCESS VALVES**

## 1. GENERAL

### 1.1 Description

.1 This Section specifies the supply, installation and testing of valves used for isolation, manual throttling, and bypass.

### 1.2 Definitions

.1 Valve Identification: valves are identified in the Drawings by valve symbols. Refer to the Drawings for lists of valve symbols and labels.

.2 Actuators: valves are supplied with their standard operators as detailed in Part 2 unless otherwise noted in Section 11105 or Instrumentation Specification Sheets.

.3 Detailed Valve Specification Sheets:

.1 Detailed valve specification sheets are provided in Section 11105 for each type of valve which is:

.1 Identified in the Drawings with a valve symbol and/or,

.2 Described in Part 2 of this Specification Section.

.2 Where there is a conflict between valves described in this Section and other valves described in Division 15 and Division 17, conform to the most stringent requirements.

.4 Instrument Data Sheets for Modulating Control Valves: Division 17 specifies and takes responsibility for the supply and installation of electric and pneumatic control valves, complete with valve body, actuator, position indicator, and other ancillaries. Valve bodies for these products will comply with the requirements as specified in Section 11105 and this Section.

### 1.3 Submittals for Review

.1 Shop Drawings: submit the following information in accordance with Section 01300:

.1 Catalog cuts and/or Shop Drawings for each type of valve indicating the valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.

.2 An amended Detailed Valve Specification Sheet for all valves. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.

.2 Operating and maintenance data for incorporation in operation and maintenance manual, as specified in Section 01730. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer's identifying numbers.

.3 Affidavits and registration numbers described below in Quality Assurance.

### 1.4 Quality Assurance

.1 Provide Canadian Registry Number (CRN) designated by the Province of Manitoba for each valve type.

.2 Provide affidavits of compliance, as required by AWWA C500 for gate valves.

.3 For butterfly valves to be installed below ground, provide affidavits of compliance with AWWA C504.

.4 Valves are to be marked in accordance with MSS SP-25.

### 1.5 Shipment, Protection and Storage

.1 Deliver valves to site in accordance with Section 01600 and using loading methods which do not damage casings or coatings.

.2 Clearly tag valves stating size, type, coatings, and mating parts.

.3 Store on-site until ready for incorporation in the Work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

## 2. PRODUCTS

### 2.1 General

.1 Provide valves of the same type, size range and service from a single manufacturer.

.2 Provide new, unused valves for the Work.

.3 Valve materials to be free from defects or flaws, with true alignment and bores.

.4 Unless otherwise indicated on the Process and Instrumentation drawings or specified in Division 17, valves shall be the same size as the pipe run in which they are to be installed.

.5 Clearly mark valve bodies in raised lettering to indicate the valve type, rating, and where applicable, the direction of flow. Conform to MSS SP25.

.6 Provide padlockable lockout feature on all sizes of the following valve types:

.1 Automated Control Valves (electric and pneumatic); FCV, LCV, PCV and XV only. Refer to the Drawings for abbreviation definitions.

.2 Specialty Valves; FV and PRV only. Refer to the Drawings for abbreviation definitions.

.3 Manual Isolation and Shut-off Valves; BF, BV, GL, GV, KV and PV only. Refer to Section 11105 for abbreviation definitions.

.7 Specific requirements for the materials, ratings and service conditions for each valve are listed in Section 11105.

.8 Valves to open counter-clockwise.

## 2.2 Drawings

.1 The process schematics indicate major process valves required for the process to operate as intended.

.2 The detailed process Drawings and process standard Drawings indicate the valves on the process schematics plus other valves required for isolation.

.3 In pipe runs less than 100 mm diameter, in addition to the valves indicated on the P&IDs, detailed Drawings and standard Drawings, provide isolation valves in straight pipe runs at intervals no greater than 60 m and at takeoffs to individual services. Provide ball isolation valves in pipe of 65 mm diameter and less, or in pipe of less than 100 mm diameter and carrying solids. Provide butterfly isolation valves in pipe of 75 mm diameter and greater and not carrying solids.

.4 In pipe runs carrying sludge or scum, tap bottom of pipe at low point of runs and install short nipple and isolation valve.

.5 Provide valves and taps on top of pipe at high point in all liquid pipe runs greater than 60 m length where the change in slope exceeds 4 percent.

.6 Provide flushing connections and valves as shown in standard details, at 30 m intervals on any primary sludge, primary and thickener scum and thickened secondary sludge lines.

.7 Unless otherwise specified, provide gate valves 400 mm and larger with a bypass valve sized in accordance with AWWA C500.

.8 Where a valve may be required for the process to function correctly or is required to satisfy fire and safety codes but it is not shown in the Drawings, inform the Contract Administrator and provide details and suggestions for remedial action. Do not commence piping in the related pipe run until obtaining the Contract Administrator's approval.

## 2.3 Valve Ends

.1 In pipe runs less than 75 mm diameter provide valves with female threaded ends, unless indicated otherwise. Threads to conform to ANSI B1.20.1.

.2 Valves in pipe runs equal to or greater than 75 mm diameter to be flanged unless indicated otherwise.

.3 For cast iron body valves, drill flanges to Class 125 pattern conforming to ANSI B16.1. For steel body valves, flanges to be Class 150 pattern or Class 300 pattern conforming to ANSI B16.5 or as noted in Section 11105.

.4 Do not use grooved joint valve ends.

.5 Use flanged joints for buried and exterior valves. The flanges are to be compatible with the pipe and jointing technique used.

.6 Use flanged joints for buried butterfly valves.

.7 Lug style wafer body valves shall have tapped holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.8 Wafer body valves shall have positioning holes, suitable for the bolt spacing of the pipe flanges placed on either side.

.9 For gate valves, end flanges shall be integral with the gate valve body and be faced and drilled in accordance with ANSI B16.1, Class 125 flanges.

## 2.4 Manual Operators

.1 Provide valves with manual operators unless specifically indicated otherwise on the process schematic drawings, mechanical drawings, in Section 11105, Division 17 or the Instrumentation Specification sheets.

.2 For handwheels, clearly show the direction of opening in raised lettering and symbols.

.3 Handwheel diameter to conform to the following:

| Nominal Valve Diameter (mm) | Minimum Handwheel Diameter (mm) |
|---|---|
| 12 | 50 |
| 20 | 50 |
| 25 | 60 |
| 38 | 75 |
| 50 | 85 |
| 65 | 105 |
| 75 | 200 |
| 100 | 250 |
| 150 | 300 |
| 200 | 350 |
| 250 | 400 |
| 300 | 450 |
| 350 | 450 |
| 400 | 550 |
| 450 | 600 |
| 500 | 600 |
| 600 | 600 |

.4 The maximum rim pull on a handwheel not to exceed 300 N when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft-mounted handwheel would require greater than this force to operate, provide a gear operator. Unless different operators are scheduled or shown in the drawings, conform to the following minimum requirements:

.1 Gate Valves: less than 300 mm, handwheel; equal to or greater than 300 mm, gear operator.

.2 Knife Gate Valves: less than 300 mm, handwheel; equal to or greater than 300 mm, gear operator.

.3 Globe and Needle Valves: less than 200 mm, handwheel; equal to or greater than 200 mm, gear operator.

.5 Match existing operating nuts. Provide 2 eight-point operating wrenches.

.6 Supply stem extensions and valve boxes for buried valves specified in the Drawings, Sections 11105, and in Clause 2.5 of this Section. Provide two operating tees.

.7 Lever operators to conform to the following dimensions:

| Nominal Valve Diameter (mm) | Minimum Length of Lever (mm) |
|---|---|
| 6 | 80 |
| 12 | 80 |
| 20 | 100 |
| 38 | 150 |
| 50 | 150 |
| 65 | 150 |
| 75 | 175 |
| 100 | 225 |
| 150 | 250 |
| 200 | 300 |
| 250 | 450 |
| 300 | 450 |

.8 Quarter-turn lever operators to be perpendicular to the pipe run when the valve is closed.

.9 Lever operators on ball valves to be 2-position. Provide butterfly valves with 10-position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.

.10 The maximum pull at the end of the lever arm not to exceed 300 N when one side of the valve is at test pressure and one side is at atmospheric pressure. Where greater than this force would be required to operate the valve with a lever, provide a gear operator. Unless different operators are scheduled or shown in the Drawings, conform to the following minimum requirements:

.1 Plug Valves and Ball Valves: less than 150 mm, lever operator; greater than or equal to 150 mm, gear operator.

.2 Butterfly Valves: less than 250 mm, lever operator; greater than or equal to 250 mm, gear operator.

.11 Gear operator to be worm gear type, equipped with a handwheel and a visual indicator of the valve position. Equip operators with adjustable mechanical stop-limiting devices to prevent overtravel of the disc/ball in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Gear operators shall be grease lubricated. Where gear operators are intended for direct bury or submergence, seal units with long life lubricant.

.12 Manual operators for butterfly and gate valves for buried service to include an AWWA operating nut and be gasketed and grease packed for submerged operation at water pressures to 700 kPa. Operators for exposed service shall be gasketed for weatherproof service. Place gearboxes above ground and liquid surfaces.

.13 Gear and manual operators for submerged service to be permanently lubricated and sealed for operation at water pressures to 700 kPa.

.14 For manual valves on lines 75 mm and greater, mounted over 2.0 m above the operating floor, provide chain wheel gear operators. Design the operator so that a force of 150 N is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. The chain pulley to mesh positively with the chain. Extend the chain from the valve operator to operating height 1.2 m above the floor or as directed by the Contract Administrator. The exact dimensions shall be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.

## 2.5 Valve Stem Extensions

.1 Provide valve stem extensions where additional clearance is required for pipe insulation, where valve operation without the extension is difficult, and in manholes.

.2 Where angle valve stem extensions are employed, they shall be angle geared. Universal joint types are not permitted.

## 2.6 Insulation

.1 In insulated pipe runs, insulate valves in accordance with Section 11059.

.2 Preform insulation in a shape suitable for the valve, of the same material specified in Section 11059.

.3 Recovering to be as specified in Section 11059, with transition sections for the joints between the valve insulation and the pipe insulation.

.4 Insulation to be removable and reusable without destroying insulation or recovering.

## 2.7 Protective Coatings

.1 Unless otherwise specified, provide valves coated in accordance with Section 11900.

## 2.8 Cathodic Protection

.1 Unless otherwise specified, provide cathodic protection to underground valves.

### 2.9 Spare Parts

.1 Provide one spare valve including the appropriate operator for each valve type and size.

.2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years. At the Contract Administrator's request, provide a price for these parts.

## 3. EXECUTION

### 3.1 Preparation

.1 The valve and piping arrangement indicated in the Drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Work.

.2 Prior to the installation of the valves, field measure and check all equipment locations, pipe alignments, and structural installation. Ensure that the valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for pneumatic and electric actuators.

.3 Where conflicts are identified, inform the Contract Administrator and initiate the necessary piping modifications at no cost to the City.

### 3.2 Valve Installation

.1 Install valves in conjunction with the piping described in Sections 11050 and with control valves and their appurtenances described in Division 17.

.2 In horizontal pipe runs other than in locations where space does not permit, mount all valves except for butterfly valves and trunnion ball valves with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator shaft pointing down.

.3 Mount butterfly valves and trunnion ball valves with the shaft in a horizontal orientation.

.4 When joining valves to pipe or fittings, do not over-torque bolts to correct for misalignment.

.5 Support valves in position using temporary supports until valves are fixed in place.

.6 Permanently support valves to prevent transmission of loads to adjacent pipework or equipment.

.7 Where valves are installed in PVC pipework greater than 100 mm diameter, support valves independently and brace against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

.8 Generally pipe supports and hangers are not shown unless for indication purposes only.

.9 Install gate valves in the closed position.

.10 Install valves which are bubble-tight in one direction to seal in a direction opposite to normal flow unless otherwise noted or directed by the Contract Administrator.

.11 Unless otherwise specified, install single-seated ball valves and knife gate valves with the seat downstream. Install at tank connections with seat away from tank. Install on pump discharge and suction lines with seat adjacent to the pump.

.12 Install all valves in accordance with the manufacturer's recommendations.

.13 Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tapewrap.

## 3.3 Valve Extensions

.1 Install valve stem extensions where necessary to provide clearance from insulation.

## 3.4 Insulation

.1 Install insulation and recovering as specified in Section 11059.

## 3.5 Valve Testing

.1 Operate valves under simulated or real process conditions to ensure they operate as intended.

.2 Pressure test the valves in conjunction with the pipes in which the valves are installed as specified in Section 11050.

**END OF SECTION**

**DETAILED VALVE SPECIFICATION**

## 1. GENERAL

### 1.1 Description

.1 This Section provides a summary of the valve body materials, valve performances and reference Specifications for use in the Work and should be read in conjunction with Sections 11050, 11055, and 11100. Furnish all valves in accordance with the requirements of this Section and those requirements of Sections 11050, 11055, and 11100. Where there is a conflict, conform to the most stringent requirements.

.2 This Specification Section is comprehensive; some commodities and valve types may not be applicable to the Work.

.3 Table 1 provides a reference table of commodities and valves acceptable for use with these commodities, unless otherwise specified. The valve abbreviation on Table 1 indicates the Detailed Valve Specification Sheet to be referenced. Provide the valve type as indicated in the Drawings by the valve symbol shown. Match the symbol, commodity and line size to the Detailed Valve Specification Sheet.

.4 Valves identified in the Drawings with an equipment identification symbol or instrument identification symbol are specified in Sections 11100 and 17213, respectively. Detailed Valve Specification Sheets referenced by other Sections are independent of Table 1.

.5 Named Acceptable Products are shown to define basic materials and performance criteria required for each valve type. Modify valves as specified to meet the service requirements of the system and detailed specifications.

### 1.2 Definitions

.1 Abbreviations used in Detailed Valve Specification Sheets:

| | |
|---|---|
| BF | Butterfly Valve |
| BV | Ball Valve |
| CV | Check Valve |
| GL | Globe Valve |
| GV | Gate Valve |
| KV | Knife Valve |
| NV | Needle Valve |
| PRV | Pressure Regulating Valve |
| PSV | Pressure Safety Valve (pressure relief valve) |
| PV | Plug Valve |
| SV | Solenoid valve |
| TW | Two-way and Three-way Multiport Valve |

## 2. PRODUCTS

### 2.1 Schedule

.1 Pages 3 to 31 following.

## 3. EXECUTION

.1 Not used

## DETAILED VALVE SPECIFICATION

**BF01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Butterfly Valve | **BF01** | Air | 75 | 5-120 | 850 | 120 |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron / Ductile Iron | Size Range | 50 mm to 600 mm |
| Disc | Ductile Iron | Rating | 850 CWP |
| Disc Trim | Bronze or Nickel (Note 1) | Body/Valve Ends | Lugged (Note 2) |
| Seats | EPDM | Type of Disc | |
| Shaft | Stainless Steel (416) | Operator | Note 3 |
| | | Actuator | Note 4 |
| | | Lining | |
| | | Coating | |

**NOTES**

1. Full bronze disc for valves below 300 mm.
2. Full lug, wafer style body for placement between two Class 125 flanges.
3. See Section 15100.
4. See Division 17.
5. Provide valves for CWP 1400 kPag on IA, CA services.
6. Provide valves with 304 stainless steel body and disc for PA system submerged locations.

**ACCEPTABLE PRODUCTS**

| | | | |
|---|---|---|---|
| | Bray Series 31 | DeZurik BRS | |
| Nibco LD2000 | Grinnell Series 8000 | Crane Resilient Seat | |
| Kitz 5112 or 5141 | Victaulic Vic 300 Masterseal | Victaulic Vic series 763 (submerged service) | |

**DETAILED VALVE SPECIFICATION**

**BF02**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Butterfly Valve | **BF02** | Liquid | 600 | 5-30 | 1350 | 50 |

| **TYPICAL SERVICE** |
|---|
| FW, ML, RAS, TCE |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron | Size Range | 50 mm to 600 mm |
| Disc | Ductile Iron | Rating | 1350 CWP |
| Disc Trim | Bronze or Nickel (Note 1) | Body/Valve Ends | Lug Wafer (Note 2) |
| Seats | Buna-N | Type of Disc | |
| Shaft | Stainless Steel (416) | Operator | Note 3 |
| | | Actuator | Note 4 |
| | | Lining | |
| | | Coating | |

**NOTES**

1. Full bronze disc for valves below 200 mm.
2. Full lug, wafer style body for placement between two Class 125 flanges. In steel piping provide weldneck flanges on each side of valve.
3. See Section 15100.
4. Refer to Division 17.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| | Bray Series 31H | DeZurik BRS | |
| Kitz 5112 or 5141 | Nibco LD2000 | | Crane |

**DETAILED VALVE SPECIFICATION**

**BF07**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Butterfly Valve | **BF07** | Air | 75 | 5-120 | 850 | 120 |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron | Size Range | 75 mm to 600 mm |
| Disc | Steel or Ductile Iron | Rating | Class 125 |
| Disc Trim | N/A | Body/Valve Ends | Wafer |
| Seats | None | Type of Disc | Damper Style |
| Shaft | Stainless Steel (316) | Operator | Gear Operator (Note 1) |
| | | Actuator | (Note 2) |
| | | Lining | |
| | | Coating | |

**NOTES**

1. See Section 15100.
2. Refer to Division 17

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Fisher 8560 | Neles Jamesbury 815W | | Bray Series 31 |

**DETAILED VALVE SPECIFICATION**

**BF08**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Butterfly Valve | **BF08** | Liquid | 600 | 5-30 | 1350 | 50 |

| **TYPICAL SERVICE** |
|---|
| RAS |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron | Size Range | 600 mm to 1050 mm |
| Disc | Ductile Iron | Rating | 1350 CWP |
| Disc Trim | Bronze or Nickel (Note 1) | Body/Valve Ends | Flanged |
| Seats | Buna-N | Type of Disc | |
| Shaft | Stainless Steel (416) | Operator | Note 1 |
| | | Actuator | Note 2 |
| | | Lining | |
| | | Coating | |

**NOTES**

1. See Section 15100.
2. Refer to Division 17.

**ACCEPTABLE PRODUCTS**

| | | | |
|---|---|---|---|
| | Bray Series 36 | DeZurik BAW | Nibco LD1100DF |
| Watt BF-03-DF | | | |

## DETAILED VALVE SPECIFICATION

**BV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Valve | **BV01** | Liquid/Air | 600 | 5-120 | 850 | 120 |

| **TYPICAL SERVICE** |
|---|
| FW, TCE |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | Note 2 |
| Body | Bronze or Forged Brass | Size Range | 10 mm to 65 mm |
| Ball | Bronze or Chrome plated brass - floating | Rating | Class 125 |
| Seats | PTFE | Body/Valve Ends | Female Threaded (Note 3) |
| Shaft | Bronze or Stainless Steel (Note 1) | Pattern | Compact, Regular Port |
| | | Operator | Lever |
| | | Actuator | Note 4 |
| | | | |
| | | | |
| | | | |

**NOTES**

1. Blowout-proof stem.
2. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 15100.
3. Provide threaded end cap and chain when used for drain service.
4. See division 17 for actuator specifications where required.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Newman Hattersley Fig. 1969 | Crane 9302 | Nibco 560/580 | Watts B6100/B6000 |
| Kitz Fig 58 | Toyo Fig 5044A | American Valve | |

**DETAILED VALVE SPECIFICATION**

**BV02**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Valve | **BV02** | Liquid/Gas | 910 | 5-120 | 1400 | 120 |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | Body Material: ASTM A351 (Note 2) |
| Body | Stainless Steel (Note 3) | Size Range | 10 mm to 65 mm |
| Ball | Stainless Steel – floating | Rating | CWP 1000 kPag |
| Packing | Reinforced PTFE | Body/Valve Ends | Female Threaded |
| Seats | Reinforced PTFE | Pattern | Compact, Full Port |
| Shaft | Stainless Steel (Note 1) | Operator | |
| | | Actuator | Lever |
| | | Lining | |
| | | Coating | |
| | | | |

**NOTES**

1. Blowout-proof stem.
2. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 15100.
3. For NG service, stainless steel body not required.
4. For valves 50mm and larger in DG (digester gas) service, provide Class 150 flanged connections.
5. For valves smaller than 50mm in DG (digester gas) service, provide socketweld end connections to pipe; and provide socketweld x NPT end connections for valves used for purging, venting, drains, and instrument connections. Provide plugs in purge valves, vent valves and drain valves.
6. Use fire safe valve tested to API 607 for NG and DG service.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Crane 9501 | Kitz Type 600 UTKM | Neles Jamesbury 3000M | Watts |
| American Valve | | | |

## DETAILED VALVE SPECIFICATION

**BV04**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Valve | **BV04** | Liquid | 1000 | 5 to 30 | 1400 | 50 |

| **TYPICAL SERVICE** |
|---|
| ML, RAS, WAS |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Carbon Steel or Stainless Steel | Size Range | 10 mm to 64 mm (Note 2) |
| Ball | Stainless Steel (304) | Rating | CWP 1400 kPag |
| Seats | PTFE or RTFE | Body/Valve Ends | Female Threaded |
| Shaft | Stainless Steel (304 or 315) | Pattern | Compact, Full Port |
| | (Note 2) | Operator | |
| | | Actuator | Lever |
| | | | |
| | | | |
| | | | |

**NOTES**

1. Blowout proof stem.
2. Isolation valve for flushing connections.
3. For valves in PVC piping use BV06

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Velan M1113 or M1102 | Watts C-FBV/S-FBV | American Valve | |

## DETAILED VALVE SPECIFICATION

**BV05**

**GENERAL**

| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | OPERATING LIMITS | | DESIGN LIMITS | |
|---|---|---|---|---|---|---|
| | | | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Valve | **BV05** | Liquid | 100 – 900 | 5 to 30 | 1000 | 50 |

**TYPICAL SERVICE**

FW, TCE, WAS

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | MSS-SP72 (Note 4) |
| Body | Cast Steel or Cast Iron or Steel | Size Range | 75 mm to 450 mm (Note 5) |
| Ball | Stainless Steel (316) | Rating | CWP 1400 kPag |
| Packing | Reinforced PTFE or AFE | Body/Valve Ends | Split Body, Flanged (Note 4) |
| Seats | Reinforced PTFE | Pattern | Full Port |
| Shaft | Stainless Steel (315) | Operator | Notes 1, 3 |
| | (Note 2) | Actuator | Note 3 |
| | | | |
| | | | |
| | | | |

**NOTES**

1. See Section 15100.
2. Blowout proof stem.
3. See Division 17.
4. Provide Class 125 to suit cast or ductile iron piping systems and Class 150 for steel systems.
5. Provide trunnion mounted ball on all valves 250 mm diameter and greater.

**ACCEPTABLE PRODUCTS**

| | | | |
|---|---|---|---|
| Kitz 150 SCTBZM | Watts G4000/G4000T | Velan F-10402-SSGA | Neles Jamesbury Series 6000/9000 |
| American Valve Model 4000 | | | |

**DETAILED VALVE SPECIFICATION**

**BV06**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Valve | **BV06** | Liquid | 100 – 750 | 5 to 40 | 1000 | 60 |

| **TYPICAL SERVICE** |
|---|
| SA, CE |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | Material: ASTM D1784 (Grade A)<br>Threads: ASTM D2464 |
| Body | PVC | Size Range | 10 mm to 65 mm |
| Ball | PVC – floating ball | Rating | CWP 1000 kPag |
| Packing | O-Ring, EPDM or Viton (Note 4) | Body/Valve Ends | Schedule 80, Female Threaded, True Union |
| Seats | PTFE | Pattern | Full Port (Note 2) |
| Shaft | PVC (Note 1) | Operator | Lever |
| | | Actuator | (Note 5) |
| | | | |
| | | | |
| | | | |

**NOTES**

1. Blowout proof ball and stem required.
2. Bi-directional.
3. This valve is for use in PVC piping systems only; also refer to BV02.
4. Use EPDM in chlorine solution service (CS).
5. Ensure valve bonnet and actuator are compatible.

**ACCEPTABLE PRODUCTS**

| | | | |
|---|---|---|---|
| Chemline Type 21 or 26 | Hayward True Union | Nibco Tru-Bloc PVC | Fabco Super Bloc |

**DETAILED VALVE SPECIFICATION**

**BV07**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Valve | **BV07** | Liquid | 600 | 5 to 40 | 850 | 60 |

| **TYPICAL SERVICE** |
|---|
| SA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | ASTM D1784 (Grade A) |
| Body | PVC | Size Range | 75 mm to 100 mm |
| Ball | PVC – floating ball | Rating | CWP 1000 kPag |
| Packing | O-Ring, EPDM or Viton | Body/Valve Ends | Schedule 80, Flanged, True Union |
| Seats | PTFE | Pattern | Full Port (Note 2) |
| Shaft | PVC (Note 1) | Operator | Lever |
| | | Actuator | |
| | | | |
| | | | |
| | | | |

**NOTES**

1. Blowout proof ball and stem required.
2. Bi-directional.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Chemline Type 21 | Hayward True Union | Nibco Tru-Bloc PVC | Fabco Super Bloc |

## DETAILED VALVE SPECIFICATION

**CV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Check Valve | **CV01** | Liquid | 600 | 5-30 | 850 | 50 |

| **TYPICAL SERVICE** |
|---|
| FW, RAS, TCE, WAS |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | Body Material: ASTM B62 |
| Body | Bronze | Size Range | 10 mm to 65 mm (Note 1) |
| Disc | Bronze | Rating | Class 125 |
| Seats | Bronze | Valve Ends | Female Threads |
| Hinge pin, trim | Bronze | Type of Disc | Swing Check, Regular Port |
| Spring | | Operator | |
| | | Actuator | |
| | | Lining | |
| | | Coating | |
| | | | |

| **NOTES** |
|---|
| 1. FM approval required for valves in FPS systems and valves in systems connected to FPS systems. |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Crane 1707 | Newman Hattersley A60 | Kitz No. 22 | Jenkins 996 |
| Toyo 236 | | | |

**DETAILED VALVE SPECIFICATION**

**CV02**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Check Valve | **CV02** | Liquid | 600 | 5-30 | 850 | 50 |

| **TYPICAL SERVICE** |
|---|
| FW, CE, TCE, WAS |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | AWWA C508 |
| Body | Cast Iron | Size Range | 75 mm to 600 mm |
| Disc | Cast or Ductile Iron | Rating | Class 125 |
| Seats | Bronze | Valve Ends | Flanged |
| Hinge pin, trim | Stainless steel | Type of Disc | Swing Check (Note 1) |
| | | Operator | (Note 1) |
| | | Actuator | |
| | | Lining | |
| | | Coating | |
| | | | |

**NOTES**

1. For all check valves on pump discharges, provide weighted lever arm.

**ACCEPTABLE PRODUCTS**

| | | | |
|---|---|---|---|
| Crane 370 series; 147XU | APCO Series 6000 Convertible | Newman Hattersley 651 | Terminal City |
| Jenkins 587 | Powell 559 | Lunkenheimer 1790 | Toyo Fig 435A |
| Kitz Fig 78 | | | |

**DETAILED VALVE SPECIFICATION**

**CV03**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Check Valve | **CV03** | Liquid | 600 | 5-30 | 700 | 50 |

| **TYPICAL SERVICE** |
|---|
| SA, CE |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | PVC | Size Range | 10 mm to 60 mm |
| Ball / Disc | PVC | Rating | Class 150 |
| | | Valve Ends | True Union or Flanged |
| Seats | Viton | Type of Check | Swing Check (note 2) |
| | | Operator | |
| | | Actuator | |
| | | Lining | |
| | | Coating | |
| | | | |

| **NOTES** |
|---|
| 1. Threaded ends under 65mm. |
| 2. Use Ball check under 20mm. |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Chemline BT | Hayward True Check | | |

**DETAILED VALVE SPECIFICATION**

**CV04**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Check Valve | **CV04** | Air&Digester Gas | 100 | 5-100 | 400 | 150 |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | Note 3 |
| Body | Stainless Steel | Size Range | 75 mm to 750 mm |
| Disc | Stainless Steel | Rating | Class 125 |
| Seats | | Valve Ends | (Note 1) |
| Hinge pin, trim | Stainless Steel | Type of Disc | Split Disk/Double Leaf |
| Spring | Stainless Steel | Operator | |
| | | Actuator | |
| | | Lining | |
| | | Coating | |
| | | Specials | (Note 2) |

**NOTES**

1. Wafer Body for mounting between Class 150 flanges.
2. Provide lifting lugs on valve greater than 50kg.
3. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 15100.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| APCO 9000 | Val-Matic 8000 | Proquip Twin Flapper | Mission 12 HMP |
| Gulf MB12-5-0-9-1-5-F | CenterLine Series 800 | | |

## DETAILED VALVE SPECIFICATION

**CV07**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Check Valve | **CV07** | Air | 700 | 50 | 1000 | 100 |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | ANSI B2.1 |
| Body | 316 Stainless Steel | Size Range | 10 mm to 65 mm |
| Disc | 316 Stainless Steel | Rating | Class 200 |
| Disc Trim | 316 Stainless Steel | Valve Ends | Female threaded |
| Seats | 316 Stainless Steel | Type of Disc | Swing |
| Pin | 316 Stainless Steel | Operator | |
| | | Actuator | |
| | | Lining | |
| | | Coating | |
| | | | |

| **NOTES** |
|---|
| |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Kitz AK200UOM | Crane 61600 | Jenkins 1328 | |

**DETAILED VALVE SPECIFICATION**

**CV09**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Ball Check Valve | **CV09** | Liquid | 350 | | | |
| **TYPICAL SERVICE** | | | | | | |
| WAS, ML, RAS, TCE | | | | | | |
| **VALVE MATERIALS** | | | **VALVE DESCRIPTION** | | | |
| ITEM | MATERIAL | | Reference Document | | | |
| Body | Cast Iron | | Size Range | | up to 300 mm | |
| Ball | Buna n | | Rating | | Class 125 | |
| Seats | | | Valve Ends | | Flanged | |
| | | | | | | |
| | | | Operator | | | |
| | | | Actuator | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **NOTES** | | | | | | |
| | | | | | | |
| **ACCEPTABLE PRODUCTS** | | | | | | |
| Danfoss Flomatic 408 | | | | | | |

## DETAILED VALVE SPECIFICATION

**GV02**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Gate Valve | **GV02** | Liquid | 600 | 5-30 | 850 | 50 |

| **TYPICAL SERVICE** |
|---|
| SA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | PVC | Size Range | 10 mm to 200 mm |
| Disc | Polypropylene | Rating | Class 150 |
| Shaft O-Ring | EPDM | Valve Ends | Flanged |
| | | Type of Disc | Solid Wedge |
| Shaft | PVC | Operator | Handwheel, NRS |
| Handwheel | Polypropylene | Actuator | |
| | | Lining | |
| | | Coating | |
| | | | |

| **NOTES** |
|---|
| |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Fabco GT50 | Chemline CGA | | |

## DETAILED VALVE SPECIFICATION

**KV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Knife Gate Valve | **KV01** | Liquid | 600 | 5-30 | 850 | 50 |

| **TYPICAL SERVICE** |
|---|
| TCE, FW |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron | Size Range | 75 mm to 1000 mm |
| Disc | Stainless Steel | Rating | Class 125 |
| Seats | Buna-N | Valve Ends | Lugged |
| Seals | Buna-N | Type of Disc | |
| Shaft | Stainless Steel | Operator | RS, Bonnetless (Note 1, 2), Handwheel |
| Wiper Ring | Reinforced PTFE | Actuator | |
| Pillars | Stainless Steel | Lining | |
| | | Coating | |
| | | | |

**NOTES**

1. See Section 15100.
2. Provide bonnet with stainless steel (304) stem extension for below grade and submerged services.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| DeZurik Series L | Fabri-Valve Fig. 37 | Red Valve Series G | Orbinox Series 10 |

## DETAILED VALVE SPECIFICATION

**NV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Needle Valve | **NV01** | Liquid/Air | 800 | 5-100 | 1000 | 140 |

| **TYPICAL SERVICE** |
|---|
| |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | (Note 1) |
| Body | Stainless Steel | Size Range | 10 mm to 65 mm |
| Stem | Stainless Steel | Rating | Class 150, 600 psi |
| Seats | Stainless Steel | Valve Ends | Female threaded (Note 1) |
| Seals/Packing | PTFE | Type of Disc | Needle |
| Handle | Stainless Steel or Phenolic | Operator | Screwed Bonnet, Handwheel |
| | | Actuator | |
| | | Lining | |
| | | Coating | |
| | | | |

**NOTES**

1. Female threads to suit commodity piping.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Swagelok JN Series | Anderson, Greenwood H Series | Lunkenheimer 1732 | Parker |
| | Century CM2 | | |

**DETAILED VALVE SPECIFICATION**

**PRV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Pressure regulator Valve | **PRV01** | Liquid | | | | |

| **TYPICAL SERVICE** |
|---|
| FW |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Bronze | Size Range | 10 mm to 65 mm |
| Sleeve | | Rating | |
| Shaft | | Valve Ends | FNPT |
| | | Type of mechanism | Diaphragm |
| | | Operator | |
| | | Actuator | |
| | | | |

**NOTES**

1. See Section 15100.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Fisher Regulator | | | |

**DETAILED VALVE SPECIFICATION**

**PRV02**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Pressure Regulator Valve | **PRV02** | Gas | | | | |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Stainless Steel | Size Range | 10 mm to 65 mm |
| Sleeve | | Rating | |
| Shaft | | Valve Ends | FNPT |
| | | Type of mechanism | Diaphragm |
| | | Operator | |
| | | Actuator | |
| | | | |

**NOTES**

1. See Section 15100.
2. Natural Gas service may be Carbon Steel.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Fisher Regulator | | | |

**DETAILED VALVE SPECIFICATION**

**PRV03**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Pressure Regulator Valve | **PRV03** | Gas | | | | |

| **TYPICAL SERVICE** |
|---|
| PA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Stainless Steel | Size Range | 75 mm to 100 mm |
| Sleeve | | Rating | Class 150 |
| Shaft | | Valve Ends | RFWN Flange ANSI 150# |
| | | Type of mechanism | Diaphragm |
| | | Operator | |
| | | Actuator | |
| | | | |

**NOTES**

1. See Section 15100.

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Fisher Regulator | | | |

## DETAILED VALVE SPECIFICATION

**PRV05**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Pressure Regulating Valve | **PRV05** | Water | 850 | 5-25 | 1050 | 40 |

| **TYPICAL SERVICE** |
|---|
| FW |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Ductile Iron | Size Range | 100 mm |
| Disc | EPDM or Buna N | Rating | Class 150 |
| Disc Trim | None | Body/Valve Ends | Flanged |
| Seats | 316 Stainless Steel | Pilot valves | Bronze with SS internals |
| Shaft | Stainless Steel (316) | Operator | NA |
| Bushings | Brass or bronze | Actuator | NA |
| Spring | 302 Stainless Steel | Lining | Epoxy |
| Fastenings | SS | Coating | Epoxy |

| **NOTES** |
|---|
| 1. Suitable for use with reclaimed water with residual suspended solids. |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Singer 106-PR | | | |

**DETAILED VALVE SPECIFICATION**

**PSV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Pressure Safety Valve | **PSV01** | liquid | | | | |

| **TYPICAL SERVICE** |
|---|
| SA |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | PVC | Size Range | 10 mm to 150 mm |
| Spring | Stainless Steel | Rating | |
| Disc assembly | PVC | Valve Ends | True union |
| Seals | Viton or EPDM | Type of mechanism | Spring |
| | | Operator | |
| | | Actuator | |
| | | | |

| **NOTES** |
|---|
| 1. See Section 15100. |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Hayward | Chemline | | |

**DETAILED VALVE SPECIFICATION**

**PV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Plug Valve | **PV01** | Liquid | 600 | 5-30 | 850 | 50 |

| **TYPICAL SERVICE** |
|---|
| CE, WAS |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron | Size Range | 75 mm to 600 mm |
| Plug | Cast Iron (see plug coating) | Rating | Class 150 |
| Seats | Removed | Valve Ends | Victaulic or Flanged |
| Seals | Multiple Packing | Type of Plug | Eccentric |
| Shaft | Steel | Operator | Square nut (Note 1) |
| Bearings | Stainless Steel | Actuator | |
| | | Lining | Glass lined |
| | | Plug Coating | Buna-N, Al-Clad, or Hycar |
| | | Coating | |

| **NOTES** |
|---|
| 1. See Section 11100. |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Victaulic Series 365 | Pratt Ballcentric | | |

**DETAILED VALVE SPECIFICATION**

**PV04**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Plug Valve | **PV04** | Liquid | 600 | 5-30 | 850 | 50 |

| **TYPICAL SERVICE** |
|---|
| FW, ML, RAS, WAS |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Cast Iron | Size Range | 50 mm to 600 mm |
| Plug | Cast Iron (see plug coating) | Rating | Class 150 |
| Seats | Nickel | Valve Ends | Victaulic |
| Seals | O-Rings, Buna-N | Type of Plug | Eccentric |
| Shaft | Steel | Operator | Square nut (Note 1) |
| Bearings | Stainless Steel | Actuator | |
| | | Lining | Abrasion Resistant |
| | | Plug Coating | Buna-N, Al-Clad, or Hycar |
| | | Coating | |

| **NOTES** |
|---|
| 1. See Section 11100. |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| Victaulic Style | | | |

**DETAILED VALVE SPECIFICATION**

**SV01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| Solenoid Valve | **SV01** | Liquid | 1000 | 5 to 30 | 1400 | 50 |

| **TYPICAL SERVICE** |
|---|
| FW |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Carbon Steel or Stainless Steel | Size Range | 10 mm to 64 mm (Note 2) |
| Plug | Stainless Steel (304) | Rating | CWP 1400 kPag |
| Seats | PTFE or RTFE | Body/Valve Ends | Female Threaded |
| Shaft | Stainless Steel (304 or 315) | Pattern | |
| | (Note 2) | Operator | |
| | | Actuator | |
| | | | |
| | | | |
| | | | |

| **NOTES** |
|---|
| |

| **ACCEPTABLE PRODUCTS** | | | |
|---|---|---|---|
| ASCO | | | |

## DETAILED VALVE SPECIFICATION

**TW01**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| 2-Way Multiport | **TW01** | Liquid | 300 | -5 to 115 | 1720 | 120 |

| **TYPICAL SERVICE** |
|---|
| |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | |
| Body | Bronze (Note 2) | Size Range | 10 mm to 200 mm |
| Disc | Bronze (Note 4) | Rating | CWP 1720 kPag |
| Packing | PTFE | Valve Ends | (Note 1) |
| Seats | (Note 6) | Pattern | Two way |
| Shaft | Stainless Steel 304 | Operator | |
| Plug | (Note 5) | Actuator | (Note 3) |
| | | Control Characteristics | Linear, equal percentage |
| | | Rangeability | 1 to 50 |
| | | | |
| | | | |

**NOTES**

1. Valves less than or equal to 50mm threaded; greater than 50mm flanged
2. Flanged bodies to be cast iron
3. Refer to Division 17 and Drawings for actuator specification; thermostatically controlled valve.
4. Provide valves with threaded bodies with removable teflon discs and brass disc holder
5. Provide valves with threaded bodies with contoured brass plug; flanged bodies with cast iron plug
6. Provide valves with threaded bodies with replaceable brass seats; flanged bodoes with replaceable bronze seats

| **ACCEPTABLE PRODUCTS** | |
|---|---|
| Honeywell | |

## DETAILED VALVE SPECIFICATION

**TW03**

| **GENERAL** | | | | | | |
|---|---|---|---|---|---|---|
| | | | OPERATING LIMITS | | DESIGN LIMITS | |
| TYPE OF VALVE | SYMBOL | TYPE OF COMMODITY | PRESSURE (kPag) | TEMP. (°C) | PRESSURE (kPag) | TEMP. (°C) |
| 3-Way Multiport | **TW03** | Gas | 15-240 | 5-120 | 500 | 150 |
| **TYPICAL SERVICE** | | | | | | |
| | | | | | | |

| **VALVE MATERIALS** | | **VALVE DESCRIPTION** | |
|---|---|---|---|
| ITEM | MATERIAL | Reference Document | CGA B105 - (Note 3)<br>API 599, 60 |
| Body | Stainless Steel (316) (Note4) | Size Range | 75 mm to 400 mm |
| Plug | Stainless Steel (316) | Rating | Class 125 |
| Seats | Stainless Steel (304) | Valve Ends | FF Flanges |
| Seals | O-Rings, PTFE | Type of Plug | Parallel |
| Shaft | Same as Plug | Operator | Gear Operator (Note 1) |
| | | Actuator | (Note 2) |
| | | Body Style | T-Port, Rectangular Port, Regular Pattern |
| | | Plug Coating | Nickel Plated, PTFE coating |
| | | Lubrication | 330 White |
| | | | |

**NOTES**

1. See Section 15100.
2. See Division 17.
3. When this valve is installed into a gas service it must comply with the applicable requirements: also refer to Section 15100.
4. Stainless steel body not required for NG service

| **ACCEPTABLE PRODUCTS** | |
|---|---|
| NEO Model #1-AS-80118 | Newman Millikan 200M |

**END OF SECTION**

# VALVE AND GATE ACTUATORS

## 1. GENERAL

### 1.1 Work Included

.1 Supply, delivery, and supervision of installation, and testing of process electric and pneumatic actuators.

### 1.2 Submissions

.1 Shop Drawings: submit Shop Drawings for all actuators in accordance with Section 01300 and Section 11005. In addition to the information requirements of Section 11005, include the following:

.1 Calculations indicating the operating torque of the valve or gate for which the actuator is to be supplied.

.2 The torque rating of the actuator.

.2 Operating and Maintenance Data: Provide for incorporation in O&M Manual as specified in Section 01735.

### 1.3 Delivery and Storage

.1 Deliver actuators to Site using unloading methods which do not damage casings or coatings.

.2 Clearly tag actuators indicating size, type, model number, coatings, and mating parts.

.3 Store on site for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

### 1.4 Process Valve and Actuator Detailed Specification Sheets and Schedules

.1 Process Valves are identified in the drawings by an alpha-numeric code.

.2 Create a valve schedule listing the critical valves required for process operation. The schedule lists the valves and actuators by type, and the function and location of the valve in the process. Ensure all valves and actuators are in compliance with the Section 11100. Do not commence Work on any piping runs until review of valve and actuator selection has been received from the Contract Administrator.

## 2. PRODUCTS

### 2.1 General

.1 Provide new, unused actuators for the Work.

.2 Use materials for actuators that are free from defects or flaws.

.3 Tag actuators to indicate operating characteristics and inlet and outlet ports for electric or pneumatic services.

.4 Standard of acceptance for all electric actuators shall be Limitorque.

.5 Provide actuators with mechanical position indicators.

**2.2 Drawings**

.1 Review and verify piping and instrumentation drawings (P&IDs), ensuring that they indicate all valves and automatic actuators that are critical to proper process operation. Where valves or actuators are not indicated, inform Contract Administrator.

**2.3 Manual Actuators**

.1 Provide valves with manual actuators unless indicated otherwise in other specification sections or shown on the process and instrumentation drawings.

.2 For manual actuators located more than 1830 mm above the floor, provide chain operators.

**2.4 Electric Actuators, Open/Close, Quarter Turn, Less than 1,000 N-m Torque**

.1 Use electric operators that are suitable for mounting on quarter turn valves intended for on/off service.

.2 For actuators rated at less than or equal to 100 Nm, incorporate a 120V/1 phase/60 Hz motor. For actuators rated at greater than 500 Nm and less than or equal to 1,000 Nm, use a 208 V/3 phase/60 Hz motor. In each case, use motors that are high torque, reversible.

.3 Use motors that are rated for continuous duty, as defined in the appropriate NEMA standard.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Make each actuator capable of operating in any horizontal or vertical orientation.

.8 Provide external mechanical indication of valve position.

.9 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.10 For actuator drive train, use steel or aluminum gears arranged with worm gears or compound gear assembly. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an ABFMA B10 life in excess of 40,000 hours.

.11 Use gears and bearings that are non-lubricated or permanently lubricated.

.12 In each actuator, incorporate two SPDT travel limit switches, 10A, 120V AC, CSA listed. The travel limit switches shall each be adjustable.

.13 In each actuator, incorporate two SPDT torque limit switches, 10A, 120V AC. Make the torque limit switches factory pre-set and field adjustable.

.14 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.15 Protect exterior mounted actuators against high temperature and condensation.

.16 Design the actuator so that the opening and closing speed is field adjustable.

.17 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

**2.5 Electric Actuators, Open/Close, Quarter Turn, Greater or Equal to 1,000 kN-m Torque**

.1 Use electric operators that are suitable for mounting on quarter turn valves intended for open/close service.

.2 Incorporate a 600V/3 phase/60 Hz motor. Use motors that are high torque, reversible. Select motor that is capable of at least 10 starts per hour. Size motor to open valve within 60 seconds maximum.

.3 Use motors that are rated for continuous duty, as defined in IEC Standard 34-1.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Provide external mechanical indication of valve position.

.8 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.9 For actuator drive train, use stainless steel or machine steel gears and shafts. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an ABFMA B10 life in excess of 40,000 hours.

.10 Use oil lubricated gearbox. Seal using o-rings or gaskets. Provide a minimum of two filling points.

.11 In each actuator, incorporate two SPDT travel limit switches, 10A, 120V AC, CSA listed. The travel limit switches shall each be adjustable.

.12 In each actuator, incorporate two SPDT torque limit switches, 10A, 120V AC. Make the torque limit switches factory pre-set and field adjustable.

.13 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.14 Protect exterior mounted actuators against high temperature and condensation.

.15 Design the actuator so that the opening and closing speed is field adjustable.

.16 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

**2.6 Electric Actuators, Open/Close, Multi-Turn**

.1 Use electric operators that are suitable for mounting on non-rising stem valves or gates that are intended for open/close service.

.2 Incorporate a 600V/3 phase/60 Hz motor. Use motors that are high torque, reversible. Select motor that is capable of at least 10 starts per hour. Size motor to provide a minimum of 30 rpm or sufficiently high to open or close gate within 10 minutes, whichever requires greater motor size.

.3 Use motors that are rated for continuous duty, as defined in IEC Standard 34-1.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve or gate. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Provide external mechanical indication of valve or gate position.

.8 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.9 For actuator drive train, use stainless steel or machine steel gears and shafts. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Provide method that allows higher shock loads to valves or gates at the beginning of operation so that they unseat. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an ABFMA B10 life in excess of 40,000 hours.

.10 Use oil lubricated gearbox. Seal using o-rings or gaskets. Provide a minimum of two filling points.

.11 Design so that motor can be disconnected without draining the lubricant from the actuator gear case.

.12 In each actuator, incorporate two SPDT travel limit switches, 10A, 120V AC, CSA listed. The travel limit switches shall each be adjustable.

.13 In each actuator, incorporate two SPDT torque limit switches, 10A, 120V AC. Make the torque limit switches factory pre-set and field adjustable.

.14 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.15 Protect exterior mounted actuators against high temperature and condensation.

.16 Design the actuator so that the opening and closing speed is field adjustable.

.17 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

## 2.7 Electric Actuators, Modulating

.1 Select actuators for modulating duty that are generally as described in Clause 2.6, but that modulate in response to a 4-20 mA control signal. For modulating actuators, incorporate a servo drive system suitable for continuous modulation.

.2 For modulating service, select motors that are capable of 1200 starts per hour.

.3 Fit actuators for modulating duty with a position retransmit module (4-20 mA) for remote indication.

## 2.8 Current-to-Pneumatic (I/P) Converters

.1 Provide I/P converters where required.

.2 Supply all required hardware for mounting the I/P converter on the controlled device.

.3 I/P converter to be of EEMAC 4, minimum.

.4 I/P converter to operate with instrument quality control air at an operating pressure range of 20 to 200 kPa.

**2.9 Valve Positioners**

.1 When specified on the instrument specification sheets supply compatible positioners pre-mounted to each actuator. Do not mount the positioner upside down.

.2 Each positioner to service the entire operating range of the actuator. The equipment position shall be fed back to the positioner through a mechanical linkage.

.3 Positioner to operate with instrument quality, oil-free control air.

.4 Provide three independent, interchangeable cams for each positioner -linear function, square function, and square root function.

.5 Mount a pressure gauge on the positioner to measure air output.

**2.10 Position Switches and Indicators**

.1 When specified on the Instrument Specification Sheets, supply actuator assemblies pre-mounted with external position monitors which include two (2) cam actuated "GO" Form C rated proximity switches, a 5-pole male receptacle, a polycarbonate dome beacon and an EEMAC 4 (minimum) enclosure.

.2 Cams to be fastened to a splined shaft and adjustable without set screws.

.3 Provide a visual indicator with beacon type display showing red when the controlled device is in the closed position, and green in the open position.

.4 Supply all required hardware for mounting of position monitor in accordance with the specified valve/actuator orientation.

.5 Diaphragm actuated valves to have external position monitor actuated through linkages.

.6 Enclosures to be suitable for environment to which they are exposed.

**2.11 Finishes**

.1 Actuators shall be shop finished in accordance with Section 11901.

**3. EXECUTION**

**3.1 Preparation**

.1 Prior to the installation of the actuators, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual actuators and that sufficient space and accessibility is available for maintenance and to allow unobstructed view of operation and position of pneumatic and electric actuators.

.2 Where conflicts are identified, inform the Contract Administrator and initiate the necessary piping modifications.

## 3.2 Installation Training

.1 Inform the installer of all procedures and requirements necessary for the successful installation of the equipment. Attest to the installer's understanding by completing Form 101 as shown in Section 01650.

## 3.3 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Cooperate with the installer to fulfill the requirements for a successful installation, as documented by Form 102, illustrated in Section 01650.

## 3.4 Testing

.1 Ensure the equipment, including all component parts, operates as intended. Testing includes field verification of operating speed and torque outputs at rated operating conditions.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650.

## 3.5 Commissioning

.1 Attend during commissioning of the process system which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

**END OF SECTION**

# ACTUATED PROCESS VALVES AND GATES SCHEDULE

**Open/Close Actuated Valves**

C690-FCV
C695-FCV
C710-FCV
C740-FCV

**Modulating Valves/Gates**

C010-WG
C020-WG
C660-FCV
C675-FCV
C685-FCV
C904-FCV
C914-FCV

**Rotary Valves**

C630-FCV

**Solenoid Valves**

C106-FV
C206-FV
C705-FV
C706-FV

**Notes:**

1. Refer to Mechanical specifications for actuators for dampers, mechanical valves etc.

**END OF SECTION**

# DOWNWARD OPENING WEIR GATES

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies the supply and supervision of the installation and commissioning of downward opening self contained fabricated weir gates with actuators.

### 1.2 Submittals

.1 Shop Drawings: submit in accordance with Section 01300 and Section 11005.

.2 Provide:

.1 Frame assembly details

.2 Concrete embedment and attachment details

.3 Installation instructions

.4 Operator details

.5 Stem and Yoke details

.6 Seal Details

.3 Operating and Maintenance Data: Provide for incorporation in O&M Manual as specified in Section 01735.

.4 Design calculations and supporting data for all gates showing stresses, loads and deflection for critical parts under design head conditions.

### 1.3 Performance

.1 Weir gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.01 L/s per metre of seal periphery under the design seating head and 0.02 L/s per metre of seal periphery for the design unseating head.

.2 Weir gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).

.3 The weir gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

## 2. PRODUCTS

### 2.1 General

.1 Shop assemble and inspect gates to ensure that field fitting will not be required.

## 2.2 Acceptable Manufacturers

.1 Fontaine

## 2.3 Weir Gates

.1 Weir gate configuration

.1 Type: 45 degree V-notch

.2 Depth of v-notch: 700 mm

.3 Refer to Drawings for exact dimensions

.2 Weir gates shall be self-contained and of the non-rising stem configuration.

.3 The gate frame shall be constructed of structural members or formed plate welded to form a rigid one piece-frame. The frame shall be of the integral flange back design suitable for mounting on a concrete wall (CW). The guide slot shall be made of the “True” ultra high molecular weight polyethylene (UHMWPE).

.4 The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.

.5 The guides shall be made of the “True” UHMWPE and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

.6 The bottom and side seals shall be made of the “true” UHMWPE of the self adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide.

.7 Seals shall maintain the specified leakage rate in both seating and unseating conditions.

## 2.4 Lift Assemblies

.1 The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 178 N effort on the crank or handwheel.

.2 The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type.

.3 The stem design force shall not be less than 1.25 times the output thrust of the electric motor in the stalled condition.

.4 For stems in more than one (1) piece and with a diameter of 45 mm and larger, the different sections shall be joined together by solid couplings. The couplings shall be grooved and keyed and shall be of greater strength than the stem. Stems with a diameter smaller than 45 mm shall be pinned to an extension tube.

.5 Gates having a width equal to or greater than two (2) times their height shall be provided with two (2) lifting mechanisms connected by a tandem shaft.

.6 Stem guides shall be fabricated from stainless steel. The guide shall be equipped with an ultra high molecular weight polyethylene (UHMWPE) bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/R ratio shall not be greater than 200.

.7 Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

## 2.5 Lifting Mechanism

.1 Operators shall be provided by the gate manufacturer. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 178 N on the crank or handwheel and shall be able to withstand, without damage, an effort of 356 N.

.2 Gearboxes shall be provided when required to maintain the operating force below 178 N. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. The operating shaft shall be fitted with a 50 mm square operating nut and removable crank. The crank shall be fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 380 mm and the maximum handwheel diameter shall be 600 mm.

.3 Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

.4 Provide actuators in accordance with Section 11125.

## 2.6 Materials

.1 Frame, yoke, stem guides, slide, stem extension: Stainless Steel 316L

.2 Guides, side and bottom seals, stem guide liner: Ultra high molecular weight polyethylene (UHMWPE), ASTM D-4020-96

.3 Compression cord: Nitrile ASTM D-2000 M6BG

.4 Threaded stem: Type 316 stainless steel

.5 Fasteners: ASTM F593 and F594 GR2 for type 316

.6 Pedestal, handwheel, crank: Tenzaloy aluminum alloy ZC81A

.7 Gasket (between frame and wall): EPDM ASTM 1056

.8 Stem cover: Polycarbonate ASTM A-707

.9 Lift nut: Manganeze bronze , ASTM B584, UNS-C86500

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 Manufacturer's representative shall be required to attend the Site to train installation personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

### 3.2 Installation

.1 Coordinate blockouts or cast in place items.

.2 Install slide gates with square corners, in a vertical plane, with tolerances within manufacturer's recommendations.

.3 Install gate operators as per manufacturer's recommendations. Align to ensure there is no distortion of stems or moving parts.

.4 Install weir plates as shown in the Drawings.

### 3.3 Testing

.1 Operate each gate with and without liquid to show that each can be operated with applied torques within design limits.

.2 Test each gate for leakage by filling the channel on one (1) side of the gate and measuring leakage through the gate. Undertake the test after 24 hours to allow for the concrete to absorb water.

### 3.4 Commissioning

.1 Arrange manufacturers representative attendance during commissioning of the process system which includes the gates specified in this Section to ensure that each gate functions as intended in the process system.

**END OF SECTION**

**PROCESS MOTORS 150 kW AND LESS**

## 1. GENERAL

### 1.1 Description

.1 This Section specifies alternating current induction motors, 150 kW or less, to be provided with the driven equipment.

.2 This Section does not specify medium voltage (2300 V and greater) and specialty motors such as submersible motors, valve operator motors or torque rated motors.

.3 Unless specified otherwise, the manufacturer of the driven equipment is to provide electric motors as an integral component of the driven equipment, as specified in Section 11005.

.4 This Section specifies motors suitable for driving centrifugal pumps, fans, blowers, compressors, gears, progressive cavity pumps or other loads fed via the variable frequency drive or connected across-the-line.

### 1.2 Reference Standards

.1 Conform to the following reference standards, in accordance with Section 01060:

.1 CSA C22.2 No. 100, Motors and Generators

.2 CSA C22.2 No. 145, Motors and Generators for Use in Hazardous Locations

.3 CSA C390, Energy Efficient Test Methods for Three Phase Induction Motors

.4 EEMAC M1-7, Motors and Generators

.5 NEMA Std. MG1, Motors and Generators

.6 IEEE 112, Polyphase Induction Motors and Generators - Testing

.7 IEEE 114, Single Phase Induction Motors - Testing

### 1.3 Submittals

.1 Shop Drawings: submit with the related items of equipment in accordance with Section 01300 and Section 11005. In addition, submit the following details for each size or type of motor driven equipment.

.1 Shop Drawings and product data in accordance with Division 16

.2 Overall dimensions of motor

.3 Shaft centreline to base dimension

.4 Shaft extension diameter and keyway, coupling dimensions and details

.5 Fixing support dimensions

.6 Terminal box location and size of terminals

.7 Arrangement and dimensions of accessories

.8 Diagram of connections

.9 Speed and torque characteristic

.10 Weight of motor

.11 Installation data

.12 Rotation direction

.13 Starting restrictions (time between starts)

.14 Terminal leads marking

.15 Bearing data (including part numbers)

.16 Recommended lubricant

.17 Design ambient temperature and temperature rise ratings

.18 Torque characteristics including rated starting torque and breakdown torque

.19 The ABFMA L-10 rated life for the motor bearings

.20 The nominal efficiency of all motors

.21 Class, division, group, and UL frame temperature limit code for explosion-proof motors

.2 Operating and Maintenance Data: Provide for incorporation in O&M Manual of the related item of process equipment as specified in Section 01735.

## 1.4 Coordination

.1 Ensure motor is compatible with all anticipated loads and equipment operating conditions.

.2 For motors fed via VFD, communicate motor requirements to the VFD manufacturer, and comply with drive requirements of the VFD manufacturer in accordance with Division 16.

## 1.5 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

### 1.6 Shipment, Protection and Storage

.1 Ship, protect and store equipment in a manner that prevents damage or premature aging

.2 Handle motors with suitable lifting equipment.

.3 Store motors in heated, dry, weather-protected enclosure.

## 2. PRODUCTS

### 2.1 Description

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 220 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

### 2.2 Acceptable Manufacturers

.1 Baldor

.2 General Electric

.3 GEC Alsthom

.4 Reliance

.5 Siemens

.6 Toshiba

.7 U.S. Motors

.8 Westinghouse

### 2.3 Materials

.1 Motors: to EEMAC M1-6

.2 Lead markings: to EEMAC M2-1

.3 Unless specified otherwise, provide all motors with:

.1 Cast iron frame

.2 Cast metal fan blades and shrouds

.3 Stainless steel hardware

.4 Nonhygroscopic windings

## 2.4 Components

.1 Bearings

.1 Provide sealed ball bearing type on motors less than 37.5 kW.

.2 Bearings on 37.5 kW motors or larger to be greasable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.

.2 Provide adequately sized, diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for ODP and TEFC motors.

.3 Provide adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.

.4 Provide a ground connection and lifting eyes or lugs.

.5 Align and balance the motor with the related equipment in the shop to minimize vibration and undue stresses.

.6 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 V, single phase, 60 Hz power supply.

.7 Current Imbalance

.1 Do not exceed the values listed below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

.1 Under 37.5 kW: 25 percent

.2 37.5 kW and above: 10 percent

.2 Base imbalance criteria upon the lowest value measured.

.8 Winding Overtemperature Protection

.1 Provide stator winding overtemperature protection on all motors rated 45 kW and larger.

.2 Provide stator winding overtemperature protection on motors rated less than 45 kW, when required by the specific equipment specification section, or if recommended by the driven equipment manufacturer.

.3 Overtemperature protection for motors rated 45 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor overtemperature protection. Provide one detector per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a

NEMA 4 enclosure in Type 2 motors and a NEMA 7C or 9 enclosure for Type 3 motors.

## 2.5 High Efficiency Motors

.1 Use motors that have efficiencies that conform to or exceed the requirements of EPACT.

.2 Where vertical motors are specified or provided, ensure efficiency is within 0.5 percent of the values specified for horizontal motors.

.3 Test motor efficiency in accordance with CSA C390 and NEMA MG1, accounting for stray load losses, measured indirectly based on the IEEE method.

## 2.6 Motors Smaller Than 0.25 kW

.1 General

.1 Unless otherwise specified, provide squirrel cage, single phase, capacitor start, induction run type motors 0.25 kW and smaller.

.2 Provide single phase motors with Class F insulation.

.3 Small fan motors may be split-phase or shaded pole type.

.4 Provide copper windings.

.2 Rating

.1 Unless specified otherwise, provide motors rated for operation at 115/1/60 VAC, and continuous-time rated in conformance with NEMA Standard MG1, paragraph 10.35.

.3 Enclosures

.1 Unless otherwise specified, provide motors with totally enclosed fan cooled (TEFC) or totally enclosed non-ventilated (TENV) enclosures.

.2 Where explosion-proof motors are specified or required, provide explosion-proof motors bearing the UL label for Class I, Division 1, Group D hazardous locations.

.3 Provide advice in the enclosure to detect overtemperature and automatically de-energize the motor.

## 2.7 Motors 0.25 kW to 150 kW

.1 General

.1 Unless otherwise specified, provide 3-phase, squirrel cage, full voltage start, high efficiency induction type motors 0.25 kW to 150 kW.

.2 Rating

.1 Unless otherwise specified, provide heavy duty, high efficiency, and TEFC motors for all motors which run continuously.

.2 Unless otherwise specified, provide squirrel cage induction type motors, with a service factor of 1.15 at 40°C ambient, Class F insulation and non-hygroscopic windings.

.3 Provide motors with EEMAC Design B torque characteristics. Size motors to satisfy the driven equipment's starting torque requirements. For special high torque applications such as sweep arm drives, motors with Design C characteristics may be specified or provided subject to the Contract Administrator's acceptance.

.4 Rated for 600 V 3 phase 60 Hz service

.5 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10 percent to -10 percent of nameplate voltage.

.6 Motors with a service factor of 1.0 to operate at no more than 90 percent of their nameplate current rating and motors with a service factor of 1.15 to operate at not more than 100 percent of their nameplate current rating.

.7 Ensure sufficient capacity to operate the driven load and associated devices under all conditions of operation without overloading.

.3 Enclosure and Insulation

.1 Classify motors as:

.1 Type 1 (General Duty)

.2 Type 2 (Process)

.3 Type 3 (Explosion-proof)

.2 Enclosures and insulation systems are specified in the following clauses. Temperature rise for all motor types not to exceed that permitted by Note II, paragraph 12.42, NEMA MG1.

.3 Provide non-hygroscopic insulation.

.4 Type 1 Motors (General Duty): Unless specified otherwise, provide TEFC enclosures with Class F insulation.

.5 Type 2 Motors (Process): Provide TEFC enclosures, with Class F insulation, suitable for moist and corrosive environment. Provide Class F insulation with Class B temperature rise for motors rated 7.5 kW and larger. Coat all internal surfaces with an epoxy paint. Aluminum frame motors are permitted. Steel frame motors are permitted for motors with frames 184 and smaller.

.6 Type 3 Motors (Explosion-proof): Provide motors to be rated for operation in a Class 1, Division 1, Group D hazardous location in accordance with CSA C22.1. Provide Class F insulation. Steel frame motors are not permitted. Provide an approved breather/drain device in the motor drain hole.

**2.8 Motors for Variable Frequency Drives**

.1 Comply with the characteristics of the intended variable frequency drives.

.2 Select premium efficiency units, inverter duty rated, in conformance with NEMA MG1.

.3 Use Type 2 or Type 3 motors.

.4 Insulation: Class F insulation with Class B temperature rise, suitable for moist and corrosive environments and in accordance with NEMA MG1, Part 30 and Part 31.

.5 Motors for variable frequency systems are not to deliver more than 80 percent of the motor's service factor rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

.6 Ensure motors have adequate cooling capacity when operating through the entire speed range capacity of the drive.

**2.9 Vertical Motors**

.1 Unless otherwise specified, provide full voltage vertical motors with a Type P base specifically designed for vertical installation.

.2 Universal position motors are not acceptable.

.3 Provide vertical motors with solid shafts unless specified otherwise.

.4 Provide thrust bearing rating compatible with the loads imposed by the driven equipment.

**2.10 Two-Speed Motors**

.1 Provide two-speed motors with separate windings. Single winding two speed motors are not acceptable.

**2.11 Power Factor Correction Capacitor Sizing**

.1 Confirm the maximum capacitor size which may be connected to motors 37.5 kW and larger, on constant speed drives.

**2.12 Finishes**

.1 Factory paint motors as specified in Section 11900.

### 2.13 Equipment Identification

.1 Provide equipment identification in accordance with Division 11 and Division 16.

.2 Nameplates

.1 Provide motor nameplates on engraved or stamped stainless steel. Include information enumerated in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.

.2 Additionally, indicate:

.1 The AFBMA L-10 rated life for the motor bearings for motors 37.5 kW and larger.

.2 The nominal efficiency for all motors.

.3 Class, division, group and UL frame temperature limit code for explosion-proof motors.

.4 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

### 2.14 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with Section 01750.

## 3. EXECUTION

### 3.1 Manufacturers Representative

.1 All motors are supplied as an integral component of some other item of equipment. The manufacturer's representative for that equipment is responsible for the supervision of installation, site testing, and commissioning of the motor as part of the equipment as specified in other sections. Ensure that the motor manufacturer's representative informs both the representative for the equipment and the installer of requirements for the motor, installation, testing, and commissioning.

### 3.2 Installation

.1 Dry the motor if dampness present, in accordance with manufacturer's recommendations.

.2 Install or ensure the motor is properly installed to provide satisfactory service.

.3 Make connections as indicated. Use liquid-tight PVC jacketed flexible conduit between rigid conduit and motor.

.4 Make flexible conduit long enough to permit movement of motor over entire length of slide rails, when applicable.

.5 Check for correct direction of rotation, with motor uncoupled from driven equipment.

.6 Align and couple motor to driven machinery to manufacturer's instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.

.7 Install anchor devices and setting templates in accordance with Division 3.

## 3.3 Testing

.1 Perform tests and document results in accordance with Division 16.

## 3.4 Testing and Commissioning

.1 Ensure the motor operates as intended during testing of the individual equipment and during process commissioning.

**END OF SECTION**

**PROCESS MOTORS GREATER THAN 150 kW**

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies alternating current induction motors, greater than 150 kW.

.2 This Section does not specify specialty motors such as submersible, hoist, valve operator, torque rated, or inverter duty motors.

.3 Provide motors for starting and accelerating the driven load up to operating speed and for developing sufficient torque to fulfil the acceleration and the steady state requirements of the driven equipment without exceeding the normal operating limits of the system.

.4 Unless specified otherwise, the manufacturer of the driven equipment is to provide electric motors as an integral component of the driven equipment, as specified in Section 11005.

### 1.2 Reference Standards

.1 Conform to the following reference standards, in accordance with Section 01060:

.1 CSA C22.2 No. 100, Motors and Generators

.2 CSA C22.2 No. 145, Motors and Generators for Use in Hazardous Locations

.3 CSA C390, Energy Efficient Test Methods for Three Phase Induction Motors

.4 EEMAC M1-7, Motors and Generators

.5 EEMAC M2-1, Lead Marking and Connections for Single Phase and Poly Phase Induction Motors

.6 NEMA Std. MG1, Motors and Generators

.7 IEEE 112, Polyphase Induction Motors and Generators - Testing

### 1.3 Submittals

.1 Shop Drawings: submit with the related items of equipment in accordance with Section 01300 and Section 11005. In addition, submit the following details for each size or type of motor driven equipment.

.1 Overall dimensions of motor

.2 Shaft centreline to base dimension

.3 Shaft extension diameter and keyway, coupling dimensions and details

.4 Fixing support dimensions

.5 Terminal box location and size of terminals

.6 Arrangement and dimensions of accessories

.7 Diagram of connections

.8 Speed/torque characteristic

.9 Weight of motor

.10 Installation data

.11 Rotation direction

.12 Starting restrictions (time between starts)

.13 Terminal leads marking

.14 Bearing data (including part numbers)

.15 Recommended lubricant

.16 Design ambient temperature

.17 The AFBMA L-10 rated life for the motor bearings

.18 The nominal efficiency for all motors

.19 Class, division, group and UL frame temperature limit code for explosion-proof motors.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual of the related item of process equipment as specified in Section 01735.

## 1.4 Coordination

.1 Ensure motor is compatible with all anticipated loads and equipment operating conditions.

.2 For motors fed via VFD, communicate motor requirements to the VFD manufacturer, and comply with drive requirements of the VFD manufacturer in accordance with Division 16.

## 1.5 Shipment, Protection and Storage

.1 Ship, protect and store equipment in a manner that prevents damage or premature aging

.2 Handle motors with suitable lifting equipment.

.3 Store motors in heated, dry, weather-protected enclosure.

## 2. PRODUCTS

### 2.1 Description

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 220 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature at the minimum speed of the driven equipment.

### 2.2 Acceptable Manufacturers

.1 Toshiba EQPIII

### 2.3 General

.1 Unless otherwise specified, provide 3-phase, squirrel cage, full voltage start, high efficiency, induction type motors.

### 2.4 Rating

.1 Provide motors for continuous operation, heavy duty service, high efficiency.

.2 Provide squirrel cage induction type, form wound, Class H insulation, non-hygroscopic winding motors, for severe moisture and corrosive environment.

.3 Design for EEMAC Design B torque characteristics.

.4 Provide motors rated for 600 V, 3-phase, 60 Hz service unless otherwise specified.

.5 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10 percent to -10 percent of nameplate voltage.

.6 Service factor: 1.15 (for sinusoidal 60 Hz) designed for operation in a 40°C ambient temperature.

.7 Ensure sufficient capacity to operate the driven load and associated devices under all operating conditions without overloading.

### 2.5 Efficiency

.1 Provide high efficiency horizontal motors

.2 Where vertical motors are specified or provided, ensure efficiency is within 0.5 percent of values specified for horizontal motors.

.3 Test motor efficiency in accordance with CSA C390, or equivalent, which accounts for stray load losses and measures them indirectly based on the IEEE method.

## 2.6 Materials

.1 Motors: to EEMAC M1-7

.2 Lead markings: to EEMAC M2-1

.3 Unless specified otherwise, provide all motors with:

.1 Cast iron frame

.2 Cast metal fan blades and shrouds

.3 Stainless steel hardware

.4 Nonhygroscopic windings

## 2.7 Motor Windings and Winding RTDs

.1 Design the motor to permit the removal of the rotor and shaft without removal of the stator.

.2 Provide copper stator form wound windings.

.3 Provide windings vacuum, pressure impregnated and capable of passing tests equal to the EEMAC water immersion test.

.4 Provide motor thermal overload protection by embedding six flat, laminated 100 ohm platinum RTDs (two per phase winding); fit in slots between stator windings and locate near the hottest point of the winding.

.5 Provide each RTD complete with three insulated stranded copper leads. Terminate RTD leads in a separate instrument termination box.

.6 Provide RTD thermal overload protection.

## 2.8 Motor Noise Abatement

.1 The maximum pressure level from the motors must not exceed 85 dBA at a distance of one metre from the motor surface.

.2 Determine the sound level in accordance with IEEE standards.

## 2.9 Motor Anchoring

.1 Mount the motor on the supporting stand.

.2 Provide mounting stand-to-motor attachment hardware as recommended by the manufacturer, subject to review.

**2.10 Motor Vibration Switches**

.1 Provide switches installed on motors to monitor the following:

.1 Case vibration

.2 Include all provisions for mounting the vibration switches in accordance with the manufacturer's requirements.

**2.11 Motor Enclosures**

.1 Provide open drip-proof guarded motor enclosures.

.2 Protect the air intake and discharge openings with stainless steel metal guard screens.

.3 Equip all moving or energized parts with adequate guards or other suitable enclosure to prevent accidental contact.

**2.12 Motor Grounding**

.1 Provide the motor frames with a grounding termination pad located in the main power lead conduit box.

.2 Provide grounding pads with tapped holes, matching bronze bolts, and copper cable lugs.

**2.13 Motor Bearings and Bearing RTDs**

.1 Provide anti-friction ball or roller bearings fitted with inner bearing caps for the protection of the bearings.

.2 Provide grease fittings for lubrication during operation, and grease discharge or relief opening.

.3 Design bearings for a minimum AFBMA B-10 life of 100,000 hours under the most severe operating conditions.

.4 Design motor to protect against circulating shaft current.

.5 Furnish motor with 100 ohm platinum RTD temperature sensors on upper and lower bearings, wired to instrument terminal box.

.6 Provide each RTD sensor complete with stainless steel fluid seal spring-loaded holder 12 NPT motor connection and 20 NPT enclosure connection, tip-sensitive stainless steel 100 ohm platinum RTD (three stranded, insulated copper leads) and copper-free aluminum connection head complete with terminals with 20 NPT connection.

**PROCESS MOTORS GREATER THAN 150 kW**

**2.14 Motor Lifting Lugs**

.1 Provide the motors with lifting lugs or other approved means to allow installation and maintenance of the motors.

.2 Make the lifting lugs compatible with the appropriate hoists and cranes.

**2.15 Current Imbalance**

.1 Do not exceed 10 percent phase current imbalance when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

.2 Base imbalance as a percentage of the lowest phase current measured.

**2.16 Motor Terminal Box**

.1 Furnish the motors with extra large terminal boxes having sufficient size to accommodate cables as detailed on the electrical drawings, with provision for stress cones.

.2 Provide air seals where leads pass through the motor enclosure and frame.

.3 Do not locate terminal boxes in air intake or discharge paths.

.4 Provide separate terminal boxes as required for space heater leads and all other required instrumentation and control connections.

**2.17 Power Factor Correction Capacitor Sizing**

.1 Confirm the maximum capacitor size which may be connected to motor.

**2.18 Finishes**

.1 Factory paint motors as specified in Section 11900.

**2.19 Mounting**

.1 Supply all motors integrally with the related equipment.

.2 Factory align and balance the motor with the related equipment to minimize vibration and undue stresses.

**2.20 Nameplates**

.1 Provide motor nameplates on engraved or stamped stainless steel. Include information enumerated in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.

.2 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

### 2.21 Spare Parts

.1 In addition to the maintenance materials and spare parts in accordance with Section 01750, provide the following

.1 One set of bearings.

## 3. EXECUTION

### 3.1 Manufacturers Representative

.1 All motors are supplied as an integral component of some other item of equipment. The manufacturer's representative for that equipment is responsible for the supervision of installation, Site testing, and commissioning of the motor as part of the equipment as specified in other Sections. Ensure that the motor manufacturer's representative informs both the representative for the equipment and the installer of requirements for the motor, installation, testing and commissioning.

### 3.2 Installation

.1 Ensure the motor is properly installed to provide satisfactory service.

### 3.3 Testing and Commissioning

.1 Ensure the motor operates as intended during testing of the individual equipment and during process commissioning.

**END OF SECTION**

# SUBMERSIBLE MOTORS

## 1. GENERAL

### 1.1 Work Included

.1 Supply and supervision of the installation, testing, and commissioning of submersible motors.

### 1.2 Submittals

.1 Shop Drawings: submit with the related item of process equipment in accordance with Section 01300 and Section 11005. In addition, submit the following details:

.1 Submit efficiency and power factor information at 100 percent and 75 percent load for each motor size and type required.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual of the related item of process equipment as specified in Section 01300.

### 1.3 Coordination

.1 For motors fed via variable frequency drives, communicate motor requirements to the VFD manufacturer and comply with drive requirements of the VFD manufacturer in accordance with Division 16.

### 1.4 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, and to the requirements specified.

### 1.5 Shipment, Protection and Storage

.1 Ship, protect, and store equipment in a manner that prevents damage or premature aging.

.2 Handle motors with suitable lifting equipment

.3 Store motors in heated, dry, weather-protected enclosure

## 2. PRODUCTS

### 2.1 Description

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 220 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

**2.2 Acceptable Manufacturers**

.1 Siemens

.2 General Electric

.3 Toshiba

.4 Westinghouse

.5 Reliance Electric

.6 Flygt

**2.3 Exposure Classification**

.1 The exposure classification for each motor is specified with the related equipment.

.2 Provide as a minimum TEXP motors for areas where dangerous gases may occur or which are to be immersed in flammable liquids.

.3 In all other areas, provide totally enclosed, waterproof motors.

**2.4 Motors - Sewage Application**

.1 Provide motors suitable for heavy duty service.

.2 Squirrel cage induction type with non-hygroscopic windings. Insulation temperature rise not to exceed Class F. Insulation to be moisture resistant.

.3 For starting and torque characteristics, conform to EEMAC Design B.

.4 316, 416, or 417L stainless steel motor shafts.

.5 For services 0.37 kW and greater provide motors nameplate rated for 600 V, 60 Hz, 3-phase service unless otherwise specified.

.6 Design motors for full voltage starting and capable of running successfully when terminal voltage is from +10 percent to -10 percent of nameplate voltage. Motors with a service factor of 1.0 shall run at not more than 90 percent of nameplate current rating and motors with a service factor of 1.15 shall operate at not more than 100 percent of nameplate current rating.

.7 Provide motors capable of ten evenly spaced starts per hour on a continuous basis without temperature rises which would harm insulation and windings.

.8 Design motors for semi-continuous immersion in liquid with an ambient temperature of 40°C unless higher temperatures are noted. Design casing for adequate heat rejection. Designs utilizing the circulation of the pumping liquid are not permitted.

.9 Where motors are designated for intermittent immersion, provide cooling fins, sealed fan units, or other devices suitable for the function.

.10 Provide thermal protection. Two bimetallic sensors shall sense when the motor temperature rises above 140°C. The motor shall automatically restart after cool-down. For TEXP motors, calibrate the two bimetallic sensors to shut down the motor at 120°C. Include three additional thermistors which shut down the motor if a temperature of 140°C is sensed. On sensing this condition, the motor will be shut down and held until reset. Use the thermal switches in conjunction with and supplemental to external thermal motor overload protection.

.11 For motors greater than or equal to 3.75 kW (5 hp), provide a moisture sensing device in the stator housing.

.12 Attach an oil-filled reservoir to the bottom of the motor. Prohibit the ingress of moisture with inner and outer single mechanical seals. Mechanical seals to be tungsten carbide or sintered silicon carbide, both faces.

.13 Place a moisture sensing device in the reservoir to indicate seal failure.

.14 Provide sealed ball bearing type bearings with an AFBMA B10 life of 100,000 hours.

.15 Provide 304 or 316 stainless steel hardware.

.16 Ensure motors used with variable speed drives have adequate cooling capacity when operating through the entire speed range capacity of the drive.

**2.5 Cable**

.1 Supply submersible motors with a minimum length of cable to reach the pump's control panel and starter, and capable of continuous submergence under water without loss of watertight integrity to a depth of 20 m.

.2 Provide cable that contains power and ground wires, copper, of sufficient size for the service and in compliance with applicable codes.

.3 Provide cable that contains instrument leads, shielded as necessary to prevent electrical interference.

.4 Provide heavy duty cable, water tight and capable of withstanding operating loads.

.5 Seal end of cable prior to shipping to prevent ingress of moisture.

**2.6 Finishes**

.1 Factory paint submersible motors as specified in Section 11900.

**2.7 Mounting**

.1 Supply all motors integrally with the related equipment.

.2 Factory align and balance the motor with the related equipment to minimize vibration and undue stresses.

## 3. EXECUTION

**3.1 Manufacturer's Representative**

.1 All motors are supplied as an integral component of some other item of equipment. The manufacturer's representative for that equipment is responsible for the supervision of installation, Site testing, and commissioning of the motor as part of the equipment as specified in other Sections. Ensure that the motor manufacturer's representative informs both the representative for the equipment and the installer of requirements for the motor, installation, testing, and commissioning.

**3.2 Installation**

.1 Ensure the motor is properly installed to provide satisfactory service.

**3.3 Testing and Commissioning**

.1 Ensure the motor operates as intended during testing of the individual equipment and during process commissioning.

**END OF SECTION**

**PROCESS PUMPS – GENERAL REQUIREMENTS**

## 1. GENERAL

### 1.1 Description

.1 This Section defines the general requirements for the supply, installation, and commissioning of all pumps required for this project.

### 1.2 Definitions

.1 The terms in the Specification generally comply with the definitions of the Hydraulic Institute.

.2 Definitions

.1 Efficiency: pump efficiency shall be calculated as the delivered hydraulic power divided by the electrical power at the inlet box of the pump. It shall take full account of mechanical and electrical losses.

.2 Performance Curve: the performance curve is a graph of the flow delivered (L/s, x-axis) in relation to the discharge head (metres, y-axis). It generally denotes efficiencies as isopleths and may include NPSH requirements as a function of the flow.

.3 Best Efficiency Point: the best efficiency point is the point in the pump performance curve where the pump operates at its highest efficiency.

.4 Rating Point: the pump rating point is the combination of discharge head and flow which the pump must satisfy. It typically is determined on the basis of all duty pumps (one or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, maximum discharge head, etc.) This condition is listed in the detailed pump specification and must be satisfied by the pump supplied.

.5 Low Head Point: the low head point is the combination of head and flow which corresponds to the least head the pump might operate against. It is determined on the basis of only one duty pump operating against the system conditions which would produce the least discharge pressure (typically minimum headloss, maximum suction head, minimum discharge head, etc.) The minimum system head is shown or described for each pump. The manufacturer must ensure that the pump can operate satisfactorily, without cavitation in the pump casing or over-stressing of the motor, at the intersection of the pump curve and the minimum head curve, or low head point.

.6 Low Speed Point: the minimum flow and head conditions against which a variable speed pump is expected to operate.

.7 NPSH (Net Positive Suction Head): the total pressure (atmospheric) at the pump suction. The available NPSH is the pressure available at the pump suction and is a function of site atmospheric pressure and suction piping losses. Required NPSH is the pressure required at the pump suction to ensure cavitation due to water column separation does not occur. Required NPSH shall be defined by the pump supplier at the pump inlet connection whether that be at the casing or at the face of a suction reducer/elbow supplied as an integral part of the pump.

.8 Minimum Diameter Passing: solids-handling pumps have listed a minimum diameter passing. A sphere of this size must be capable of passing from the pump intake to the discharge.

## 1.3 Submissions

.1 Shop Drawings: submit in accordance with Section 01300 and Section 11005. For all pump Shop Drawings, in addition to the requirements of Section 11005, include the following specific details:

.1 Performance curve for the pumping unit(s) superimposed on the system curve for the particular pumping application. Where the system curve is not included in the specifications, request this information from the Contract Administrator when required. With the performance curve, include efficiency isopleths and NPSHR variation with flow. Where required in the specific pump sections, the performance curve should be certified in accordance with Hydraulic Institute Standards.

.2 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, description of construction complete with illustrative drawings, and any other pertinent information.

.3 List of materials of construction, detailing the component parts of the pump(s), their materials of construction, and reference specifications for those materials.

.4 Required ancillary services including, but not limited to electrical, seal water, and drains. The sizes, ratings, and any other pertinent information related to these services.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services (electrical, seal water, drains, etc.)

.6 Start-up instructions including lubricant requirements, electrical requirements, etc.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual as specified in Division 1. Include the following:

.1 Complete description of operation

.2 General arrangement and detailed drawings

.3 Wiring diagrams for power and control schematics

.4 Parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connection and the parts manufacturer's identifying numbers.

.3 Number of weeks prior to shipment that Contract Administrator will be required to supply final conditions of flow and head for trimming the impeller. Manufacture casings to the conditions given on the system head curves, but complete final trim of the impellers according to the flow and head supplied for this pump on or before a date agreed on between Contractor and the Contract Administrator.

**1.4 Delivery and Storage**

.1 Ship pre-assembled to the degree that is possible. Inform installer of any site assembly requirements.

.2 Securely fasten heavy wood blanks to the pump flanges. Use blanks that are larger diameter than the flange. Protect machined surfaces against rusting. Protect threaded connections with threaded plugs or caps. Protect open, plain pipe ends with caps.

.3 Where pumps are to be stored on-site for any period of time exceeding on week, instruct site staff of specific requirements to ensure there is no uneven wear or distortion of pump component parts.

.4 Identify any special storage requirements.

**1.5 Coordination**

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

**2. PRODUCTS**

**2.1 Pump Performance Requirements**

.1 Provide pumps that are suitable for continuous duty.

.2 Select impellers for fixed speed pumps that permit operation at an efficiency within 5 percent of the efficiency at the Best Efficiency Point.

.3 For variable speed pumps, select pump speed and impeller diameter which allow operation from the Rating Point to the Low Speed Point at efficiencies with 10 percent of efficiency at the Best Efficiency Point.

.4 Ensure that motors are sufficiently sized to drive pumps at a maximum speed when the head is as defined for the low head point.

.5 Provide pumps capable of operating at 30 percent of the flow at the rated capacity with good efficiency without exceeding the motor horsepower, and capable of operating at any point on its characteristic curve, to where that curve intersects the low head point, without exceeding motor power rating.

## 2.2 Pressure Sensing

.1 Supply a means of measuring inlet and outlet pressure with each pump, except as noted.

.2 For centrifugal pumps handling clean water, provide gauges for the inlet and outlet of each pump. Mount on the connections described for equipment in Section 11005.

.3 For submersible pumps, provide only one gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 m of the wetwell.

.4 For centrifugal pumps handling sewage, sludge, grit, or effluent water, provide one pressure sensor and one gauge for each pump. Refer to standard details for mounting requirements.

.5 For positive displacement pumps (diaphragm, piston, etc.), provide full pipe diameter annular ring pressure sensor for both the suction and discharge, complete with gauges and connections for instrumentation devices.

.6 Gauges:

.1 Supply gauges that are 75 mm diameter, 6.35 mm bottom connection, complete with shut off cock with stainless steel movement and Bourdon tube.

.2 Use metric units of measurement (kPa or Pa), clearly indicated on the face of the gauge.

.3 Calibrate the gauges to read pressure ranges approximately as follows:

| | **Actual Pressure** | **Gauge Pressure Range** |
|---|---|---|
| Suction | -50 kPa to 50 kPa | -50 kPa to 350 kPa |
| | 50 kPa to 200 kPa | 0 kPa to 350 kPa |
| | 200 kPa to 700 kPa | 0 kPa to 1000 kPa |
| Discharge | 50 kPa to 350 kPa | 0 kPa to 700 kPa |
| | 350 kPa to 700 kPa | 0 kPa to 1000 kPa |
| | 700 kPa to 1500 kPa | 0 kPa to 2000 kPa |

.4 Acceptable manufacturers: Ashcroft, H.O. Trerice

.7 Pressure Sensors

.1 Provide annular ring, flow through type pressure sensors, with stainless steel body, a sensing element compatible with the corrosive and abrasive nature of the fluid being measured, 25 mm diameter.

.2 Acceptable products: Red Valve Series 42 or Robbins and Myers RKL Series W.

.3 Provide stainless steel nipples extending to a tee from the pressure sensor. Mount the gauge on one leg of the tee. If a pressure indicator/transmitter/switch is shown on the drawings, mount on the other side of the tee. Otherwise, plug the tee.

.4 Supply annular type pressure sensors with their initial fill of fluid.

## 2.3 Pump Seals

.1 Provide cartridge type, single mechanical seals, externally mounted.

.2 Provide non-destructive, self-aligning seals of the stationary design with require no wearing sleeve for the shaft.

.3 Materials of construction

| Type of Service | Metal Parts | Spring(s) | O-Rings | Faces |
|---|---|---|---|---|
| Potable water | 316 or 317L Stainless Steel | 316 or Hastelloy C | Buna-N or Viton | Silicon Carbide on Carbon |
| Sewage | 316 or 317L Stainless Steel | 316 or Hastelloy C | Viton | Sintered Silicon Carbide on Carbon |
| Secondary Sludge and Scum | 316 or 317L Stainless Steel | 316 or Hastelloy C | Viton | Tungsten Carbide on Sintered Silicon Carbide |
| Primary Sludge, Digested Sludge, and Grit | 316 or 317L Stainless Steel | 316 or Hastelloy C | Viton | Tungsten Carbide on Sintered Silicon Carbide |

.4 Approved manufacturers

.1 Durametalic

.2 John Crane

.3 Chesterton

## 2.4 Bearings

.1 Refer to Section 11005

.2 For all pumps other than submersible and where otherwise noted in the detailed specifications, provide a bearing shield, complete with labyrinth seals, to prevent the ingress of water.

**2.5 Protective Guards**

.1 Provide a protective guard for all couplings and keys, drive belts, or other exposed rotating devices. As a minimum, conform to the requirements of Section 11005.

**2.6 Couplings**

.1 For all pumps other than submersible and where noted otherwise in the detailed specifications, provide flexible, double disc, spacer type couplings conforming with Section 11005.

.2 Design couplings so that the pump unit can be disassembled without disturbing face piping.

.3 Acceptable Products: Wood Sureflex, Rex Omega

**2.7 Shafts**

.1 Design shafts to absorb 1.15 times the rated power of the motors required to drive the pumps when the pump is fitted with maximum size impellers.

.2 Use stainless steel shafts, without any allowance for shaft sleeves.

**2.8 V-Belt Drives**

.1 Do not use V-belt drives unless specified or shown on the Drawings.

.2 Conform to the requirements of Section 11005.

**2.9 Seal Water Connection**

.1 For each pump handling fluids with abrasive or corrosive components, including wastewater flows of any type, provide seal water connections to the pump seals.

.2 For seal water piping and fittings, unless otherwise specified, use 12 mm diameter.

.3 Seal water connections consist of the following:

.1 Isolating valve: ball valve type BV01. Refer to Section 11105.

.2 Filter strainer, copper and brass with stainless steel screen basket.

.3 Pressure regulator, copper and brass

.4 Solenoid valve, copper, power to open

.5 Rotameter, 0 to 10 L/min, rated for 1000 kPa

.6 Needle valve, separate or integral with the rotameter. For separate, use NV01.

.7 Flow switch, Rosemount or Foxboro

**2.10 Spare Parts**

.1 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one set of pump bearings.

.2 For each size of seal water connection, one rotameter.

.3 For each centrifugal pump type and size, provide a single impeller, wear plate, suction ring (if replaceable), one pumps shaft, and nut.

**2.11 Factory Performance Testing**

.1 Where required for specific pumps, as noted in the sections related to those pumps, factory performance test all pumps.

.2 Conduct factory performance testing in compliance with the Hydraulic Institute Standards.

.3 Inform the Contract Administrator at least three weeks prior to the factory testing to allow for his attendance.

.4 Certify test results and summarize findings in a short report. Submit report within three weeks of completing factory tests.

.5 Where a pump does not satisfy the specified performance requirements within the tolerances specified by the Hydraulics Institute, redesign, modify, and retest the pump, all at no additional cost.

.6 Do no ship the pump until the test result report has been submitted to the Contract Administrator.

**2.12 Finishes**

.1 Factory prime and paint all pumps in accordance with Section 11901.

**3. EXECUTION**

**3.1 General**

.1 Comply with the requirements of the specific sections for the pumps to be provided.

**3.2 Installation**

.1 Comply with the requirements of Section 11020 and any special requirements listed in the specific sections related to each pump.

## 3.3 Testing

.1 Field test all pumps greater than or equal to 3.7 kW, and smaller units where noted, to verify performance.

.2 Provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.

.3 Flow Metering

.1 Where possible, use fill and draw techniques to determine the amount of flow conveyed during the test period. Ensure that the volumes are sufficient for at least five minutes of pump operation at the flows that are to be tested, other than run-out.

.2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing when accepted by the Contract Administrator. Ensure that the permanent flow meters are calibrated to within 5 percent of the rated flow of the pump to be tested prior to testing.

.3 Temporary metering may be used if accepted by the Contract Administrator. Temporary meters must have an accuracy of ±5 percent, at the rated flow of the pump, to be acceptable.

.4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing is to be conducted by an agency acceptable to the Contract Administrator. Measured flows during the testing will be certified to be within 5 percent of the actual flows by a qualified Professional Engineer.

.4 Pressure Monitoring

.1 Do not use permanent gauges for pressure monitoring during tests. Temporary test gauges can be connected to the permanent gauge taps.

.2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within 2.5 percent. Where pump suction draws from an open tank or wet well, test gauge must be capable of measuring pressure at pump suction within 1.0 kPa.

.3 Provide evidence of pressure gauge calibration within three months of conducting tests.

.5 Test pump at a minimum of three flow conditions, typically corresponding to the rating point flow, 75 percent of that flow, and 120 percent of that flow. At each test point, measure flow, pressure, and amperage. In addition, verify run-out conditions.

.6 For variable speed pumps, conduct the tests at two speeds, typically 100 percent of the design speed and 30 percent of the design speed.

.7 Field Test Report

.1 Compile field test results into a report for submittal to the Contract Administrator.

.2 Describe test set-up and measurement devices used to conduct the tests.

.3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submission.

.8 Where field tests to not verify compliance with specified performance requirements, investigate cause for noncompliance, undertake remedial Work as required to bring pump into compliance, or replace the pump and all necessary ancillaries, and retest to prove compliance. All Work required to bring the pump into compliance is the responsibility of the Contractor.

**END OF SECTION**

# SUBMERSIBLE PUMPS

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of submersible pumps.

### 1.2 Related Work

.1 11395 Submersible Mixers

### 1.3 Coordination

.1 All submersible pumps and submersible mixers shall be the product of a single manufacturer

## 2. PRODUCTS

### 2.1 Detailed Pump Specification Sheets

.1 Specific pumps are listed in detailed specification sheets.

### 2.2 Design Standard

.1 KSB

### 2.3 Acceptable Manufacturers

.1 ABS

.2 ITT Flygt

### 2.4 Design

.1 Provide pumps which are capable of running dry for prolonged periods.

.2 Pumps shall automatically connect to the discharge elbow when lowered into place, and shall be easily removed for inspection or service without the need for personnel to enter the pump well.

.3 Pump and motor assemblies shall be a close coupled integral, wetwell submersible type.

.4 Seal the pump to the discharge elbow by a simple linear downward motion of the pump. Provide a sliding guide bracket attached to the pump.

.5 Guide the entire weight of the pump by a double guide bar and press the pump tightly against the discharge elbow with metal to metal contact.

.6 Provide pumps and all appurtenances capable of withstanding corrosion in an environment containing an average chloride concentration of 550 mg/L

.7 Provide pumps and all appurtenances capable of operating in wastewater of temperature between 15°C and 36°C.

**2.5 Impeller**

.1 Provide a cast iron, dynamically balanced, single vane non-clogging impeller.

.2 Provide an impeller capable of pumping solids as defined by the minimum size passing listed in the detailed specification sheets.

.3 Firmly affix the impeller directly to the motor shaft through a keyed and bolted connection. Design the connection to minimize solids capture.

**2.6 Pump Volute**

.1 Cast iron, Class 30, to ASTM A48.

.2 Single piece, non-concentric design.

.3 Fit a stainless steel wear ring to the volute inlet to provide efficient sealing between the volute and the impeller.

**2.7 Motor**

.1 Motor types, voltages, service conditions and power ratings are indicated in the detailed pump specification sheets.

.2 Motors and the associated shafts, bearings, and seals shall comply with the provisions of Section 11205 and Section 11207.

**2.8 Cables**

.1 Provide approved SOW type cables, with a 90°C rating and neoprene jackets.

.2 Seal the junction chamber, containing the junction board, from the motor with an O-ring seal.

.3 Connect the cable conductors and stator leads with threaded binding posts permanently mounted into the terminal insulation the board, and thus permanently leak-proof.

.4 Provide the cable entry body with a strain relief function (separate from the cable sealing function) which strain relief is to be applied from the outer side of the cable entry assembly.

**2.9 Accessories**

.1 Galvanized lifting chain, shackle and hook.

.2 Power cable.

.3 Galvanized steel double guide bar with upper guide bar holder.

**2.10 Finishes**

.1 Coat the pump exterior with an alkyd resin based primer and chlorinated rubber paint finish.

## 3. EXECUTION

**3.1 Manufacturer's Representative**

.1 Manufacturer's representative is to attend the Site to train installation personnel; to train operating personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

**3.2 Installation Training**

.1 Instruct the installer in the methods and precautions to be followed in the installation of the pump.

.2 The manufacturer's representative shall confirm the installer's understanding by completing Form 101, included in Section 01650.

**3.3 Installation**

.1 Ensure that the pump is installed and aligned in accordance with Section 11020, as required to provide satisfactory service.

.2 Cooperate with the installer to fulfill the requirements for a successful installation as documented by Form 102, included in Section 01650.

.3 Install control panel as directed by the Contract Administrator.

**3.4 Testing**

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

**3.5 Training**

.1 Allow for a minimum of 1 day of operation and maintenance training as outlined in Section 01664

**3.6 Commissioning**

.1 Attend during commissioning of the process system which includes the pump specified in this Section to ensure that the pump functions as intended in the process system.

**END OF SECTION**

**DETAILED PUMP SPECIFICATION**

**Description**: SBR WAS pump

**Tag Number:** C150-P; C250-P

**Design Conditions:**

| | |
|---|---|
| Liquid: | Mixed liquor |
| Liquid temperature: | 15°C - 36°C |
| Solids content: | < 1% |
| NPSHA: | 15 m |
| Atmospheric pressure: | 98.7 kPa |
| Minimum solids passing | 64 mm |

**Rating Point:**

| | |
|---|---|
| Rating Point Design Flow | 80.6 L/s (290 $m^3$/h) |
| Rating Point TDH | 11 m |

*Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.*

**Construction:**

| | |
|---|---|
| Discharge Connection: | 150 mm |
| Flange Rating: | Class 125 |
| Seals: | Tandem Mechanical |
| Impeller Type: | Single Vane |
| Impeller Material: | Cast Iron |
| Casing Material: | Cast Iron |

**Driver:**

| | |
|---|---|
| Drive Type: | Fixed Speed |
| Motor Type: | Submersible |
| Phases/Voltage/Frequency: | 600V/3-phase/60 Hz |
| Motor Size: | 23.9 kW |
| Maximum Motor Speed: | 1200 RPM |

**Accessories:**

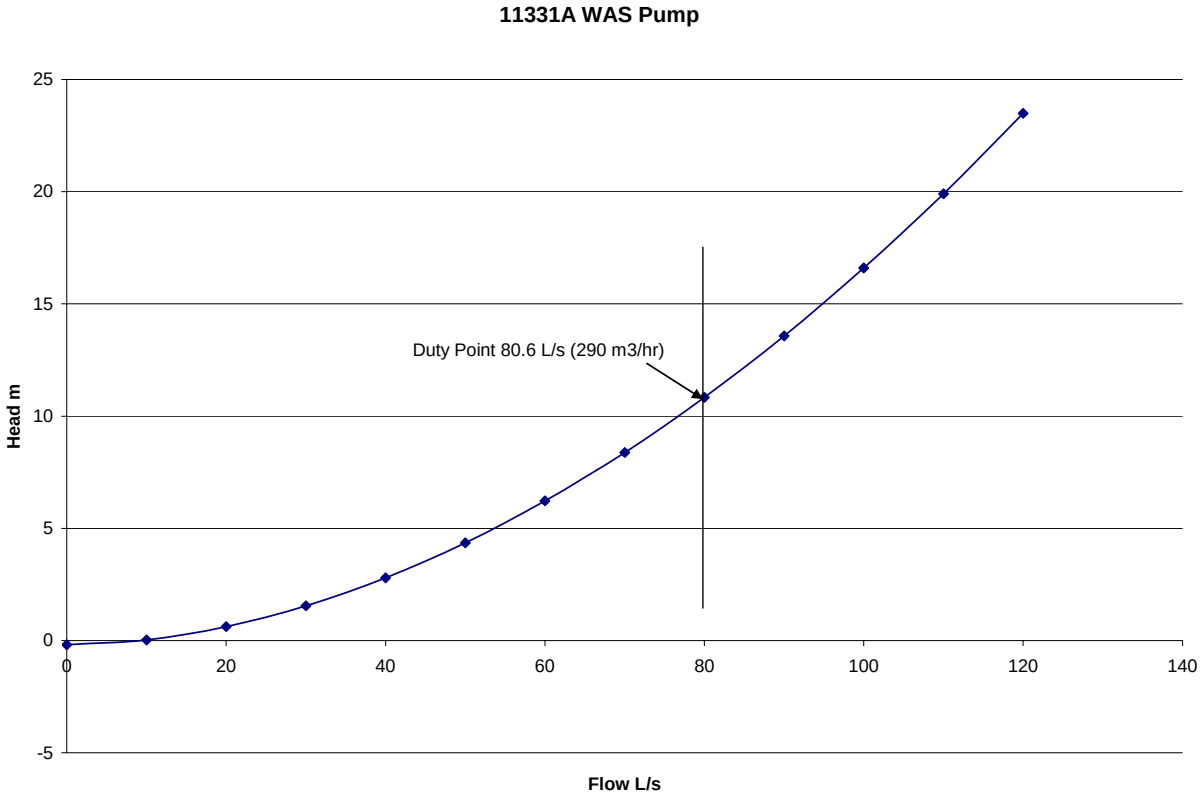
Slip on discharge flange
Guide rails and upper guide bar holder
Discharge elbow
15 m power/control cable
Lifting chain

**Acceptable Manufacturers:**

KSB (Design Standard), ABS, Flygt

**DETAILED PUMP SPECIFICATION**

**System Curve:**




**END OF SECTION**

**DETAILED PUMP SPECIFICATION**

**Description**: Equalization Basin pumps

**Tag Number:** C330-P; C340-P

**Design Conditions:**

| | |
|---|---|
| Liquid: | SBR Effluent |
| Liquid temperature: | 25°C - 36°C |
| Solids content: | < 1% |
| NPSHA: | 10 - 13 m |
| Atmospheric pressure: | 98.7 kPa |
| Minimum solids passing | 64 mm |

**Rating Point:**

| | |
|---|---|
| Rating Point Design Flow | 80.6 L/s (290 m3/h) |
| Rating Point TDH | 11 m (eq tank empty); 7.3 m (eq tank full) |

*Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.*

**Construction:**

| | |
|---|---|
| Discharge Connection: | 150 mm |
| Flange Rating: | Class 125 |
| Seals: | Tandem Mechanical |
| Impeller Type: | Single Vane |
| Impeller Material: | Cast Iron |
| Casing Material: | Cast Iron |

**Driver:**

| | |
|---|---|
| Drive Type: | Variable Speed |
| Motor Type: | Submersible |
| Phases/Voltage/Frequency: | 600V/3-phase/60 Hz |
| Motor Size: | 23.9 kW |
| Maximum Motor Speed: | 1200 rpm |

**Accessories:**

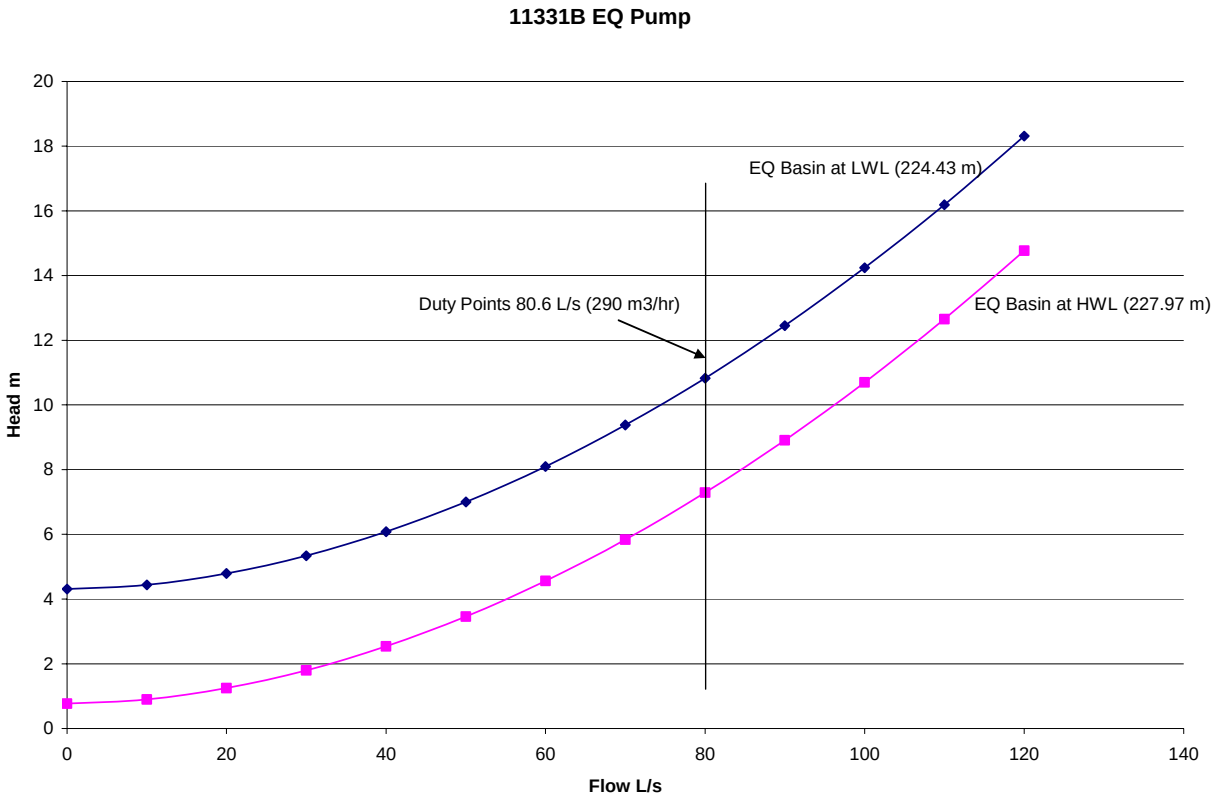
Slip on discharge flange
Guide rails and upper guide bar holder
Discharge elbow
15 m power/control cable
Lifting chain

**Acceptable Manufacturers:**

KSB (Design Standard), ABS, Flygt

**DETAILED PUMP SPECIFICATION**

**System Curve:**




**END OF SECTION**

**DETAILED PUMP SPECIFICATION**

**Description**: Mixed Liquor Pump

**Tag Number:** C140-P; C240-P

**Design Conditions (See Attached System Curves):**

| | |
|---|---|
| Liquid: | Mixed liquor |
| Liquid temperature: | 15°C to 36°C |
| Solids content: | < 1% |
| NPSHA: | 15 m |
| Atmospheric pressure: | 98.7 kPa |
| Minimum solids passing | 64 mm |

**Rating Point:**

| | |
|---|---|
| Rating Point Design Flow | 3.9 L/s |
| Rating Point TDH | 2.5 m |

*Each pump shall be capable of operating at the above mentioned design flow and total dynamic head defined by the system head curves.*

**Construction:**

| | |
|---|---|
| Discharge Connection: | 80 mm |
| Flange Rating: | Class 125 |
| Seals: | Tandem Mechanical |
| Impeller Type: | Single Vane |
| Impeller Material: | Cast Iron |
| Casing Material: | Cast Iron |

**Driver:**

| | |
|---|---|
| Drive Type: | Constant Speed |
| Motor Type: | Submersible |
| Phases/Voltage/Frequency: | 600V/3-phase/60 Hz |
| Motor Size: | 0.82 kW |
| Maximum Motor Speed: | 1200 RPM |

**Accessories:**

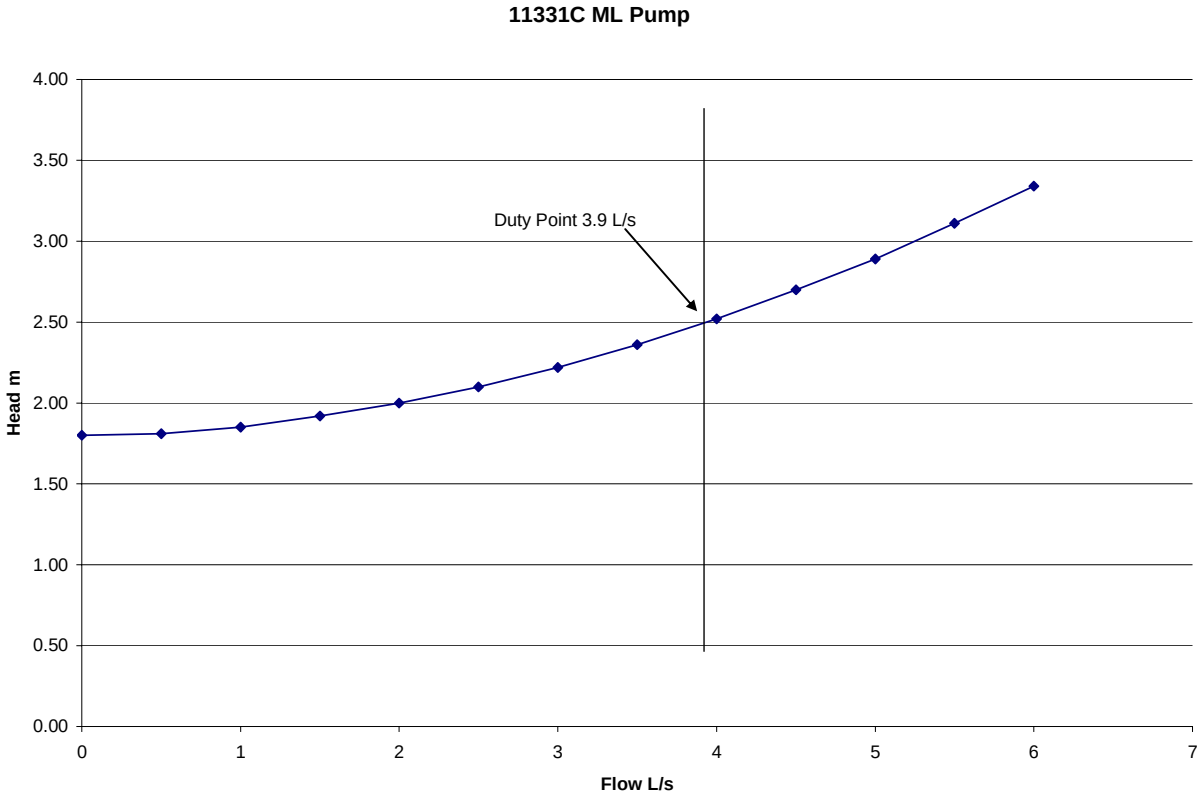
Slip on discharge flange
Guide rails and upper guide bar holder
Discharge elbow
15 m power/control cable
Lifting chain

**Acceptable Manufacturers:**

KSB (Design Standard), ABS, Flygt

**DETAILED PUMP SPECIFICATION**

**System Curve:**




**END OF SECTION**

# DIAPHRAGM METERING PUMPS, SKID-MOUNTED

## 1. GENERAL

### 1.1 Work Included

.1 Supply and installation, testing, and commissioning of a skid-mounted, pre-piped, pre-wired and pressure tested, complete and functional diaphragm pump systems for designated chemicals dosing application, as per the Drawings.

### 1.2 Submittals

.1 Submit Shop Drawings in accordance with Section 01300 and Section 11005.

.2 Operation and maintenance data: provide for incorporation in O&M Manual as specified in Section 01735. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogue with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

### 1.3 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work, including the following:

.1 Division 16, Electrical

.2 Division 17, Instrumentation and Controls

### 1.4 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, distortion or weathering of components.

.3 Identify all other special storage requirements.

## 2. PRODUCTS

### 2.1 Description

.1 Provide equipment capable of pumping methanol and ethanol from the top of the double-walled storage tanks.

.2 Each pumping system includes a diaphragm metering pump, pressure relief valve, pulsation damper, pressure indicator/transmitter, high pressure switch, low flow switch, backpressure valves, enclosure temperature indicator/transmitter, drip tray, level switch, and all associated piping and fittings, in accordance with the Drawings.

.3 The whole system shall take into account the atmospheric temperature, the specific gravity, viscosity, flammability, and temperature of the fluid being pumped.

.4 Each pump shall be dedicated to one of the storage tanks.

**2.2 Tag Numbers**

.1 C730-P

.2 C760-P

**2.3 Acceptable Manufacturers**

.1 Abel (as supplied by Power & Mine)

.2 Prominent (as supplied by Metcon)

**2.4 Capacities and Performance**

.1 Methanol liquid properties

.1 Specific gravity: 0.793 at 20°C

.2 Viscosity: 1.75 cp at -40°C; 0.59 cp at 20°C

.3 Boiling point: 64.5°C

.4 Freezing point: -97.5°C

.5 Flash point: 11°C

.6 Classification: Class 1B liquid

.7 Methanol is flammable and poisonous

.2 Ethanol liquid properties

.1 Specific gravity: 0.789

.2 Viscosity: 4.98 cp at -40°C; 1.2 cp at 20°C

.3 Boiling point: 78°C

.4 Freezing point: -144°C

.5 Flash point: 14°C

.6 Classification: Class 1B liquid

.7 Ethanol is flammable

.3 Fluid temperature: -40°C to 35°C

.4 Ambient environment temperature -40°C to 35°C

.5 Diaphragm Metering Pumps:

.1 Maximum capacity, each: 1500 L/hr.

.2 Maximum backpressure: 100 kPa (before backpressure valve).

.3 Maximum negative suction pressure: 35 kPa (methanol storage tank empty).

.4 Maximum differential pressure pump suction and discharge: 135 kPa

**2.5 Materials**

.1 Diaphragm: EPDM or PTFE cable of operation over the range of specified fluid temperatures.

.2 Pump casing: cast iron

.3 Fabricate pipes and valves of stainless steel 304

.4 Fabricate skid of epoxy coated carbon steel.

**2.6 Diaphragm Pumps**

.1 Provide diaphragm metering pump with hydraulic double diaphragm.

.2 Provide gearbox with manual speed adjustment for altering pump frequency.

.3 Include hydraulic relief valves to protect pumps against overpressure. Set valves according to manufacturer's recommendations. Fabricate of materials resistant to the specified fluid.

.4 Provide high pressure switches on the discharge of each pump.

.5 The pumps shall provide a constant flow rate for a particular stroke length and provide constant output flow over the full range of fluid levels in the storage tanks.

.6 The pumps shall have a pumping accuracy of ±5 percent.

.7 Construct the pump parts in contact with the fluid from materials suitable for the specified fluids.

.8 Provide pressure relief valve and backpressure regulating valve for each pump discharge, sized for the maximum pump flow with an adjustable pressure range. Valve material to be compatible with the fluids being pumped.

.9 Provide 1.5 kW (2 hp) explosion proof (EXP) motors in accordance with Section 11205 suitable for 600 VAC/ 60 Hz /3-phase power supply.

.10 Provide a platform-mounted support frame for the skid assembly. Fabricate support frame of epoxy coated carbon steel. Provide sufficient strength to allow the support frame to carry the full weight of all of the skid components when full of fluid.

.11 Enclose each skid in an epoxy coated carbon steel cabinet-type weather proof enclosure. Provide manually adjustable louvers to facilitate ventilation of the enclosure during the summer.

.12 Provide support frame and pedestals to support the enclosure. Bottom of enclosure to be 800 mm from walkway. Provide means to fix frame and pedestals to the elevated walkway located on the platform.

.13 Provide heat tracing on enclosure together with a thermostat, if required for protection of the equipment at low temperatures.

.14 All equipment and instrumentation shall rated for Zone 1.

## 2.7 Piping and Valves

.1 Provide stainless steel 304 piping and flange connections. All flanges shall be wire connected for electrical continuity.

.2 Provide all the valves of stainless steel.

## 2.8 Control Description

.1 The pump is started automatically by the Distributed Control System (DCS) at the start of the anoxic phase of the sequencing batch reactor operation. High loads of nitrate in the sequencing batch reactors will require almost continual operation of the pump during the anoxic phases; low loads of nitrate will require that the pump operates for short periods during the anoxic cycles. The operation of the pumps is controlled by the DCS.

## 2.9 Painting

.1 Shop prime and paint equipment in accordance with Section 11901.

## 2.10 Spare Parts and Maintenance Materials

.1 Provide the following spare parts:

.2 Two (2) pump diaphragms.

.3 One (1) set of ball check valves.

.4 One (1) set of ball check valve seats.

.5 One (1) set of gaskets and O-rings.

.6 One (1) backpressure valve diaphragm.

.7 One (1) pressure relief valve diaphragm.

.2 Provide a list of spare parts which would be expected to be required over a period of five years under normal conditions. At the Contract Administrator's request, provide a price for the listed parts.

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 To ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures, arrange for a technically qualified manufacturer's representative to witness the installation Work, certify correct installation, train operating and maintenance staff, and undertake system testing.

### 3.2 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installer's understanding by completing Form 101, included in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation by completing Form 102, included in Section 01650.

### 3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment by completing Form 103, included in Section 01650.

### 3.4 Commissioning

.1 Attend during commissioning of the process system which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

**END OF SECTION**

# SUBMERSIBLE HORIZONTAL PROPELLER MIXERS

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of horizontally mounted submersible propeller mixers and all associated appurtenances in two (2) sequencing batch reactors and the equalization basin.

### 1.2 Related Work

.1 Section 11331 - Submersible Pumps

### 1.3 Coordination

.1 All submersible pumps and submersible mixers shall be the product of a single manufacturer

### 1.4 Submittals

.1 Shop Drawings: submit in accordance with Sections 01300 and 11005, and include:

.1 Performance evaluation for the mixing units including characteristics of induced flow, calculations of energy gradient through the tank, and other pertinent details which illustrate the ability of the mixing system to maintain homogeneity or the desired level of turbulence within the process system.

.2 Motor operating data, including motor and insulation ratings, operating voltage and amperage tolerances, description of construction complete with illustrative drawings, and any other pertinent information.

.3 List of materials of construction, detailing the component parts of the mixer(s), their materials of construction, and reference specifications for those materials.

.4 Required ancillary equipment including but not limited to electrical and lifting appliances and anchor bolts. Provide the sizes, ratings, and any other information related to this equipment.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary equipment.

.6 Start-up instructions including lubricant requirements, electrical requirements.

.7 Provide supporting data (either hydraulic testing or computer modeling) to support the proposed mixing energy levels, and location/orientation of the mixers to meet the requirements set out in Clause 3.3.

.2 Operating and Maintenance Data: provide for incorporation in O&M Manual as specified in Section 01300. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connections and the part manufacturer's identifying numbers.

### 1.5 Shipment, Protection, and Storage

.1 Ship the equipment pre-assembled to the degree possible; identify any Site assembly requirements.

.2 Identify special storage requirements. Store on-site until ready for incorporation in the Work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

## 2. PRODUCTS

### 2.1 Description

.1 This Section covers medium speed, medium diameter propeller mixers.

.1 Medium speed, medium diameter propeller mixers rotate at between 200 RPM and 1200 RPM.

.2 Refer to the detailed specification sheets for specific mixer type

.2 Mixers are submersible, horizontally mounted, and include a motor and propeller in a close coupled configuration.

.3 Provide materials suitable for use in anoxic and anaerobic activated sludge.

.4 Provide mixers able to be raised and lowered and easily removable for inspection without the need for personnel to enter tank.

.5 Guide the entire weight of the mixer unit by a single bracket or double bracket, as specified in the data sheets, designed to handle all thrust created by the mixer.

.6 The mixer, appurtenances, and cable are to be capable of continuous underwater operation.

.7 Provide mixers and all appurtenances capable of withstanding corrosion in an environment containing an average chloride concentration of 550 mg/L

.8 Provide mixers and all appurtenances capable of operating in wastewater of temperature between 15°C and 36°C.

### 2.2 Design Standard

.1 ITT Flygt

**2.3 Acceptable Manufacturers**

.1 ABS

.2 KSB

**2.4 Capacities and Performance**

.1 Refer to the detailed specification sheets

**2.5 Propeller**

.1 Provide two- to four-blade, non-clogging propellers, with back curved leading edges that shed stringy material.

.2 Fabricate propeller of type 316 stainless steel.

.3 Secure propeller to the propeller shaft by polygon friction fitting and nut.

.4 Dynamically balance propeller.

**2.6 Propeller Shaft**

.1 Fabricate shafts of type 329 or 431 stainless steel conforming to ASTM A276.

.2 Provide shafts of sufficient size to limit whip or deflection.

.3 Design mixers such that shafts operate at less than 80 percent of their critical speed.

**2.7 Bearings**

.1 Support propeller shafts by two (2) permanently lubricated bearings. The outer bearing a double row angular contact ball bearing and the inner bearing a single row, cylindrical roller bearing or ball bearing.

.2 ABMA B10 bearing life: 100,000 hours.

**2.8 Motor**

.1 Provide submersible motors in compliance with Section 11205 and 11207.

.2 Motor types, voltages, service conditions and power ratings are indicated in the detailed mixer data sheets.

**2.9 Seals**

.1 Fit the propeller shaft with a mechanical seal and two lip seals where it exits the moisture protection oil reservoir.

.2 Provide single mechanical seals with type 316 stainless steel metal parts, Viton O-rings, and tungsten carbide faces.

.3 Provide lip seals made of Viton (inner) and nitrile rubber (outer).

**2.10 Accessories**

.1 Guide Brackets and Guidebars:

.1 Provide each unit with an integral sliding bracket and single or double guidebar, as specified in the data sheets.

.2 Configure single mast guidebar arrangements as hollow square sections; 100 x 100 mm square by 4.0 mm thick. Mast to pivot to provide adjustable angle of rotation.

.3 Configure double mast guidebar arrangement of two cylindrical sections; 114.3 mm diameter, 6.0 mm thick. Provide brackets to ensure angle of mixer installation from the horizontal will be the angle recommended by the supplier.

.4 Provide upper and lower mounting brackets for the guidebars and mast-mounted socket.

.5 All material and accessories to be stainless steel, as detailed in the data sheets.

.6 All stainless steel components must be pickled and passivated.

.2 Provide a power cable.

.3 Provide a stainless steel lifting cable, shackle and hook.

**2.11 Painting**

.1 Equipment, excluding stainless steel or aluminum components, shall be provided with protective coatings suitable for submerged or splash zone service conditions.

.2 Shop prime and paint metals in accordance with manufacturer’s written recommendations.

**2.12 Welding**

.1 All stainless steel welds for the guide rails shall be pickled and passivated.

**2.13 Spare Parts**

.1 For each mixer, provide one spare mechanical seal, one spare lip seal of each type, and one set of bearings.

.2 For each mixer type and size, provide a single propeller, and one propeller shaft and end fitting.

.3 Provide a list of spare parts which might be required during the initial five years of operation. Provide prices for each part.

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 The manufacturer's representative shall be required to attend the site to train installation personnel, train operating and maintenance staff, to witness installation and testing to ensure the equipment is installed and operated as intended.

### 3.2 Installation

.1 Verify satisfactory delivery of the equipment by completing Form 100, included in Section 01650.

.2 Ensure that each mixer is installed and aligned, as required to provide satisfactory service. Mixers to be installed sufficiently high above the floor to accommodate the fine bubble aeration system (top of diffuser at 300 mm above floor).

.3 Instruct the installer in the methods and precautions to be followed in the installation of the equipment. Certify the installer’s understanding by completing Form 101, included in Section 01650.

.4 Cooperate with the Contractor to fulfill the requirements for a successful installation as documented by Form 102, included in Section 01650.

.5 Conform to the requirements of Section 01664.

### 3.3 Equipment Performance Testing

.1 Ensure that each mixer, including all components parts, operates as intended.

.2 Demonstrate satisfaction of requirements specified herein.

.3 Cooperate with the Contractor to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

.4 Conduct testing to confirm satisfactory mixing. Conduct these tests using mixed liquor similar to that expected under normal operating conditions. Fill the tank with this liquid, ensuring the solids are close to the maximum concentration listed. Start and continue mixing for one half hour. At that time, withdraw samples from at least three points in the tank.

.5 Sample locations shall be confirmed with Contract Administrator.

.6 Analyze each sample to determine the suspended solids content. The test will be deemed successful if all suspended solids concentrations are within 10 percent of the average. Repeat the test at a concentration about 50 percent of the initial test. The same conditions apply.

.7 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 104, included in Section 01670.

## 3.4 Training

.1 Conform to the requirements of Section 01664.

**END OF SECTION**

# DETAILED MIXER SPECIFICATION

**Description:** Equalization Basin Mixers

**Tag Number:** C310-MXR, C320-MXR

**Propeller:**

| | |
|---|---|
| Type: | Medium speed, medium diameter |
| Number of blades: | Two or Three |
| Maximum propeller speed: | 860 RPM |

**Construction:**

| | |
|---|---|
| Blade material: | 316 stainless steel |
| Propeller housing: | 316 stainless steel |
| Stator housing: | 316 stainless steel |
| Shaft: | 329 stainless steel |

**Driver:**

| | |
|---|---|
| Drive Type: | Constant Speed |
| Motor Type: | Submersible, totally enclosed |
| Voltage/Phase/Frequency: | 600 V/3-phase/60 Hz |
| Motor Size: | 3 kW |
| Motor Speed: | 860 RPM |

**Testing:**

Test the mixing intensity to ensure agitation is sufficient.

**Accessories:**

Single mast, stainless steel guide bars complete with all mounting brackets.
12m lifting chain per mixer
15m power/control cable per mixer

**Acceptable Manufacturers:**

Flygt (Design Standard), ABS, KSB

**END OF SECTION**

## DETAILED MIXER SPECIFICATION

**Description:** SBR Mixers

**Tag Number:** C110-MXR, C120-MXR, C130-MXR, C210-MXR, C220-MXR, C230-MXR

**Propeller:**

| | |
|---|---|
| Type: | Medium speed, medium diameter |
| Number of blades: | Two or Three |
| Maximum propeller speed: | 580 RPM |

**Construction:**

| | |
|---|---|
| Blade material: | 316 stainless steel |
| Propeller housing: | 316 stainless steel |
| Stator housing: | 316 stainless steel |
| Shaft: | 329 stainless steel |

**Driver:**

| | |
|---|---|
| Drive Type: | Constant Speed |
| Motor Type: | Submersible, totally enclosed |
| Voltage/Phase/Frequency: | 600 V/3-phase/60 Hz |
| Motor Size: | 6.2 kW |
| Motor Speed: | 580 RPM |

**Testing:**

Test the mixing intensity to ensure agitation is sufficient.

**Accessories:**

Single mast, stainless steel guide bars complete with all mounting brackets.
12 m lifting chain per mixer
15 m power/control cable per mixer

**Acceptable Manufacturers:**

Flygt (Design Standard), ABS, KSB

**END OF SECTION**

**POSITIVE DISPLACEMENT BLOWERS**

## 1. GENERAL

### 1.1 Work Included

.1 Supply, installation, testing and commissioning of rotary lobe positive displacement blowers as shown on the Drawings and specified herein.

### 1.2 Submittals

.1 Shop Drawings: in addition to the information specified in Section 11005, submit the following:

.1 Descriptive literature for all ancillary items of equipment including the following:

.1 Blower data

.2 Manufacturer of all components supplied

.3 Capacity

.4 Discharge pressure

.5 Component weights

.6 Power in kW required at rated capacity and pressure considering all losses within the equipment package up to the point of discharge piping connection

.7 Rated maximum pressure rise of blowers

.8 Bearing life

.9 Motor data

.10 Gauges

.11 Intake filter

.12 Pressure relief valve

.13 Flex connectors

.14 Discharge check valve

.15 ASME PTC-9 performance tests

.2 Sound Power Levels: provide a list of predicted sound power levels outside the acoustic enclosure for the complete functional equipment package when operating at design operating capacity. Report the predicted sound power levels in a standard format conforming to the requirements of the Acoustical Engineering Institute.

.2 Operation and Maintenance Data: provide for incorporation in the O&M Manual as specified in Section 01730. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts, with section drawings, illustrating the connections and parts manufacturer's identifying numbers.

### 1.3 Coordination

.1 Coordinate with other Divisions to ensure that there is no conflict with the Work.

### 1.4 Shipment, Protection, and Storage

.1 Ship all equipment skid-mounted and pre-assembled, to the degree which is practicable.

.2 Provide complete storage instructions, in addition to those of Section 11005, indicating specific requirements necessary to prevent any weathering, corrosion, contamination, mechanical damage, freezing, or any other deterioration of components.

### 1.5 Quality Assurance

.1 All blowers and appurtenances furnished under this Section shall be supplied by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of the equipment to be furnished

.2 The equipment shall be designed, constructed, and installed in accordance with the best practices and methods, and shall operate satisfactorily when installed as shown on the Drawings. At the Contract Administrator's request, the vendor shall submit a reference list including at least five installations involving similar installations operating for five years or more.

.3 The vendor's organization shall be certified according to a recognized quality program such as ISO 9000 or similar.

## 2. PRODUCTS

### 2.1 Description

.1 All of the equipment specified herein is intended to be standard equipment for use in an aeration system and in pneumatic unloading system.

.2 Provide lobe type blowers with side-mounted suction and discharge connections.

.3 Equip each blower with an inlet filter, inlet and outlet silencers, discharge pressure gauge, check valve on the discharge piping, discharge butterfly valve, temperature indicators to measure suction and discharge temperature, and expansion joints for the inlet and outlet.

.4 Design the blowers for continuous service. Mount on a common baseplate with the electric motor drive.

.5 Specified design suction and discharge conditions are at the flanged connections. Include pressure loss consideration for the intake filter, discharge check valve and intermediate piping.

**2.2 Design Criteria**

.1 Number of process air blowers: 4

.2 Number of soda ash unloading blowers: 1

.3 Free field noise at 1 m: 80 dBa outside acoustic enclosure

.1 Overall noise level from assembled blower and silencers in acoustic enclosure not to exceed 80 dBa at 1 m from equipment. Noise level to be measured according to DIN45635 and supported by certified, published data from the manufacturer covering the entire machine package.

.4 Equipment size limitations will be as indicated on the Drawings

.1 Coordinate blower dimensions and weights with hoists as specified in Division 14.

**2.3 Acceptable Products**

.1 Aerzen (Design Standard)

.2 Kaeser

**2.4 Materials**

.1 Fabricate impellers of steel.

.2 Fabricate blower casings of heavy duty close grained ASTM A48 cast iron.

.3 Fabricate timing gears of hardened steel.

.4 Fabricate the blower base, motor pedestal, V-belt drive guard and gears of ASTM A36 steel or equivalent.

**2.5 Blower Casing**

.1 Blower casing shall be one-piece construction with separate sideplates that are bolted and pinned to the housing, and suitably ribbed to prevent distortion under the specified operating conditions.

.2 Casing shall incorporate a proven means of pulsation cancellation such that the noise measured at the outline of the blower package does not exceed 80 dBA

.1 Blowers that do not incorporate pulsation cancellation shall provide design and sizing calculations for discharge silencer to comply with this noise requirement for the entire range for the blower

.2 Discharge pulsation dampeners-silencers shall be covered by a five year unconditional warranty on structural failure.

.3 The vibration level measured at the blower casing, in the X/Y planes of the bearings, shall not exceed 0.5 inch per second RMS when operating at the specified maximum operating pressure and speed in the actual blower package.

## 2.6 Impellers

.1 Provide straight, three-lobe type impellers designed to operate without rubbing or liquid seals or lubrication. Machine impellers on all exterior surfaces for operation at close clearances.

.2 Design blower to operate below the following maximum rotating speeds:

.1 Less than or equal to 7.5 kW: 2700 rpm

.2 Greater than 7.5 kW and less than or equal to 37.5 kW: 1800 rpm

.3 Greater than 37.5 kW: 1600 rpm

.3 Each impeller shall be of rigid design with first lateral critical speed at least 120 percent of the maximum allowable operating speed.

.4 Shaft shall be drop forged in one single piece of ASTM 1043 or equivalent.

.5 Cast, hollow rotors shall be capped, dust tight. Open rotors are not acceptable.

.6 The impellers shall be statically and dynamically balanced per ISO1940/ANSI S2.19 G6.3.

.7 Each impeller/shaft shall be supported by cylindrical roller bearings, and fixed to control the axial location of the impeller/shaft in the unit. A double sealing arrangement shall be provided to prevent lubricant from contaminating the air stream but must not utilize any type of lip type seal.

## 2.7 Timing Gears

.1 Design gearbox to AGMA standards for heavy duty, continuous operation.

.2 Finish machine gears on all surfaces and attach to shafts in such a manner as to permit easy retiming of the unit.

.3 Enclose timing gears and gear end bearings in an oil-tight housing.

.4 Splash-oil lubricate the timing gears. Grease lubrication shall not be acceptable.

## 2.8 Bearings

.1 Provide grease- or oil-lubricated anti-friction bearings, designed to withstand all stresses for the service specified.

.2 Provide bearings with B-10 bearing life of 40,000 hours.

.1 Notwithstanding the theoretical bearing life calculations, the bearings shall be sized for a minimum of five years of continuous duty between overhauls.

.3 Design so that inspection or replacement of bearings is possible without disconnecting piping or disassembling the blower.

.4 Design bearing housings to effect a complete separation between the bearings and casing to isolate bearings from heat generated by the blower.

**2.9 Motor**

.1 Provide a TEFC electric motor complying with Section 11205 or Section 11206 (as applicable), except as noted below.

.2 Frame size shall be suitable for overhung belt drive.

.3 Electrical

.1 Provide inverter-rated motor suitable for variable frequency drive speed control.

.2 Motor shall be suitable for continuous duty in ambient temperatures ranging from -30°C to +45°C at the rated service factor.

.3 Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor.

.4 All motors for use with variable frequency drives shall use copper stator windings with minimum double coated Class H Amid-Imid type 200°C varnish insulation. Full phase insulation is to be utilized on all motors. Motor leads shall be stranded copper and be permanently identified.

.5 Motors shall be capable of performing with inertia loading as follows:

.1 TEFC: +200 percent of values in MG1-12.50 Table 12.3

.2 ODP: +150 percent of values in MG1-12.50 Table 12.3

.6 Motor lamination must be of C5 type, C3 is not acceptable.

.7 Provide RTDs (1 per phase) for all blower motors (process air blowers and soda ash unloading blower)

.4 Mechanical

.1 Bearings shall be either ball bearings or cylindrical roller bearings, drive end and opposite drive end.

.2 Bearings shall be selected to provide an L-10 rated life of 40,000 hours per AFBMA standard V-belt drive applications with external load factors per NEMA MG1-14.42 and 100,000 hours L-10 rated life in direct-coupled applications.

.3 Bearings will have a maximum of 45°C rise at rated power for 4-pole and 6-pole motors and a maximum of 50°C rise for 2-pole motors.

.4 All motors 280 frame and larger are to be regreasable while in operation. Regreasable bearings to be complete with cast iron inner bearing cap. Smaller frame motors are to be supplied with sealed bearings.

.5 Frame and end brackets shall be a minimum of grade 25 cast iron construction.

.6 External cooling fans shall be of non-sparking corrosion-resistant material such as fiberglass reinforced Nylon 66 on all ratings including 2-pole.

.7 Shaft slingers are required on all TEFC motors to minimize entrance of moisture and contaminants into the bearing chamber.

.8 The terminal box volume will be one size larger than NEMA requirements and shall be rotatable in 90 degree increments. Gaskets shall be provided between the T-box and frame and the T-box base and cover. Terminal boxes can be supplied as either pressed steel or optional cast iron

.9 Two breather holes shall be provided at the lowest points in the motor frame.

.10 Lifting bolts, with safety factor of 10, shall be provided on 180T frames and larger.

.11 All hardware shall be zinc-dichromate plated.

.12 The motor nameplate shall be engraved or stamped on 304 stainless steel and fastened to the motor frame with 4 stainless steel drive pins.

.13 The motor (2-, 4-, 6-, and 8-pole) will be dynamically balanced to a maximum of 0.5 mils peak to peak maximum displacement at the bearing housing. Balance washers shall be permanently fixed stainless steel.

.14 Motors shall be capable of all position mounting and operation including vertical foot mount belt drive applications.

.15 All motors shall be required to have sound pressure levels at 1 m of less than 85 dbA (IEEE 85).

.16 All motors shall have their exterior prepared with a rust prohibiting primer with an environmentally responsible waterborne acrylic enamel paint top coat on all exposed surfaces. The paint to be suitable to withstand harsh environmental conditions.

.17 Motors shall be individually boxed or crated in sufficient manner to protect product during shipment and storage. Packaging shall allow stacking of motors.

.5 Acceptable Product

.1 Toshiba EQPIII for motors greater than 150 kW

.2 Toshiba EPCAT for motors less than 150 kW

## 2.10 Belts

.1 Connect the positive displacement blower to the drive through V-belt and sheaves.

.2 Provide high-capacity type, oil- and heat-resistant, and static-dissipating V-belts.

.3 Design the drive for a minimum service factor of 1.4 times operating brake kilowatt (BkW) power, or 1.1 times the motor nameplate kW, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower BkW.

.4 Sheaves shall be dynamically balanced for linear tip speeds greater than 2000 m/min.

## 2.11 Drive Guard

.1 Provide OSHA-compliant belt guards for each belt drive.

.2 Fabricate the V-belt drive guard of steel no thinner than 1.5 mm.

## 2.12 Drive Shaft

.1 Fabricate drive shafts from hot rolled steel bar, ground and polished, of sufficient diameter to prevent deflection or whip at design operating speed.

.2 Size the shafts so that the rotating assembly operates a minimum of 20 percent below the first critical speed.

.3 Where the blower shafts pass through the impeller casing, provide suitable seals to minimize air leakage and maintain operating efficiency.

.4 Extend the shaft to permit connection to a V-belt drive.

## 2.13 Mounting

.1 Factory mount the blower and motor unit together with all accessories and appurtenances, including V-belt drive, inlet filter, inlet silencer, discharge silencer, pressure relief valve, check valve, vibration isolation, inlet and discharge flexible connections/expansion joints, and instrumentation, on a single heavy full-length steel frame, properly cross braced to form a rigid support for the entire unit. Design the frame to have a safety factor of 2.0 for all dead and live loads. The only connections required by the contractor shall be discharge piping to the blower assembly and the electric power to the motor.

.2 Provide vibration isolation between the blower and base plate and the floor to prevent noise and vibration transmission to the floor or piping.

## 2.14 Accessories

.1 Sound Enclosure

.1 Each blower shall be supplied with a sound enclosure covering the entire blower package including the drive motor. Design the sound enclosure for easy inspection and maintenance of all blower package components. Panels shall be made of galvanized steel sheet, internally and externally coated.

.2 Mount the enclosure and the blower package on a skid/oil-drip pan designed for meeting environment protection standards and for easy transportation and installation. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts.

.3 Provide a cooling fan for sufficient heat removal from the sound enclosure.

.4 Electrical components, instrumentation, and instrument connections shall not interfere with moveable panels of the sound enclosure.

.2 Pressure Relief Valve

.1 Supply one (1) adjustable spring loaded or weighted pressure relief valve for each blower, set to open at a pressure suitable to prevent overloading of the blower and driver.

.2 Mount the pressure relief valve on the discharge side of the blower mounted after the discharge silencer and before the check valve.

.3 Select a relief valve capable of passing 100 percent of the design flow to prevent overload on blower and driver.

.4 The pressure relief valve shall also be housed by the sound enclosure and shall relieve into a segmented section of the sound enclosure

.3 Expansion Joints

.1 Each blower package shall have a flexible connector located at the inlet and the discharge of the package.

.2 The flexible connectors shall be sized for a standard, schedule 40 pipe diameter and shall prevent the transmission of noise and vibrations from the blower package into the piping.

.3 Configure the flexible section as a single convolution able to withstand longitudinal and radial stresses developed during the blower operation.

.4 Select the material of the flexible section of the expansion joint to withstand continuous duty operation at 80 kPa(g) pressure and 150°C temperature.

.5 Furnish retaining rings and control rods with each expansion joint to allow maximum concurrent longitudinal movements, hoop stress, and flange sealing.

.6 Provide expansion joints with flat-faced flanged end connections to ANSI Class 125 standard.

.4 Inlet Filter

.1 Provide cleanable and replaceable dry type line size, inline air filters suitable for 120 percent of the design volume, and capable of retaining at least 98 percent of particles 10 microns or larger.

.2 Inlet filter shall be suitable for indoor installation.

.3 Filter element shall be washable by maintenance personnel.

.4 Filter performance losses shall be included by the blower vendor in the blower performance calculation.

.5 Inlet Silencer

.1 Provide each blower with a combination chamber and absorptive design inlet silencer.

.2 Silencer performance losses shall be included by the blower vendor in the blower performance calculation.

.6 Discharge Silencer

.1 Each blower shall be supplied with one combination base frame discharge silencer. The silencer shall be a chamber type design for maximum sound attenuation and shall not use fibrous materials or any absorption materials or internal diffusers.

.2 The silencer shall feature a single shell of pressure vessel quality steel with continuous welds. The silencer must be subject to a pressure test for tightness and strength at a minimum of 1.65 times the pressure setting of the pressure safety valve.

.3 The temperature rating shall be 150ºC.

.4 The design of the silencer must accommodate being bolted directly to the blower discharge flange with no intermediate pieces as well as to assure that there will be no pipe beating noise or pipe harmonics whether one blower or multiple blowers are running.

.5 The discharge silencer shall be designed to reduce the noise emitted by the piping leaving the blower package to 85 dB(A), over the entire range of operation, based on a carbon steel, schedule 40 piping of a diameter equal to the blower package nominal connection size. A grounding lug fully welded to the base shall be supplied by the blower manufacturer.

.6 Discharge silencer performance losses shall be included by the blower vendor in the blower performance calculation.

.7 Gauges

.1 Provide gauges on the discharge piping of each blower.

.2 Provide glycerin filled type with 60 mm dial, 6.35 mm bottom connection, stainless steel movement Bourdon tube gauges.

.3 For the discharge gauge select a range of 0 to 150 kPa. For the suction gauge select a range 600 mm water column vacuum to 600 mm water column positive pressure. Indicate the units of measurement on the face of the gauge.

.4 Provide a differential pressure indicator transmitter for the inlet filter.

.8 Check Valve:

.1 Each blower shall be supplied with one check valve installed on the discharge line.

.2 The check valve shall be of the full bore low pressure drop, flapper type design with a cast aluminum body, valve plates of aluminum bronze or other corrosion-resistant material and an EPDM flat full-contact seal.

.3 The valve shall be removable without disturbing the piping.

.4 Check valve performance losses shall be included by the blower vendor in the blower performance calculation and shall be factory assembled.

.9 Temperature Indicators:

.1 For the inlet, discharge, and enclosure:

.1 Provide Type 304 stainless steel, bimetallic element temperature indicators dampened with silicone for vibration reduction, external recalibrator, adjustable angle viewing face, 125 mm diameter, stainless steel thermowell.

.2 Provide -50°C to 50°C range on inlet, 0°C to 150°C range on discharge.

.10 Switches

.1 Inlet vacuum switch with brass thermowell, NEMA 4X

.2 Discharge pressure switch with brass thermowell, NEMA 4X

.3 Blower vibration switch and mounting hardware for blowers with motors greater than 150 kW

.4 Motor vibration switch and mounting hardware for motors greater than 150 kW

### 2.15 Acoustic Air Intake Box

.1 Provide galvanized steel acoustic air intake box for each blower. Box shall be externally mounted on blower building wall. Box shall be Aerzen Model CMPER and shall include duct transition, aluminum louvres, and acoustic foam. Box finish shall match the building cladding.

### 2.16 Finishes

.1 Shop prime and paint in accordance with Section 11901.

### 2.17 Spare Parts

.1 Provide the following spare parts for each size and type of blower

.1 One (1) set of belts for each blower

.2 One (1) set of filter elements for each air inlet filter for each blower

.3 One (1) set of tools required for changing oil and performing belt maintenance shall be provided for each blower.

.2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years. At the Contract Administrator's request, provide a price for these parts.

.3 Spare parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures.

### 3.2 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Inform the installer of all procedures and requirements necessary for the successful installation of the equipment. Attest to the installer's understanding by completing Form 101 as shown in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

## 3.3 Factory Testing

.1 Each blower shall be factory tested per ASME PTC-9 Performance test to verify flow, BkW, and slip at design conditions as well as blower maximum conditions. Slip test only shall not be acceptable. The acceptance criteria are ±5 percent tolerance on power and on flow regardless of the size of the machine.

## 3.4 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Measure the blower output flow at 75 percent, 100 percent, and 120 percent of the rated pressure. At the same time, measure power draw and air temperature. Record and report results.

.3 If the blower is incapable of providing the rated flow or if the power draw is more than 5 percent greater than the predicted value, reject the blower.

.4 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

## 3.5 Commissioning

.1 Attend during commissioning of the process system which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process system.

**END OF SECTION**

**DETAILED SPECIFICATION SHEET**

**Description**: SBR Process Air Blowers

**Tag Number:** C-410-AB, C420-AB, C430-AB, C440-AB

**Design Conditions:**

| | |
|---|---|
| Type | Positive Displacement Rotary Lobe |
| Air flow rate (each blower) | 127 Nm3/min (Note 1) |
| Backpressure | 67.2 kPa (Note 1) |
| Maximum Blower Speed | 1600 RPM |
| Site Elevation | 230 m |
| Inlet Temperature (minimum/maximum) | -35°C / 35°C |
| Relative Humidity (at maximum temperature/minimum temperature) | 55% / 100% |

**Construction:**

| | |
|---|---|
| Discharge Connection: | 300 mm |
| Flange Rating: | Class 125 |
| Impeller Type: | Three Lobe |
| Impeller Material: | Steel (ASTM 1043) |
| Casing Material: | Cast Iron (ASTM A48) |
| Timing Gears: | Steel |

**Driver:**

| | |
|---|---|
| Drive Type: | Variable Speed, V-Belt |
| Motor Type: | TEFC |
| Voltage/Phase/Frequency: | 600/3/60 |
| Motor Size: | 186 kW |
| Maximum Motor Speed: | 1800 RPM |

**Accessories:**

Acoustic air intake box
Acoustic enclosure
Expansion joints
Inlet filter
Suction and discharge silencers
Filter pressure differential indicator/transmitter
Suction low pressure switch
Blower vibration switch
Discharge temperature gauge
Discharge high temperature switch
Discharge pressure gauge
Discharge high pressure switch
Pressure relief valve
Expansion joints and Check valve
Motor RTD (1 per motor winding)
Motor inner and outer bearing temperature sensors
Motor vibration switch
Variable frequency drive

**DETAILED SPECIFICATION SHEET**

**Acceptable Manufacturers:**

Aerzen
Kaeser

**Notes:**

1. Each blower shall also be capable of an air flow of 115 Nm3/min at a backpressure of 73.5 kPa.

**END OF SECTION**

**DETAILED SPECIFICATION SHEET**

**Description**: Soda Ash Unloading Blower

**Tag Number:** C450-AB

**Design Conditions:**

| | |
|---|---|
| Type | Positive Displacement Rotary Lobe |
| Air flow rate (Capacity) | 17 $Nm^3/min$ (Note 1) |
| Backpressure | 83 kPa (Note1) |
| Maximum Blower Speed | 3600 RPM |
| Site Elevation | 230 m |
| Inlet Temperature (minimum/maximum) | -35°C / 35°C |
| Relative Humidity (at maximum temperature/minimum temperature) | 55% / 100% |

**Construction:**

| | |
|---|---|
| Discharge Connection: | 125 mm |
| Flange Rating: | Class 125 |
| Impeller Type: | Three Lobe |
| Impeller Material: | Steel (ASTM 1043) |
| Casing Material: | Cast Iron (ASTM A48) |
| Timing Gears: | Steel |

**Driver:**

| | |
|---|---|
| Drive Type: | Fixed Speed, V-Belt |
| Motor Type: | TEFC |
| Voltage/Phase/Frequency: | 600/3/60 |
| Motor Size: | 37 kW |
| Maximum Motor Speed: | 1800 RPM |

**Accessories:**

Acoustic air intake box, Acoustic enclosure
Suction temperature indicator/transmitter
Inlet filter
Suction and discharge silencers, Suction low pressure switch
Filter pressure differential indicator/transmitter
Discharge temperature gauge, Discharge high temperature switch
Discharge pressure gauge, Discharge high pressure switch
Pressure relief valve
Expansion joints
Check valve
Motor RTD (1 per motor winding)

**Acceptable Manufacturers:**

Aerzen (Design Standard)
Kaeser

**Notes:**

1. Exact flow and pressure responsibility of supplier of soda ash system.

**END OF SECTION**

# INSTALLATION OF AERATION EQUIPMENT

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies the installation, testing, and commissioning of the fine bubble aeration equipment for the sequencing batch reactors.

.2 The aeration equipment will be supplied by the City via a separate Contract - Contract No. 196-2006 for the Supply and Delivery of Aeration Equipment for the North End Water Pollution Control Centre Centrate Nitrogen Removal Facility.

.3 The Aeration Equipment Supply Contract includes the following:

.1 Fabrication and factory testing of the aeration equipment;

.2 Supply of aeration equipment including diffusers and related equipment;

.3 Delivery of aeration equipment to the NEWPCC;

.4 Inspection of delivered aeration equipment;

.5 Installation training for the aeration equipment;

.6 Installation witnessing of the aeration equipment;

.7 Testing assistance of the installed aeration equipment;

.8 Operations and maintenance training for the aeration equipment;

.9 O&M Manuals for the aeration equipment;

.10 As-Constructed Drawings for the aeration equipment;

.11 Technical support and remedying defects in the aeration equipment during the warranty period for the Aeration Equipment Supply Contract.

.4 Responsibilities of the Contractor include, but are not limited to:

.1 Receipt of the aeration equipment upon delivery;

.2 Off-loading and storage of the aeration equipment;

.3 Installation of the aeration equipment;

.4 Equipment testing;

.5 Coordinate installation training for the aeration equipment;

.6 Install all equipment and materials provided under the Aeration Equipment Supply Contract;

.7 Conduct equipment testing and commissioning of the aeration equipment;

.8 Coordinate operation and maintenance training for the aeration equipment.

**1.2 Coordination**

.1 Coordinate with other Divisions to ensure that there is no conflict with the Work.

**2. EXECUTION**

**2.1 Manufacturer's Representative**

.1 The Supply Contractor will provide a technically qualified manufacturer's representative. Arrange for the manufacturer's representative to:

.1 Attend and certify equipment delivery;

.2 Attend and certify installation training;

.3 Attend and certify equipment installation;

.4 Attend and certify equipment performance testing;

.5 Provide operation and maintenance training.

**2.2 Delivery, Protection, and Storage**

.1 The aeration equipment will be delivered by the Supply Contractor to the NEWPCC. Off-load the aeration equipment, take custody and store the equipment. Execute Form 100, Certificate of Equipment Delivery, in the Aeration Equipment Supply Contract (copy appended to this Section for information).

.2 Store the equipment in accordance with the requirements specified by the Supply Contractor.

**2.3 Installation**

.1 Receive installation training from the Supply Contractor. Execute Form 101, Certificate of Equipment Installation Instruction, in the Aeration Equipment Supply Contract (copy appended to this Section for information).

.2 Follow the written installation instructions and drawings provided by the Supply Contractor

.3 The aeration equipment shall be installed prior to the completion of the building, specifically prior to installation of the pre-cast double tees.

.4 Ensure the equipment is installed as required to provide satisfactory service.

.5 Cooperate with the Supply Contractor to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

## 2.4 Commissioning

.1 The Contractor is responsible for Commissioning of the process systems which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process systems.

## 2.5 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 For the aeration equipment testing requirements, refer to instructions provided by the Supply Contractor and to the requirements outlined in the Aeration Equipment Supply Contract.

.3 Cooperate with the Supply Contractor to fulfill the requirements for successful testing of the equipment. Execute Form 105, Certificate of Satisfactory Equipment Testing (copy appended to this Section for information).

## 2.6 Training

.1 Arrange and coordinate the operation and maintenance training included in the scope of services specified in the Aeration Equipment Supply Contract.

## CERTIFICATE OF EQUIPMENT DELIVERY
## FORM 100

We certify that the equipment listed below has been delivered into the care of the Installation Contractor. The equipment has been found to be in satisfactory condition. No defects in the equipment were found.

**PROJECT:** _____

**ITEM OF EQUIPMENT:** SBR Aeration Equipment

_____

**TAG NO:** _____

**REFERENCE SPECIFICATION:** _____

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

## CERTIFICATE OF EQUIPMENT INSTALLATION INSTRUCTION FORM 101

I have familiarized the Installation Contractor of the specific installation requirements related to the equipment listed below and am satisfied that he understands the required procedures.

**PROJECT:** _____

**ITEM OF EQUIPMENT:** SBR Aeration Equipment

_____

**TAG NO:** _____

**REFERENCE SPECIFICATION:** _____

_____ _____

(Authorized Signing Representative of the Contractor) Date

I certify that I have received satisfactory installation instructions from the equipment supplier.

_____ _____

(Authorized Signing Representative of the Installation Contractor) Date

## CERTIFICATE OF SATISFACTORY EQUIPMENT TESTING
## FORM 105

We certify that the equipment listed below has been tested and meets the Equipment Testing Requirements as set out in the Contract.

**PROJECT:** _____

**ITEM OF EQUIPMENT:** SBR Aeration Equipment

_____

**TAG NO:** _____

**REFERENCE SPECIFICATION:** _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

**END OF SECTION**

# INSTALLATION OF DECANTERS

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies the installation, testing, and commissioning of the decanters for the sequencing batch reactors.

.2 The decanters will be supplied by the City via a separate Contract - Contract No. 31-2006 for the Supply and Delivery of Decanters for the North End Water Pollution Control Centre Centrate Nitrogen Removal Facility.

.3 The Decanter Supply Contract includes the following:

.1 Fabrication and factory testing of the decanters;

.2 Supply of decanters including variable frequency drives and related equipment;

.3 Delivery of decanters to the NEWPCC;

.4 Inspection of delivered decanters;

.5 Installation training for the decanters;

.6 Installation witnessing of the decanters;

.7 Testing assistance of the installed decanters;

.8 Operations and maintenance training for the descanters;

.9 O&M Manuals for the decanters;

.10 As-Constructed Drawings for the decanters;

.11 Technical support and remedying defects in the decanters during the warranty period for the Decanter Supply Contract.

.4 Responsibilities of the Contractor include, but are not limited to:

.1 Receipt of the decanters upon delivery;

.2 Off-loading and storage of the decanters;

.3 Installation of the decanters;

.4 Installation of the variable frequency drives;

.5 Equipment testing;

.6 Supply and install all power supply wiring and final connections between the decanter motors and the variable frequency drives and from the decanter drives to the MCC.

.7 Supply and install data control wiring from the field-mounted switches and sensors to the drives, and from the drives to the DCS.

.8 Supply and install 600 mm diameter piping between decanters and equalization tank.

.9 Coordinate installation training for the decanters;

.10 Install all equipment and materials provided under the Decanter Supply Contract;

.11 Conduct equipment testing and commissioning of the decanters;

.12 Coordinate operation and maintenance training for the decanters.

.5 The City will be responsible for software configuration of the interface between the decanters and the Bailey Distributed Control System (DCS).

.6 Preliminary drawings of the decanter system are available for review at the offices of the Contract Administrator.

**1.2 Coordination**

.1 Coordinate with other Divisions to ensure that there is no conflict with the Work.

**2. EXECUTION**

**2.1 Manufacturer's Representative**

.1 The Supply Contractor will provide a technically qualified manufacturer's representative. Arrange for the manufacturer's representative to:

.1 Attend and certify equipment delivery;

.2 Attend and certify installation training;

.3 Attend and certify equipment installation;

.4 Attend and certify equipment performance testing;

.5 Provide operation and maintenance training.

**2.2 Delivery, Protection, and Storage**

.1 The decanters will be delivered by the Supply Contractor to the NEWPCC. Off-load the decanters, take custody and store the equipment. Execute Form 100, Certificate of Equipment Delivery, in the Decanter Supply Contract (copy appended to this Section for information).

.2 .Store the equipment in accordance with the requirements specified by the Supply Contractor.

## 2.3 Installation

.1 Receive installation training from the Supply Contractor. Execute Form 101, Certificate of Equipment Installation Instruction, in the Decanter Supply Contract (copy appended to this Section for information).

.2 Follow the written installation instructions and drawings provided by the Supply Contractor.

.3 The decanters shall be installed prior to the completion of the building, specifically prior to installation of the pre-cast double tees.

.4 Provide the Contract Administrator with a lifting strategy, which shall include details of the crane weight, the crane location and the craning operation.

.5 Ensure the equipment is installed as required to provide satisfactory service.

.6 Cooperate with the Supply Contractor to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

## 2.4 Commissioning

.1 The Contractor is responsible for Commissioning of the process systems which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process systems.

## 2.5 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 For the decanter equipment system testing requirements, refer to instructions provided by the Supply Contractor and to the requirements outlined in the Decanter Supply Contract.

.3 Cooperate with the Supply Contractor to fulfill the requirements for successful testing of the equipment. Execute Form 105, Certificate of Satisfactory Equipment Testing (copy appended to this Section for information).

## 2.6 Training

.1 Arrange and coordinate the operation and maintenance training included in the scope of services specified in the Decanter Supply Contract.

## CERTIFICATE OF EQUIPMENT DELIVERY
## FORM 100

We certify that the equipment listed below has been delivered into the care of the Installation Contractor. The equipment has been found to be in satisfactory condition. No defects in the equipment were found.

**PROJECT:** _____

**ITEM OF EQUIPMENT:** SBR Decanters

_____

**TAG NO:** _____

**REFERENCE SPECIFICATION:** _____

_____ _____

(Authorized Signing Representative of the Installation Contractor) Date

_____ _____

(Authorized Signing Representative of the Contract Administrator) Date

## CERTIFICATE OF EQUIPMENT INSTALLATION INSTRUCTION
## FORM 101

I have familiarized the Installation Contractor of the specific installation requirements related to the equipment listed below and am satisfied that he understands the required procedures.

**PROJECT:** _____

**ITEM OF EQUIPMENT:** SBR Decanters

_____

**TAG NO:** _____

**REFERENCE SPECIFICATION:** _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

I certify that I have received satisfactory installation instructions from the equipment supplier.

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

## CERTIFICATE OF SATISFACTORY EQUIPMENT TESTING
## FORM 105

We certify that the equipment listed below has been tested and meets the Equipment Testing Requirements as set out in the Contract.

**PROJECT:** _____

**ITEM OF EQUIPMENT:** SBR Decanters

_____

**TAG NO:** _____

**REFERENCE SPECIFICATION:** _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Installation Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

**END OF SECTION**

# SODA ASH SYSTEM

## 1. GENERAL

### 1.1 Work Included

.1 Supply and installation, testing and commissioning of a complete soda ash unloading, storage, make-up, and feed system including all labour, materials, tools and equipment.

### 1.2 Submittals

.1 Submit Shop Drawings, including all equipment and components, in accordance with Section 01300 and Section 11005. Include:

.1 Brochures and catalogue cuts.

.2 Basis of sizing solution tank.

.3 Performance characteristics of the volumetric screw feeder and screw conveyor.

.4 Detailed layout drawings showing the relationship between the soda ash system and other interfacing equipment.

.5 Statement from the system supplier that the shop primer has been coordinated for complete compatibility with Section 11900.

.6 Process control description including explanation on how to ensure that the required solution strength is not exceeded.

.7 Provide wiring diagrams, loop diagrams, and control philosophy for local control stations.

.8 Provide control logic and algorithms for use by the City to program the Bailey Distributed Control System.

.2 Operation and maintenance data: provide for incorporation in O&M Manual as specified in Section 01735. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogue with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

### 1.3 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

### 1.4 Shipment, Protection, and Storage

.1 Ship all equipment pre-assembled, to the degree which is practicable.

.2 Provide complete storage instructions, in addition to those of Section 11005, indicating specific requirements necessary to prevent any weathering, corrosion, contamination, mechanical damage, freezing, or any other deterioration of components.

## 2. PRODUCTS

### 2.1 Description

.1 Equipment to be capable of unloading dry bulk soda ash from a delivery truck, making various concentrations of soda ash solution, and dosing solution to the two sequencing batch reactors.

### 2.2 Acceptable Manufacturers

.1 Metcon (Design Standard)

.2 Stranco

.3 Chemco

### 2.3 Truck Unloading System

.1 Blower

.1 Provide one (1) pre-assembled rotary positive displacement blower package including acoustic air intake box, acoustic enclosure, suction temperature indicator/transmitter, expansion joints, inlet filter, suction and discharge silencers, filter pressure differential indicator/transmitter, suction low pressure switch, discharge temperature gauge, discharge high temperature switch, discharge pressure gauge, discharge high pressure switch, pressure relief valve, expansion joints, check valve, motor, PTC (1 per motor winding, and other monitoring devices. Blower shall be in accordance with Section 11455 and by the same manufacturer as the process air blowers.

.2 The noise level of the blower package shall not be greater than 80 decibels at 1 m from the blower.

.3 The blower package is to be installed in the exhaust fan building.

.4 Provide starter with blower. Starter to be rated at 600 V full voltage non-reversing and installed in a CSA 2 enclosure. Refer to Electrical Specification 16810.

.5 Design Criteria

.1 Number of units: 1

.2 Tag Number: C450-AB

.3 Minimum capacity: 17 $Nm^3$/min, discharge pressure 83 kPa. Exact blower capacity and pressure requirements is the responsibility of the supplier of the soda ash system.

.6 Provide grounding for soda ash unloading system.

.2 Conveying pipe, loading nozzle, and enclosure

.1 The soda ash conveying pipe assembly shall include 100 mm diameter steel pipe with couplers, 1.2 m long-radius elbows with supports off the silo. The length of pipe and the number of supports, couplings, and elbows shall be provided as required for a complete and operational system.

.2 Provide silo loading nozzle.

.3 The inlet end of the truck receiving pipe shall have malleable or cast iron male adapter and lockable dust cap.

.3 Truck Unloading Panel

.1 Provide a NEMA 4 externally mounted control panel with the following, as a minimum:

.1 Start unloading hand switch

.2 Stop unloading hand switch

.3 System ready light (Green when ready)

.4 Dust filter blower status light (Red when running)

.5 Dust filter shaker status light (Red when running)

.6 Unloading blower status light (Red when running)

.7 Soda ash alarm light (Amber when in alarm condition)

.8 System alarm horn

.9 Horn silence pushbutton

## 2.4 Soda Ash Silo

.1 Provide one soda ash silo (Tag Number C610) of welded or bolted steel construction, with a capacity of 100 $m^3$ minimum.

.2 The silo and all anchors shall be designed for a product weighing not less than 1,041 $kg/m^3$ and a wind load as per National Building Code.

.3 The silo shall have a 60 degree hopper (from horizontal) as a minimum.

.4 The silo system shall be designed to rest on a concrete foundation as indicated on the drawings.

.5 The silo shall be provided with an aluminum external safety ladder with cage, midrail, post, welded handrail and toe guard. The ladder shall extend up to the top of the silo with lock at the lower end. The ladder, railing, and toe guard shall conform to all applicable ANSI and OSHA requirements.

.6 All welds must be full penetration and provided by certified welder.

.7 The silo top shall have flanged openings for the dust collector, fill tube and target box, level indicator, and a flanged observation opening with a pressure-vacuum relief valve.

.8 The silo hopper shall have a flange at the outlet with width and drilling to match the bin vibrator. The silo sides shall have flanged openings for mounting the level sensors. The silo shall have flanged lifting lugs as required.

.9 Anchor bolts, connecting bolts, fasteners, etc. for the silo and support shall be Type 304 or 316 stainless steel. The anchor bolt size and spacing shall be in accordance with the manufacturers recommendations. Felt or neoprene washer/gaskets shall be furnished wherever aluminum appurtenances come in contact with the steel silo to prevent corrosion of dissimilar metals.

.10 The silo shall be provided with all necessary steel support beams for the volumetric screw feeder (dry feeder) as indicated on the drawings.

.11 The silo shall be provided with a skirt for equipment.

.12 The silo shall be coated in accordance with Sections 11900 and 11901. Internal walls shall be primed. External walls shall be primed and painted. The full height of the silo and skirt shall be cladded with 16 gauge pre-finished metal. Colour to be as selected by the Contract Administrator.

.13 Provide a Thompson Model 666E lightning terminal with suitable base to allow mounting on top of the silo roof. Provide two (2) lightning down cables to reach ground rods at base of silo.

**2.5 Dust Collector**

.1 Provide dust filter rated for the capacity of the unloading blower. Filter shall be tool-less side entry for filter exchange

.2 Provide filter blower (Tag Number C615), suitable for the application.

.3 Provide electric motor driven mechanical shaker (Tag Number C620) and bag filter suitable for cold weather and high humidity.

.4 All units mounted on the top of the silo will be exposed to rain and snow and shall have weatherproof enclosures.

**2.6 Level sensors**

.1 The storage silo shall be provided with three (3) level sensors:

.1 One (1) continuous level monitoring device (guided wave radar)

.2 One (1) high level switch

.3 One (1) low level switch

.2 All level sensors shall be provided by the silo system manufacturer.

**2.7 Vibrator**

.1 The soda ash bulk storage silo shall be provided with a bin vibrator/activator (Tag Number C625) . The vibrator shall be mounted on the hopper outlet for positive discharge of soda ash bulk from the silo.

.2 The bin vibrator shall be supported in accordance with the manufacturers written instructions. Supports shall be provided by the silo manufacturer as required.

**2.8 Knife Gate Valve**

.1 A knife gate valve (Tag Number CV628) shall be provided to isolate the silo from the lower systems. The operator shall be manual screw type hand wheel and yoke, and chain, as appropriate.

**2.9 Rotary Airlock Valve**

.1 Provide drop-through rotary airlock/feeder (Tag Number C630-FCV) with cast iron housing, headplates and six vane mild steel rotor.

**2.10 Volumetric feeder**

.1 Provide volumetric feeder with dissimilar speed, double concentric auger metering mechanism for accurate, continuous flow without flooding or bridging.

.2 Provide AC or DC variable speed drive with a turndown speed ratio of 20 to 1. The motor shall not overload when the screw feeder is started with the inlet and discharge full of product.

.3 The feeder shall be capable of feeding soda ash from 200 to 1000 kg/hour.

.4 Provide dust-tight feeder housing with easy access and easy cleaning without the need to remove the feeder from its mounting, or disassemble flexible connectors, hoppers, or remove the solution tank.

.5 The feeder shall be completely accessible to its internal components by simply removing the discharge spout.

.6 The feeder shall be provided with an integral supply hopper.

.7 Provide high and low level switches to stop and start loading the supply hopper.

**2.11 Soda Ash Solution Tank**

.1 Provide one soda ash solution tank (Tag Number C645) constructed of 304 stainless steel.

.2 Select a tank sized for the application.

.3 System shall be capable of producing 3 percent soda ash solution at a maximum soda ash solution feed rate of 28 $m^3$/hr (850 kg/hr soda ash). System shall be capable of being adjusted to make concentrations in the range 3 percent to 6 percent (3 to 28 $m^3$/hr).

.4 The tank shall have a cover. The cover shall have an access manway, feeder inlet, vent, overflow, drain, outlet, mixer, and instrumentation ports. The vent shall be equipped with a filter.

.5 The solution tank shall be provided with three (3) level sensors:

.1 One (1) continuous level monitoring device (ultrasonic)

.2 One (1) high level switch

.3 One (1) low level switch

.6 Provide one tank mixer (C650) of sufficient capacity to thoroughly mix the tank. The mixer shall include a 316L stainless steel drive.

.7 Provide water makeup system to ensure stable and consistent soda ash solution concentration. Provide all necessary instrumentation for the water system, including a pressure regulating valve, a modulating flow control valve, a pressure gauge, and a flow meter.

.8 Provide a vapour removal unit to prevent vapours from rising into the feed mechanism.

.9 Insulate and heat trace the solution tank, pipes and valves.

**2.12 Soda Ash Solution Dosing Line**

.1 Soda ash shall be dosed by gravity via two 75 mm diameter lines. Each line shall have a minimum of one isolation ball valve, a magnetic flowmeter (FE-C670/FE-C680) and one modulating ball valve (CV-675/CV-685).

.2 The modulating valves (CV-675, CV-685) adjust their position in response to signals from the flowmeter to maintain the setpoint flowrate (operator adjustable).

.3 Insulate and heat trace all pipes and valves.

**2.13 Skirt**

.1 Silo skirting to be insulated with 50 mm of extruded polystyrene rigid insulation between cladding.

.2 Silo skirting to be properly flashed and sealed in order to facilitate proper drainage and prevent any moisture penetration to the insulation or insulated area. Skirting and cladding to be 16 gauge pre-finished metal (exterior) and 16 gauge galvanized (interior). Colour to be as selected by the Contract Administrator.

.3 Provide double hollow metal doors. Doors at the base of silo to be insulated core. Door hardware to include (per leaf); 3-butt hinges, weather-stripping, threshold, door sweep, flushbolts, astragal (1), lockset (1), Frames to be thermally broken. Apply sprayed-in polyurethane foam to insulate frames. Doors and frames to be finished and painted as per other exterior metal doors in Contract. Colour to be as selected by the Contract Administrator.

**2.14 Emergency Eyewash and Shower**

.1 Provide one Haws emergency eyewash and shower installed inside the skirt. Tempered water is supplied from outside the skirt, as per the Drawings.

.2 Refer to Division 15.

**2.15 Skirt Exhaust Fan**

.1 Provide 250 cfm skirt ventilation fan complete with relief vent and backdraft damper. Fan to be controlled by manual ON/OFF switch.

.2 Refer to Division 15 for acceptable manufacturers.

**2.16 Skirt Heater**

.1 Provide 3 kW skirt electric unit heater with line voltage, heating only thermostat.

.2 Refer to Division 16.

**2.17 Lighting**

.1 Provide two interior lights and one exterior light. Lights to be 150W wall pack with polycarbonate reflector similar to Keene Model 313150 120V MA 335. Provide switch control at door.

**2.18 Controls**

.1 A PLC is not required for the system. The system will be controlled by the Bailey Distributed Control System (DCS)

.2 Provide wiring diagrams, loop diagrams, and control philosophy for local control stations.

.3 Provide control logic and algorithms for use by the City to program the Bailey DCS.

.4 In the skirt provide a NEMA 4 main control panel with hand switches and lights, as follows:

.1 For each drive provide status LED lights (Red for running, green for ready)

.2 For each drive located in the skirt, provide a COH and LOS hand switch.

.3 For each actuator that is inaccessible, provide LOR and O/C switch.

.5 For drives geographically removed from the skirt (e.g. those drives located on top of the silo), provide field mounted COH and LOS hand switches.

.6 For each actuator that is readily accessible, provide a field mounted LOR and O/C switch.

.7 For the volumetric feeder provide manual speed adjustment

**2.19 Electrical**

.1 The supplier of the soda ash system does not need to supply electrical power panels. Electrical power panels will be supplied and installed by the Contractor in accordance with the Drawings.

**2.20 Finishes**

.1 Shop prime and paint in accordance with Section 11901.

**2.21 Spare Parts and Maintenance Materials**

.1 Provide, as a minimum

.1 One (1) bin dust filter

.2 Two (2) vibrator hanger bearing sleeves

.3 Two (2) complete sets of seals for the screw feeder

.4 One (1) box of bulbs for the control panel indicator lights

.2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years. At the Contract Administrator's request, provide a price for these parts.

.3 Spare parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 Arrange for a technically qualified manufacturer's representative to attend the installation, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures.

### 3.2 Fabrication

.1 All welding procedures and welder qualifications shall be in accordance with AWS D1.1 or ASME Section IX. If requested, procedure certification reports and welder qualifications shall be submitted to the Contract Administrator for review.

.2 All butt welds shall be two sided. Welds shall be back-gouged to sound metal before welding the second side. Welding procedure certifications and welder qualification reports shall be made available to the Contract Administrator if requested.

### 3.3 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Inform the installer of all procedures and requirements necessary for the successful installation of the equipment. Attest to the installer's understanding by completing Form 101 as shown in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

### 3.4 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, included in Section 01650.

### 3.5 Commissioning

.1 Attend during commissioning of the process system which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process system.

**END OF SECTION**

**EXHAUST AIR FANS**

## 1. GENERAL

### 1.1 Work Included

.1 This Section specifies the supply and supervision of the installation, testing, and commissioning of a FRP centrifugal fan with all necessary appurtenances, which supplies foul air to the dispersion stack.

.2 Variable frequency drive.

### 1.2 Submittals

.1 In addition to the submittals required in Section 01300 and Section 11005, provide the following:

.1 Fan performance curves with fan and system operating point plotted on the curves.

.2 Unit weights.

.3 Maximum static pressure that the fan can develop with the supplied motor at the given static barometric and inlet pressures.

.4 A summary of predicted sound power levels for the centrifugal fans when operating at full capacity. Report the predicted sound power levels in a standard format conforming to the requirements of the Acoustical Engineering Institute.

.2 Provide a list of the components and materials which ship pre-assembled and a parts list for all other components and materials. Indicate weights and physical dimensions each part, assembly, and/or package to be shipped.

.3 Operation and Maintenance Data: provide for incorporation in O&M Manual as specified in Section 01730. Include complete description of operation together with general arrangement and detailed drawings; wiring diagrams for power and control schematics, parts catalogues, with complete list of repair and replacement parts with section drawings, illustrating the connections and identifying numbers.

### 1.3 Coordination

.1 Coordinate VFD with the requirements of Division 16

.2 Coordinate with other Divisions to ensure there are no conflicts in the Work.

### 1.4 Quality Assurance

.1 Conform to AMCA Bulletins regarding construction and testing. Fans to display AMCA certified rating seal.

.2 Furnish information in writing showing that fans of the same design have been in satisfactory service similar to that in this Contract for not less than two years. Include the name of the owner and the address of the installation(s).

**1.5 Shipment, Protection, and Storage**

.1 Ship pre-assembled to the degree that is practical.

.2 Identify special storage requirements. Store on-site until ready for incorporation into the work using methods recommended by the manufacturer to prevent damage, undue stress or weathering.

## 2. PRODUCTS

**2.1 Description**

.1 The fan conveys foul air from the SBRs and equalization tank to the stack.

.2 Provide fans complete with:

.1 Flanged and drilled inlet and outlet

.2 12 mm drain connection complete with 316 stainless steel tubing and ball valve

.3 Access door in fan scroll

.4 Vibration isolation

.5 Flexible connections for inlet and discharge

.6 Weatherproof housing over drive components and shafts

.7 Where inlet or outlet is exposed, provide safety screen

.3 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to other areas.

.4 Provide balanced sheaves.

.5 Provide replacement sheaves for balancing purposes.

.6 Provide OSHA approved belt guards with tachometer holes.

.7 Where explosion-proof fans are specified, construct to the equivalent of the AMCA Type A standards with explosion proof motor. Construct fan components of non-ferrous material, in such a manner to reduce the possibility of contact between rotating and stationary parts. Restrain aluminum rub rings, the impeller, bearings and shaft to prevent a lateral or axial shift. Install in accordance with requirements of Division 1, Class 1, Group D as defined in the Canadian Electrical Code.

.8 Base catalogued ratings on tests performed by an approved testing laboratory. Scheduled fan performance is the performance required under specified conditions with specified or indicated accessories; rate the proposed equipment under these conditions. Otherwise, include catalogued performance operating factors and calculations adjusting catalogued performance for specified conditions and accessories. If non-uniform air flow conditions are likely to be encountered, correct the fan rating for the additional fan inlet and outlet effect.

.9 Affix the manufacturer's product identification name plate to the fan.

.10 Provide a centrifugal fan suitable to the application, constructed of corrosion resistant materials as specified.

.11 Provide single width, single inlet fan with rotation and configuration of inlet and discharge as shown on the Drawings.

## 2.2 Design Standard

.1 Hartzell

## 2.3 Acceptable Manufacturers

.1 Ceilcote

.2 MK Plastics

.3 NYB

.4 Plasticaire

.5 Twin City

## 2.4 Capacities and Performance

.1 Performance requirements based on conditions at an altitude of 220 m AMSL (above mean sea level):

.1 Exhaust Fan

.1 Flow: 31,000 $m^3$/hr (18,245 cfm)

.2 Upstream pressure: -0.16 kPa (-0.6 inches WC)

.3 Downstream pressure: 0.49 kPa (1.9 inches WC)

.4 Differential pressure: 0.65 kPa (2.5 inch WC)

.5 Speed: variable

.6 Power: 11.1 kW

.2 Do not select fans which increase motor kilowatts, increase RPM, increase noise level, increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from that of the specified fan.

.3 Provide fans capable of accommodating static pressure variations of +25 percent with no objectionable operating characteristics.

.4 Static pressure is defined as air pressure external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if specified as part of the unit are considered as internal losses for fan.

.5 Design and rate the fan in accordance with AMCA 99.

.6 Determine performance data for fan in accordance with AMCA 210.

.7 Comply with AMCA 301 for sound power level ratings of normally ducted fans. Test in accordance with AMCA 303. Supply fans, or effectively enclose, so that personnel occupying or working in the area are not exposed to noise levels greater than 65 dBA at 3 m and 40 dBA at 50 m.

.8 Arrange fan for indicated service, constructed for AMCA class pressure ratings as indicated for system design pressure and temperature. Select fan for maximum efficiency, minimum noise, and for stability during all modes of system operation.

.9 Provide fan capable of specified performance within minus 0 percent to +10 percent.

## 2.5 Materials

.1 Fabricate the fan wheel from FRP using vinyl ester resin. Use materials specifically suitable to withstand attack from air with high concentrations of hydrogen sulphide gas. All parts in contact with the air stream are to be spark-proof. Encapsulate the fan hub in FRP for corrosion resistance.

.2 Construct fan housings of a chemical-duty grade of polyester resin.

.3 Fabricate shaft and fan support stand of steel with protective coating.

## 2.6 Fan Wheel

.1 Design fan wheel with backwardly inclined blades, and non-overloading horsepower characteristic in that brake horsepower levels off at a point on the performance curve that prevents motor overload. Key the fan wheel to the shaft; statically and dynamically balance prior to delivery.

.2 Fabricate the fan shaft of solid steel, unless otherwise specified, ground and finished as required for the service, with first critical speed not less than 25 percent higher than catalogued fan speed.

**2.7 Bearing**

.1 Provide heavy duty, grease-lubricated, self-aligning, precision anti-friction pillow block bearings, constructed of steel alloys with a certified L-10 minimum rated life of 100,000 hours under load conditions the service will impose. Rate and select bearings in accordance with AFBMA 9 and AFBMA 11. Provide dust-tight seals suitable for environment and lubricant pressures encountered. Fabricate housing of cast ferrous metal, bolted-split pillow lubricated with provisions to preclude overheating due to excess lubricant. Provide surface ball check type grease supply fittings. Provide manual or automatic grease pressure relief fittings visible from normal maintenance locations. Include extension tubes where necessary to facilitate safe maintenance during operation. Fill tubes with lubricant prior to equipment operation.

**2.8 Motor**

.1 Provide motors in accordance with Section 11205.

.2 Provide motors suitable for service with variable frequency drives.

**2.9 Drive**

.1 Provide V-belt drives, conforming to MPTA and RMA Engineering Standards. Apply drives in accordance with the manufacturer's published recommendations, except as otherwise specified. Base power rating of a V-belt on maximum pitch diameter of sheaves. Provide fixed sheave type drives with a service factor of not less than 1.5 with at least two (2) belts provided in matched sets.

.2 Provide static dissipating, heat and oil resistant belts. Provide heavy duty wire mesh belt guard with access openings for tachometer measurements.

.3 Statically and dynamically balance the sheaves. Provide machined cast ferrous metal or machined carbon steel, bushing type sheaves, secured by key and keyway. Ensure pitch diameter for fixed sheaves is not less than that recommended by NEMA MG 1. Provide sheaves selected to provide the required operating speed.

.4 Where specified, equip fans with variable frequency drives.

**2.10 Housing**

.1 Construct fan in accordance with AMCA 99, Standard 401 for spark resistance. Provide electrical grounding of fan parts and lug for grounding to building structure. Do not place bearings in the air stream.

.2 Provide exterior gel coat, coating or paint with ultraviolet light inhibiting properties for fans exposed to sunlight.

**2.11 Base**

.1 Provide fan with slide rail or equivalent adjustable motor base constructed of epoxy-coated, heavy hot rolled steel.

**2.12 Vibration Isolation**

.1 Supply vibration isolation equipment and materials by one manufacturer. Ensure equipment is sufficiently rigid for isolator point loading. Consider side loading of equipment when calculating maximum loads on isolators. Provide open spring mount vibration isolators with iso-stiff springs, heavy mounting frame and limit stop. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.

.2 Select springs to operate at no greater than two-thirds solid deflection. Provide 6 mm ribbed neoprene pads. Colour code spring mounts.

.3 Provide epoxy coated vibration isolators, epoxy coated for outdoor application.

**2.13 Finishes**

.1 Factory finish metallic equipment and component surfaces with protective coating system in accordance with Section 11900.

.2 Touch up, or completely repaint to match the original finish if necessary, all factory applied finishes which are marred, damaged, or degraded during shipping, storage, handling or installation in accordance with Section 11901.

**2.14 Spare Parts**

.1 Provide the following spare parts for each size centrifugal foul air fan in accordance with Section 11005:

.1 One (1) set of V-belts

.2 One (1) set of bearings

.3 One (1) shaft seal

**3. EXECUTION**

**3.1 Manufacturer’s Representative**

.1 Arrange for a technically qualified manufacturer's representative to attend the installation Work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures.

**3.2 Installation**

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installer’s understanding by completing Form 101, included in Section 01650.

.3 Cooperate with the Installer to fulfill the requirements for a successful installation, as documented by Form 102, included in Section 01650.

.4 Supply and install sheaves as necessary for final air balancing.

.5 Set roof mounted fans on curbs 200 mm minimum above roof. Provide acoustic insulation on duct to below roof line and on fan inlet plenum. On non-ducted rooftop fans provide drip pan for collecting condensation with drain line to nearest drain or open channel.

## 3.3 Testing

.1 Test the entire system, components and equipment in accordance with the requirements of Section 01650 to ensure the system operates as intended. Provide the following test reports:

.1 Fan data, including sound power level data (shop and field).

.2 System test reports (field).

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented in Form 103 included in Section 01650.

.3 Fan Testing, Adjusting and Balancing:

.1 Test belts and sheaves for proper alignment and tension in accordance with Section 01650, in the presence of the Contract Administrator. Ensure belts on drive side are uniformly loaded, not bouncing.

.2 Perform in accordance with the applicable and recommended procedures of SMACNA Accepted Practice for Industrial Duct Construction or ACGIH Industrial Ventilation, A Manual of Recommended Practice. Provide certified, calibrated instrumentation apparatus to measure sound levels, motor current, and power factor. Unless otherwise allowed, use only manometers and approved aneroid type gauges (such as a Magnehelic). Velometers may be used for low velocity measurements. Submit a detailed agenda of the proposed work for acceptance prior to starting any work.

.4 Systems Volume Acceptance Criteria

.1 Systems final volumes for the fan must be within +10 percent, -0 percent of design volume at design temperature.

.5 Sound Level Criteria

.1 On completion of the system, measure sound levels and record in the required test reports.

.6 System Test Reports

.1 Provide six (6) copies of final test report for all systems tested, describing all test apparatus, instrumentation calculations, factors, flow coefficients, sound levels, and equipment data based on ACGIH recommended forms or reasonable facsimiles thereof to suit project conditions. Permanently mark final adjustment and settings, drilled and pinned as an integral part of device. Include adjustment and setting data in test report.

.2 After fan testing, adjusting and balancing work has been completed and accepted, demonstrate the complete and correct functioning of systems equipment and controls by operation thereof through normal ranges and sequences, and by simulation of abnormal conditions. Manually and automatically cause every device to function as intended. Readjust, as necessary, any settings and after sufficient operating time, but not less than six hours, verify ability of equipment and controls to establish and maintain stable and accurate operation and required system performance. Note any abnormal deviations, such as excessive vibration and noise and heat. Make any necessary repairs, replacements or adjustments.

## 3.4 Commissioning

.1 Attend during commissioning of the system which includes the equipment specified in this Section to ensure the equipment functions as intended in the process system.

**END OF SECTION**

# SAMPLING EQUIPMENT

## 1. GENERAL

### 1.1 Work Included

.1 Supply and supervision of installation, testing and commissioning of sampling equipment.

### 1.2 Submittals

.1 Submit Shop Drawings in accordance with Section 01300 and Section 11005.

.2 Operation and maintenance data: provide for incorporation in O&M Manual as specified in Section 01735. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogue with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

### 1.3 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

### 1.4 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, distortion or weathering of components.

.3 Identify all other special storage requirements.

## 2. PRODUCTS

### 2.1 Sampling of Centrate Stream for Sampler C950-S

.1 Supply and install 50 mm and 32 mm diameter piping including valves, as per the Drawings.

.2 Supply and install sample pump C942-P. Sampling pump shall be Monarch BE-S75 with 32 mm NPT inlet and outlet and 208 VAC 0.56 kW (0.75 HP) motor.

.3 Supply and install 100 mm spool piece, as detailed in the Drawings.

.4 Install Bristol Equipment Company Isolok Series SAL-25 Sampler. The sampler will be supplied by the City.

.5 Supply and install compressed instrument air line to the sampler.

.6 Supply and install all electrical and control wiring.

.7 Install the sample refrigerator. The refrigerator will be supplied by the City.

**2.2 Sampling of Treated Centrate for Sampler C960-S**

.1 Supply and install 50 mm diameter piping, as per the Drawings.

.2 Supply and install submersible sample pump C952-P in accordance with Sections 11207 and 11331. Sampling pump shall be Flygt Model C3067HT with 267 impeller suitable for a flow of 3 L/s and a head of 10.5 m, with a 208 VAC/1 phase/60 Hz 1.2 kW motor.

.3 Supply and install 100 mm spool piece, as detailed in the Drawings.

.4 Install Bristol Equipment Company Isolok Series SAL-25 Sampler. The sampler will be supplied by the City.

.5 Supply and install air compressor, refrigerant dryer, and filter. Air compressor shall be Devair Model UDJ-5031 rated for 0.94 L/s (2.0 cfm) delivery at 690 kPa (100 psi) and a 120 VAC 0.37 kW (0.5 HP) motor including starter, and 113 L (30 gallon) horizontal receiver. Air dryer shall be Devair Model ASD15 120 VAC rated for 7 L/s (15 cfm). Filter shall be Devair Model SAF-S-18 in Devair Model SAF-C-18 canister.

.6 Supply and install all electrical and control wiring.

.7 Install the sample refrigerator. The refrigerator will be supplied by the City.

**2.3 Sampling of Waste Activated Sludge for Sampler C970-S**

.1 Supply and install 200 mm spool piece, as detailed in the Drawings.

.2 Install Bristol Equipment Company Isolok Series SAL-25 Sampler. The sampler will be supplied by the City.

.3 Supply and install compressed instrument air line to the sampler.

.4 Supply and install all electrical and control wiring.

.5 Install the sample refrigerator. The refrigerator will be supplied by the City.

**2.4 Sampling of Mixed Liquor for Analyzer C040**

.1 Supply and install all piping and valves, as per the Drawings.

.2 Supply and install sample pumps C190-P and C-290-P. Sampling pumps shall be Monarch BE-S50 with 32 mm NPT inlet and outlet and 208 VAC 0.37 kW (0.5 HP) motor.

.3 Supply and install dissolved oxygen and pH analyzers as detailed in Division 17.

.4 Supply and install automatic wastewater monitoring equipment as detailed in Section 11851.

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 To ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures, arrange for a technically qualified manufacturer's representative to witness the installation work, certify correct installation, train operating and maintenance staff, and undertake system testing.

### 3.2 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installer’s understanding by completing Form 101, included in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation by completing Form 102, included in Section 01650.

### 3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment by completing Form 103, included in Section 01650.

**END OF SECTION**

# AUTOMATIC WASTEWATER MONITORING EQUIPMENT

## 1. GENERAL

### 1.1 Scope

.1 This Section specifies the supply, factory testing, delivery, installation, supervision of installation, testing and commissioning of automatic wastewater monitoring equipment for detection of ammonia, nitrate, nitrite, and ortho-phosphorus.

.2 The wastewater monitoring equipment shall consist of a nutrient analysis system, filter system, and air compressor.

.3 The location of the automatic wastewater monitoring equipment will be in the Sampling Room.

### 1.2 Shop Drawings

.1 Provide Shop Drawings in accordance with the requirements of Section 01300 and Section 11005. In addition, provide the following information:

.1 Manufacturer's data including name, type, model, capacity and equipment weight.

.2 Shop Drawings including dimensions and sectional view of equipment showing details of construction, arrangement and installation.

### 1.3 Other Submittals

.1 In addition to the submittals specified in Section 11005, provide the following for information only in accordance with Section 01300:

.1 Detection and analysis technique to be provided for each specified parameter.

.2 Calibration plan describing the complete calibration series including grab sample comparisons, spiked samples and standards for all parameters.

.2 In addition to the operating and maintenance data specified in Section 11005, provide the following for operating and maintenance data in accordance with requirements of Section 01750:

.1 Complete description of equipment and operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connections and the part manufacturer's identifying numbers.

### 1.4 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts with the Work.

### 1.5 Shipment, Protection, and Storage

.1 Ship equipment and mechanisms pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no weathering, corrosion, contamination, mechanical damage, distortion, or any other deterioration of the components.

.3 Identify all other special storage requirements.

## 2. PRODUCTS

### 2.1 Nutrient Analysis System

.1 An analysis system shall include a sample pump, manifold, flow cell, and spectrographic assembly.

.2 Function

.1 A nutrient analysis system receives mixed liquor from the sequencing batch reactors (SBR 1 and SBR 2) for analysis of ammonia, nitrate, nitrite, and ortho-phosphorus.

.2 Provide process analyzer instruments, sampling lines, and all required system accessories as a package system, including responsibility for correct operation, installation and interfacing of the equipment.

.3 The nutrient analyzer system shall be capable of separately analyzing nutrients from two process sample points (SBR 1 and SBR 2). Multiple analyzers for each parameter or sample point are not acceptable.

.3 Design Standard and Acceptable Manufacturers

.1 Supply products modified as necessary by the manufacturer to provide the specified features and to meet the specified operating conditions.

.2 Design Standard

.1 ChemScan UV-4100, CL500

.4 Performance

.1 The process analyzer instrument shall be capable of nutrient detection over the following concentrations in samples that have been diluted 10:1:

.1 Ammonia-nitrogen: 0.2 to 20 mg/L

.2 Nitrate-nitrogen: 0.1 to 20 mg/L

.3 Nitrite-nitrogen: 0.1 to 15.0 mg/L

.4 Ortho-phosphorus: 0.05 to 15.0 mg/L as P

.2 The analyzer shall demonstrate accuracy for all parameters listed above in wastewater will be ±5 percent of range or better.

.3 Provide a total package process analyzer system capable of analyzing all required parameters from the sample location.

.4 Provide an externally mounted, back illuminated, LCD display with keypad for entry of operator-selected variables and menu options.

.5 Sampling Requirement

.1 Provide nutrient analysis system capable of measuring all designated parameters within 6.5 minutes or less, not including sample flush time.

.2 The total time required to measure all designated parameters at the sample point, including flushing, is to be 15 minutes or less. The analysis time shall include all time required for sample flushing and analysis for all parameters at any sample point, including reverse flow and purge cycles.

.3 The analyzer system shall be capable of receiving signals for enabling or disabling of parameter selections at each sample point and enabling or disabling analysis of any of the sample points through control system initiated commands.

.4 The analyzer system shall be configured to monitor two (2) sample points (one from SBR 1 and the other from SBR 2) through filter cartridges located in a dedicated flow-through assembly for each sample.

.5 The analysis cycle shall be initiated and controlled by the process analyzer upon receipt of a signal from the Distributed Control System (DCS). The analyzer shall also incorporate an additional sample port to manually introduce discrete samples for calibration and quality control testing.

.6 A central diaphragm sample pump shall be located within the analyzer.

.7 Furnish a dilution system consisting of potable water pump, sample pump, sample line and return line for each sample point. Dilution system shall provide a maximum of 10:1 dilution of the sample flow into the sample recirculation chamber. Wall-mount each filter system on Unistrut in close proximity to the analyzer. The dilution rate of the sample flow should be manually adjusted, with a maximum of 10:1.

.6 Detection Techniques

.1 Ion-selective electrodes or any method that employs reagents for detection of any parameter analysis are not acceptable.

.2 The use of deionized water for zeroing and cleaning solutions for optical surfaces is permissible. Submittal data shall specify the detection technique to be provided.

.3 Provide analyzer with a dedicated sample port for the introduction of calibration and test samples.

.4 Submit detection and analysis techniques for each specified parameter.

.5 Reagents for analysis of ammonia and ortho-phosphorus shall not require replenishment more often than once each month.

.6 Provide automatic zeroing capability using deionized water as the standard.

.7 Zeroing and cleaning solutions shall not need replenishment more than once every two weeks.

.8 Provide for the elimination of interferences due to background substances present during analyses using multiple wavelength ultraviolet absorbance spectrometry of a minimum 30 wavelengths.

.7 Materials

.1 Analyzer electronics modules: NEMA 4 enclosure of coated metal or fabricated using stainless steel.

.2 Flow Cell Modules: NEMA 3R enclosure of coated metal or fabricated using stainless steel.

.3 Optical window: quartz

## 2.2 Filter System

.1 The sample pump, internal to the analyzer, will draw flow through the filters when required. The filter system shall consist of a re-circulation chamber, a sample contact chamber, an air pinch valve to control flow of raw sample into the sample contact chamber, a replaceable filter cartridge with a pore size of 65 micron or less, and a PVC coupling to secure the filter cartridge in the sample contact chamber.

.2 Function

.1 The analyzer system manufacturer shall supply a filtration system for rejection of solids in the samples. Because the solids in samples from certain sample points may not settle readily or fully within a reasonable period of time, analyzer systems that rely on sample settling for reduction of solids are prohibited.

.2 The PVC coupling shall be installed to position the filter cartridge to be fully immersed in the sample contact chamber. Upon receipt of signal from the DCS, the air pinch valve is opened by a signal from the analyzer, which allows raw sample to enter the sample contact chamber. Filtered sample is drawn through the filter by the analyzer from the sample contact chamber. A 6.25 mm (0.25 inch) plastic sample line shall be installed from the filter cartridge to the analyzer and connected to the analyzer sample inlet, at a distance not in excess of 3657 mm (12 ft) from the sample contact chamber.

## 2.3 Air Compressor

.1 Supply and install air compressor. Air compressor shall be Thomas Air-Pac Model T-30HP rated for 78 L/min (2.75 cfm) at 690 kPa (100 psi), with a 17 L (4.5 gallon) pancake tank and a 115 VAC 0.93 kW (1.25 HP) motor.

.2 The analyzer system will contain an internal manifold that will permit a reversed flow of sample to purge the sample line and filter with air after each analysis cycle and back-flush the filter with potable or reclaimed water during idle periods.

**2.4 Controls, General Requirements**

.1 Outputs from the system will be monitored by the DCS.

.2 Provide a Prolinx 4021 module Serial Port with Ethernet Interface to transmit all analysis results for each parameter and output control command signals. The format for transmission is Modbus TCP/IP for transmission to the plant DCS. The contractor is required to configure this protocol. This format shall follow the technical parameters of the equipment already being installed and currently used at the NEWPCC. The Contractor shall coordinate the Ethernet Interface configuration with the City personnel.

.3 Equip the analyzer with an operator interface unit and display screen to display operating status, analysis results, operational commands, and other information required to operate and control the system.

.4 Provide a NEMA 4X control panel.

.5 In addition to PLC, provide a memory map of all process control and monitoring data for incorporation the packaged unit into the DCS.

**2.5 Protective Coatings**

.1 Preparation, primer and coatings: in accordance with Section 11901.

**2.6 Spare Parts**

.1 Provide the following spare parts:

.1 Reagent injector pump (1)

.2 Tubing for analyzer internal pump (set of 3)

.3 Reagent containers (3)

.4 Zero solution container (1)

.5 Cleaning solution container (1)

.6 Manifold valve (1)

.2 Tag and store spare parts in accordance with Section 01750.

.3 Provide a list of spare parts which would be expected to be required over a period of five years under normal conditions. At the Contract Administrator’s request, provide a price for the listed parts.

**2.7 Special Tools**

.1 Provide any special tools required for the maintenance of the equipment supplied. Special tools are defined as tools which are not normally available in mechanic or millwright tool kits and which are peculiar to the equipment supplied.

**3. EXECUTION**

**3.1 Manufacturer's Representative**

.1 Provide the services of a qualified technical representative for installation, testing and commissioning.

.2 Provide the services of a qualified technical representative for personnel training.

**3.2 Installation**

.1 Ensure the equipment is installed and aligned in accordance with Section 11005, as required to provide satisfactory service.

.2 Have the manufacturer's representative instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installers understanding by completing Form 101, included in Section 01650.

.3 Have the manufacturer's representative supervise and cooperate with the installer as necessary.

.4 Have the manufacturer's representative verify successful installation, as documented by Form 102, included in Section 01650.

**3.3 Testing**

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Performance Testing

.1 Prior to testing, provide procedure and sketches to demonstrate method of system testing to Contract Administrator for approval.

.2 Test run the sample pump to assure correct flow conditions are present in the sample circulation chamber. With adequate flow, set the correct sequence and timing for sample flush and sample analysis.

.3 Perform a complete calibration series including grab sample comparisons, spiked samples and standards for all parameters. Provide a complete description of the "Calibration Plan" as a submittal document to Contract Administrator for review.

## 3.4 Training

.1 Provide the services of a qualified technical representative for personnel training as specified below and in accordance with Section 01664.

.2 During equipment operational testing provide as a minimum:

.1 Operator and Maintenance Training: two (2) sessions, 2 hours each

.3 Six months after the operational testing provide as a minimum:

.1 Operator training: one (1) session, 1 hour

.2 Maintenance training: one (1) session, 2 hour

## 3.5 Commissioning

.1 Have the manufacturer's representative attend during commissioning of the process system, which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

**END OF SECTION**

# NITROGEN EQUIPMENT

## 1. GENERAL

### 1.1 Work Included

.1 Supply and supervision of installation, testing and commissioning of nitrogen gas feeding equipment.

### 1.2 Submittals

.1 Submit Shop Drawings in accordance with Section 01300 and Section 11005.

.2 Operation and maintenance data: provide for incorporation in O&M Manual as specified in Section 01735. Include complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogue with complete list of repair and replacement parts with section drawings illustrating the connections and identifying numbers.

### 1.3 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

### 1.4 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree possible.

.2 Provide storage instructions indicating specific requirements to ensure there is no uneven wear, distortion or weathering of components.

.3 Identify all other special storage requirements.

## 2. PRODUCTS

### 2.1 General

.1 The nitrogen equipment shall be located in the Exhaust Fan Room.

.2 Provide a complete and functional package.

.3 The nitrogen gas cylinders will be supplied by the City.

### 2.2 Acceptable Manufacturers

.1 Air Liquide

.2 Praxair

### 2.3 Equipment

.1 Provide weigh scale for gas cylinder as per the Drawings.

.2 Provide wall mounted panel, including solenoid valves with hand switches, pressure regulating valves, strainers, pressure indicators and transmitters, check valves, piping, flexible connections, and ball valves as per the Drawings.

## 3. EXECUTION

### 3.1 Manufacturer's Representative

.1 To ensure the equipment is installed, operated, and maintained in accordance with the manufacturer's recommended procedures, arrange for a technically qualified manufacturer's representative to witness the installation Work, certify correct installation, train operating and maintenance staff, and undertake system testing.

### 3.2 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the installer’s understanding by completing Form 101, included in Section 01650.

.3 Cooperate with the installer to fulfill the requirements for a successful installation by completing Form 102, included in Section 01650.

### 3.3 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment by completing Form 103, included in Section 01650.

**END OF SECTION**

# FIELD-APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

## 1. GENERAL

### 1.1 Work Included

.1 Provide, apply, and maintain the specified field applied protective and maintenance coating systems. Coatings are required on all process and mechanical equipment, vessels and pipes unless specifically deleted.

.2 Refer to Drawings and schedules for the type, location, and extent of coatings required and include for all field coating necessary to complete all the Work shown, specified, or scheduled.

### 1.2 Reference Standards

.1 Reference to the SSPC Good Painting Practice and the National Association of Corrosion Engineers specifications refers to the latest edition of these specifications.

.2 Apply all coating in accordance with manufacturers' recommendations, and to SSPC Standard. Specifications contained therein take precedence over manufacturers' recommendations.

.3 Strictly observe all safety rules and regulations of the City, applicable governing bodies, and insurance underwriters in the storage, handling, use and application of coating system material, solvents, and cleaning agents.

.4 Employ qualified and competent personnel to perform the Work in a neat and workmanlike manner, conforming to all City and Government Safety Standards and Regulations.

### 1.3 Shipment, Protection, and Storage

.1 Deliver all materials to the Site in sealed containers properly labeled as to the manufacturer's name, type, and colour of contents, date of manufacture, batch number, storage requirements, and shelf-life.

.2 Provide adequately ventilated storage for all materials and ensure compliance with fire prevention regulations.

### 1.4 Guarantee

.1 Furnish to the City a two-year guarantee in an approved format, or alternatively a 100 percent two-year maintenance bond, on completion of the Work. The Work performed by the Contractor shall be inspected by an independent inspector acceptable to the Contract Administrator. Include the cost of this inspection and the guarantee or maintenance bond in the Bid Price.

### 1.5 Restrictions

.1 Regardless of whatever else is specified in this Section, no paint containing a chromate based additive can be used. Substitute products of equal or greater quality.

## 2. PRODUCTS

### 2.1 Manufacturers

.1 All constituents of each coating system are to be provided by the same manufacturer.

### 2.2 Coating Application

.1 Use application methods in accordance with the coating manufacturer's recommendation for the particular coating being applied, and the requirements of SSPC Good Painting Practice.

.2 Provide traps or separators to remove oil and water from the air, so that the air from the spray gun impinging onto the steel substrata shows no condensed water or oil.

.3 Hand brush all welded and hard-to-spray areas prior to the first spray coat application, with coating mixed to manufacturer's recommended procedures.

.4 Coat by brush, roller, sheepskin dauber, or other suitable method, all areas inaccessible to the spray gun.

.5 Do not apply coatings to a surface at a temperature that will cause blistering, separation or otherwise be detrimental to the life of the coating.

.6 Only thinners specified by the manufacturer are acceptable.

.7 Materials that exceed manufacturer's published shelf life are not acceptable.

.8 Immediately brush out all runs, sags, blisters, etc, or remove and repair the area prior to the next application.

.9 Apply the coating using a 3-coat, 2-colour system.

.10 Apply coating by conventional or airless spray as power coating manufacturer's data sheet.

.11 Follow manufacturer's application procedures as closely as possible as to recommended pressures, atomization, etc.

.12 Provide final dry film coating thickness in accordance with the coating manufacturer's specification.

.13 Apply the coating 100 percent holiday free.

### 2.3 Drying and Curing

.1 Accommodate all drying and re-coat times in accordance with the manufacturer's specifications.

.2 Cure in accordance with the manufacturer's recommended specifications. Force curing specifications are available from manufacturer if required.

.3 Supply indirect fired heaters and ducting as required to maintain drying and curing temperatures during coating operations.

## 2.4 Quality Control and Acceptance

.1 Apply, cure, and handle coatings using procedures which produce a final product that complies to the manufacturer's published literature and performance testing conducted by the City.

.2 Ensure the finished coating is free of obvious defects such as runs, sags, blisters or pinholes, air entrapment, fish-eyes and foreign matter.

.3 Provide film thickness, as determined by a calibrated Mikrotest gauge or equivalent, in accordance with SSPC Good Painting Practice.

.4 Apply all immersion coating 100 percent holiday free.

.5 Conduct wet sponge holiday testing in accordance with proposed NACE Standard, "Holiday Detection of Internal Tubular Coatings" (less than 0.254 mm (10 mil) thickness).

.6 A "holiday" is an area of applied coating with electrical resistance less than 80,000 ohms as identified by a detection instrument connected to a clean sponge wetted with a solution of one teaspoon of detergent per 3.78 L of tap water.

.7 No immersion coating will be accepted or released from coating applicators until fully cured. Cure test will be performed using the M.E.K. rub test in conjunction with a time and temperature relationship for the coatings being used.

.8 Repair or replace at the Contractor's expense any coating not meeting the requirements of this specification.

## 2.5 Surface Treatment

.1 Remove all organic substances such as oil, grease, paraffin, etc. in accordance with SSPC-1, "Solvent Cleaning", prior to commencement of sandblast cleaning operations.

.2 Provide proper traps or separators to remove all oil and water from the air supply. The air from the blast nozzle is to be free of condensed water or oil that will impinge onto steel substrata. In high humidity areas, the use of air dryers may be required.

.3 Do not blast surfaces when surface temperatures are less than 10°C, when substrata is less than 3°C above the dew point, when the relative humidity is greater than 80 percent, or when there is a possibility that the blasted surface will be subject to wetting prior to the primer coat being applied.

.4 Blow down all surfaces with clean, dry air; brush and vacuum free of dust before the surface is primed.

.5 Do not blast more surface than can be prime coated before visible or detrimental re-rusting occurs.

.6 Use siliceous sand, free of dirt, clay or other foreign material, graded 16/30 or 20/40 mesh to give an anchor pattern 0.038 mm to .076 mm (1.5 to 3.0 mil).

## 2.6 Schedule of Surface Treatments

.1 The schedule of Surface Treatments defines the components of the protective coating systems.

| Reference | Description | Surface Treatment |
|---|---|---|
| A | Solvent Cleaning | as SSPC – SP1 |
| B | Hand Tool Cleaning | as SSPC – SP2 |
| C | Power Tool Cleaning | as SSPC – SP3 |
| D | Brush Blast | as SSPC – SP7 |
| E | Near White Metal Blast | as SSPC-SP10 |
| F | White Metal Blast | as SSPC – SP5 (NACE #1) |
| G | Abrasion | The surface shall be lightly abraded using steel wool or abrasive cloth to provide a key for the next coat, to remove runs or excessive brushmarks |
| H | Vinyl Wash Primer | DFT 13 micron<br>To be overcoated within 24 hr |
| I | Water-borne Acrylic Primer | Nominal DFT 40 micron |
| J | Inorganic Zinc Primer | Zinc in ethyl silicate vehicle<br>Minimum DFT 40 micron |
| K | Industrial Enamel<br>(to 100°C) | To CGSB 1-GP-61M<br>Alkyd Enamel<br>Minimum DFT 40 micron |
| L | High Build Epoxy | Black Polyamine cured<br>Minimum DFT 200 micron |
| M | Bituminous Paint | To AWWA C230 MIL-P-151470 |
| N | Silicone Alkyd<br>(100°C to 150°C) | Minimum 60% Solids by Wt<br>Nominal DFT 25 micron |
| O | Silicone Enamel<br>(150°C to 400°C) | To CGSB 1-GP-143M<br>Nominal DFT 40 micron |
| P | Fast Drying Aluminum Sealer | To CGSB 1-GP-69M<br>Nominal DFT 25 micron |
| Q | Canvas Insulation Sealer | Acrylic or PVA Latex |
| R | Epoxy Gloss Enamel | To CGSB 1-GP-146<br>Nominal DFT 50 micron |
| SSPC: Steel Structures Painting Council Pittsburgh PA 15213 Surface Preparation Specifications 1985 | | |

## 2.7 Schedule of Protective Systems

.1 The schedule of protective systems defines the combination of surface treatments required in each system and the sections of the plant to which it is to be applied. The systems have been grouped into there categories as follows:

.2 Category A: Immersed Service - equipment or material fully, partially, or intermittently immersed in sewage during routine plant operation.

.3 Category B: Exposed Service - equipment or material exposed to the normal range of atmospheric conditions and conditions common to sewage treatment facilities (high humidity, $H_2S$, etc.)

.4 Category C: Indoor Service - equipment or material inside buildings or other ventilated spaces.

## 2.8 Category A

.1 Category A: all category A systems will be tested by the Contract Administrator using a wet sponge holiday detector set at 67.5 volts. Touch up will be required at points where the detector is grounded.

| Reference | Surface Treatments | Typical Applications |
|---|---|---|
| A1 | A, D, I, L | Equipment or piping delivered with inorganic zinc primer, e.g., clarifier mechanisms, mixers, etc. |
| A2 | A, F, J, L ,L | Equipment or piping delivered uncoated or with coatings not compatible with high build epoxy, e.g., ductile iron, cast iron or steel pipe and pipe sleeves inside treatment units. External surfaces at valves, ferrous weir plates, weirs, penstocks, fabricated pipe supports, brackets, etc. |
| A3 | A, G, M | Aluminum surfaces in contact with concrete, e.g. stop log guides, access cover frames. |
| A4 | A, E | Ferrous metal surface cast concrete, e.g., penstocks, sluice gates |
| A5 | A | Stainless steels, plastics, and fiberglass products. |
| A6 | A, E, J, M, M | Ferrous metal immersed in abrasive environment, listed below:<br>- grit tanks |

## 2.9 Category B

.1 Schedule

| Reference | Surface Treatments | Typical Applications |
|---|---|---|
| B1 | A, B, R, R | Equipment or piping delivered with inorganic zinc primer, e.g. clarifier motor, gearbox and motor, valve headstocks, piping above ground and outside treatment units, hydrants, etc. |
| B2 | A, B, J, R ,R | Equipment or piping delivered not supplied with an inorganic zinc prime coat or with a prime coat not compatible with an inorganic zinc overcoat |
| B3 | A, G, R, R | Equipment delivered with factory applied paint which is to be painted for identification only |
| B4 | A | Stainless steel or aluminum products, e.g. insulation recovering. |

## 2.10 Category C

.1 Schedule

| Reference | Surface Treatments | Typical Applications |
|---|---|---|
| C1 | A, B, K, K | Equipment or piping delivered c/w factory finished coatings. Coated for system identification and maintenance. Surface temperature during operation not exceeding 100°C, e.g., pumps, air handling units, valves, etc. |
| C2 | A, G, K, K | Equipment or accessories fully primed. Surface temperatures not exceeding 100°C, e.g. pumps, steel piping |
| C3 | A, C, I, N, N | Equipment or accessories as C1 or C2 but with operating surface temperatures between 100°C and 150°C, e.g. air compressors, blowers |
| C4 | E, J, O | Equipment or accessories as C1 or C2 but with operating surface temperatures between 150°C and 400°C, e.g. boiler fittings |
| C5 | B, P, K, K | Piping or valves with bituminous or tar coatings. Surface temperatures not exceeding 100°C, e.g., cast iron and ductile iron pipe, valves |
| C6 | A, K, K | PVC pipe, fittings or accessories, coated for identification only |
| C7 | A, H, K, K | Aluminum insulation recovering coated for identification only |
| C8 | A, Q, G, N, N | Canvas insulation recovering. |
| NOTES: (1) Surface preparation "G" abrasion, has not been fully scheduled but is to be carried out between all coatings<br>(2) No bare ferrous metal surfaces are permitted. Pipe hangar rods etc. unless zinc or cadmium plated are to be at least prime coated. Cut ends of plated surfaces (Uni-Strut, etc.) are to be spot primed | | |

**2.11 Colour Coding**

.1 Refer to Section 11910 for pipe and equipment identification colour coding.

**2.12 Acceptable Products**

.1 Amercoat Ltd.

.2 Carboline

.3 General Paints Ltd.

.4 ICI Paints Ltd.

.5 Plasite

.6 Rust Oleum

.7 Valspar

**3. EXECUTION**

**3.1 Quality Assurance**

.1 Apply and cure all paints and coatings strictly in accordance with the manufacturer's directions.

.2 Pay particular attention to ensure the compatibility of each surface treatment with the preceding and subsequent surface treatment and coatings. Be responsible for the compatibility of all surface treatments and coatings.

## 3.2 Environmental Conditions

.1 Apply no coating when the ambient or surface temperature is below 10°C or less than 3°C above the dew point.

.2 Provide a minimum of 300 lux illumination on surface to be treated.

.3 Do not apply coatings where dust is being generated.

## 3.3 Protection

.1 Provide sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Make good any damage resulting from inadequate or unsuitable protection.

.2 Maintain all coated surfaces until completion of the Work. Make good within seven days any damage to coatings.

.3 Place cotton waste, cloths, and material which may constitute a fire hazard in closed metal containers and remove from the Site at suitable intervals.

.4 Adequately mask, or remove and replace after painting, all grease nipples, bright metal surfaces, identification plates and other items not to be painted. Do not use solvent that may remove permanent lacquer finishes.

## 3.4 Condition of Surfaces

.1 Prior to starting Work, thoroughly examine all surfaces to be treated or coated. Report, in writing, to the Contract Administrator any condition or defect that may affect the integrity or quality of the finished coating. Do not start Work on any Section until all such defects in that Section have been corrected.

.2 On all factory primed or coated equipment, touch up defects prior to the application of subsequent coatings.

.3 Be responsible for the condition of surfaces and for correcting defects and deficiencies in the surface.

## 3.5 Inspection

.1 The Contract Administrator has the right to request tests, to witness the performance of tests, or to perform tests.

.2 Such inspection does not relieve any responsibility for guarantee of the coating application from the applicator.

## 3.6 Clean-Up

.1 After acceptance of coating, remove all masking, grease, etc, from all equipment which was not intended to be coated.

.2 Remove all unused material, containers, etc, from the Site upon completion of Work.

**END OF SECTION**

# FACTORY-APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

## 1. GENERAL

### 1.1 Work Included

.1 Supply and application of all factory applied prime coats or factory applied finish coats.

### 1.2 Submissions

.1 With the equipment Shop Drawings, submit details of the coating systems to be applied.

### 1.3 Quality Assurance

.1 This Specification is intended to be a minimum reference standard. The Contractor may submit for review alternative coating systems for specific items of equipment which provide equal or better corrosion protection and maintenance service than those specified herein.

## 2. PRODUCTS

### 2.1 Surface Preparation

.1 Immersion Service: after degreasing, dry blast all ferrous components to a white metal finish in accordance with SSPC-SP5 to a degree of cleanliness in accordance with NACE #1 and obtain a 50 micron blast profile.

.2 Non-immersion Service: after degreasing, dry blast all ferrous components to a near white finish in accordance with SSPC-SP10 to a degree of cleanness in accordance with NACE #3 and obtain a 50 micron blast profile.

### 2.2 Prime Coating

.1 Prime coat all ferrous surfaces before the blasted surfaces deteriorate.

.2 Coat ferrous surfaces with inorganic zinc primer, containing a minimum of 50 percent solids by volume, applied to a minimum dry film thickness of 75 microns.

### 2.3 Finish Coats

.1 Apply finish coats in conformance with Section 11900 for service, coating types and application rates.

### 2.4 Assembly

.1 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.

.2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.

.3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers and rivets in a similar manner.

.4 Use 304 stainless steel or better for all nuts, bolts, washers and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts, washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

## 3. EXECUTION

### 3.1 Inspection

.1 Notify the Contract Administrator two weeks before commencing the protective coating to permit the inspection by the Contract Administrator of the surface preparation and protective coating application.

### 3.2 Protection

.1 Protect all coated equipment adequately against damage, dust, moisture and scratching during shipment, off-loading, and storage on-site. If, in the opinion of the Contract Administrator, the coating is damaged during shipment to the extent that touch up would not be satisfactory, return and re-coat the equipment at the Contractor's cost.

.2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

### 3.3 Application Conditions

.1 Apply all factory applied coatings under controlled conditions, in a dust-free atmosphere at a temperature of between 10°C and 20°C, and a relative humidity should not exceed 80 percent.

**END OF SECTION**

# IDENTIFICATION

## 1. GENERAL

### 1.1 Work Included

.1 Identification of equipment, motors, vessels, valves, ferrous, non-ferrous, and insulated piping.

## 2. PRODUCTS

### 2.1 Equipment Manufacturer's Nameplates

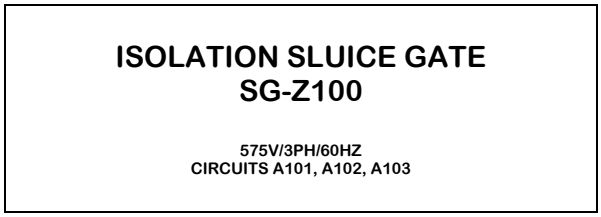
.1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Provide Underwriters' Laboratories or CSA registration plates, as required by respective agency.

.3 Manufacturer's nameplates to indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase, and power of motors.

### 2.2 Equipment - Project Identification Nameplates

.1 Supply and install white lamicoid identification plates, with black lettering, for all equipment installed under this contract. Provide identification plates that are engraved with the unit name and equipment number in 12 mm high lettering and electrical characteristics, if applicable, in 6 mm high lettering, as shown in the following example:




.2 Submit list of plates for review prior to engraving.

### 2.3 Valves

.1 Provide all valves with a white lamicoid tag, with 12 mm black engraved names and numbers.

.2 Number valves as directed by the Contract Administrator or as shown on the Drawings.

.3 Attach tags to valves using fasteners. Adhesive mounts are not acceptable.

## 2.4 Piping

.1 For all piping installed under this Contract, use pipe markers designating the pipe service and the direction of flow.

.2 Use pre-printed pipe markers. For pre-printed pipe markers, use self-adhesive, plastic coated cloth labels. In addition to its adhesive, secure each label with a full tape band at each end of the label.

.3 Make direction arrows 150 mm long by 50 mm wide for piping with an outer diameter 75 mm or larger, including insulation. Use 100 mm long by 20 mm wide arrows for smaller diameter piping. Provide double headed arrows where appropriate.

.4 Use block capital letters for names, 50 mm high for piping with an outer diameter 75 mm or larger, including insulation. Use 20 mm high letters for smaller diameters. Identify the pipe commodity using the full names detailed on the Drawings or identified in Section 15055.

.5 Use stainless steel tags for pipes and tubing with an outer diameter 20 mm and smaller.

## 2.5 Colour Coding

.1 Use a colour coded identification system on the following items:

.1 All piping and valves: paint or band the piping with the colours agreed prior to the Work, paint the valves in the colour of the system, other than valves on fire protection systems. Paint the valves on fire protection systems red.

.2 All pumps: paint pumps in the colour identifying the material being pumped

.3 All motors: paint all motors grey

.2 Identification shall consist of the following:

.1 Coating or banding of pipes and coating of valves to the colour of the medium being conveyed

.2 Coat non-submerged process equipment to match the colour requirement of the material being processed.

.3 Finish valve handles and similar appurtenances in black.

.3 Select identification colours in accordance with the colour scheme as outlined in the following table:

| Item | Colour | Colour Code |
|---|---|---|
| Potable Water | Sky Blue | SW 3021 |
| Well Water Supply | Violet | SW 3022 |
| Well Water Return | Violet | SW 3022 |
| Flushing Water | Blue | SW 3023 |
| Hot Water Supply | Green | SW 3024 |
| Hot Water Return | Aqua Green | SW 3025 |
| Glycol Supply | Medium Fuschia | SW 3026 |
| Glycol Return | Light Fuschia | SW 3027 |
| Rain Water Leaders | Grey | SW 3028 |
| Primary Effluent | Mint Yellow | SW 3030 |
| Primary Sludge | Charcoal Grey | SW 3031 |
| Return Activated Sludge | Orange | SW 3032 |
| Waste Activated Sludge | Yellow | SW 3033 |
| Sludge Mixing System | Pumpkin | SW 3034 |
| Scum/Degreasing | Blue-Grey | SW 3035 |
| Process Drain | White | SW 3036 |
| Mix Age Polymer Tanks | Med. Orange | SW 3040 |
| Polymer Feed Tanks | Teal Blue | SW 3041 |
| Dry Polymer Storage | Light Green | SW 3042 |
| Liquid Polymer Storage | Medium Green | SW 3043 |
| Sludge Feed/Transfer | Dark Yellow | SW 3044 |
| Sludge Cake Line | Medium Yellow | SW 3045 |
| Thin Sludge | Light Yellow | SW 3046 |
| Centrate | Very Light Yellow | SW 3047 |
| Sludge Cake Storage | Medium Yellow | SW 3045 |
| Treated Centrate | Blue Grey | SW 3035 |
| Sludge (Trucked) | Rich Tan | SW 3048 |
| Sludge Cake Hopper | White | SW 3049 |
| Sludge Cake Pump Drive | Dark Green | SW 3050 |
| Ferric Chloride | Bright Yellow | SW 3063 |
| Instrument Air | Forest Green | SW 3060 |
| Process Air | Terrace Green | SW 3061 |
| Oxygen | Purple | SW 3062 |
| Chlorine | Bright Yellow | SW 3063 |
| Natural Gas | Safety Yellow | SW 3064 |
| Digester Gas | Red | SW 3065 |
| Methanol | Bright Yellow | SW 3063 |
| Soda Ash | Med. Orange | SW 3040 |
| Duct Work | Warm Grey | SW 3070 |
| Steel Pipe Supports | Ansi Light Grey | SW 3071 |
| Bollards | Red | SW 3065 |
| Exterior Pedestals/Panels | Lemon Yellow | SW 3071 |
| Handrails (Painted) | Aluminum | B 59S2 |
| Motors | Red | SW 3065 |
| Motor Bases | Carmine Red | SW 3072 |
| Valves/Pumps | Match conduit | |
| Valve Hand/Chainwheels | Red | SW 3065 |
| Boilers | Heat Resistant Aluminum | B 59S3 |
| Concrete/Blockwork | Platinum Grey | SW 4012 |
| | | |
| Note: SW = Sherwin Williams | | |

## 3. EXECUTION

### 3.1 Equipment Manufacturer's Nameplates

.1 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

### 3.2 Equipment Project Identification Nameplates

.1 Attach plates to the equipment with rivets, sheet metal screws, or nuts and bolts (adhesive will not be accepted).

.2 Fasten plates in conspicuous locations. Where plates cannot be mounted on hot or cold surfaces, provide standoffs.

### 3.3 Valves

.1 Attach tags to all valves with sheet metal screws or nuts and bolts. Ensure tags are easily accessible from operator location and do not conflict with valve operation.

### 3.4 Piping

.1 On completion of protective coatings or finish painting, neatly stencil direction flow arrows and the commodity abbreviation on the pipe. Alternatively, attach pre-printed labels.

.2 Stencil or attach pipe markers in readily visible locations. Identify piping at the following locations:

.1 At each valve

.2 On both sides of wall penetrations

.3 At floor and roof penetrations

.4 On each leg of branches

.5 Every 15 m along continuous runs

**END OF SECTION**