PROCESS PIPING

1. GENERAL

1.1 Description

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

.2 Use the general requirements specified in this section integrally with the more specific requirements listed in Section 15055.

.3 Piping supports are generally not shown on the process mechanical layout 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 In order to install large diameter piping, some smaller piping and ducting may need relocation. Contractor will inspect the area of work and include any such work, allowing for the design, supply, installation and testing of the relocated items and their supports. Insulation and other finishes must be provided to match existing.

.5 The Contractor must provide the necessary submittals and ensure the proper registration of piping systems and system components as required by ACI Central.

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 0.45 m 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 and/or channels, and within 3.0 m above maximum water level of open tankage. Includes 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 B16.3, Malleable Iron Threaded Fittings Class 150 and 300

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

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

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

.7 ANSI/ASME B31.1, Power Piping

.8 ANSI/ASME B31.3, Process Piping

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

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

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

.12 ASTM A47, Malleable Iron Castings

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

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

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

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

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

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

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

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

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

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

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

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

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

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

.27 ASTM A536, Ductile Iron Castings

.28 ASTM A563, Carbon and Alloy Steel Nuts

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

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

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

.32 ASTM B32, Standard Specification for Solder Metal

.33 ASTM B88, Seamless Copper Water Tube

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

.35 ASTM D1248, Polyethylene Plastics Moulding and Extrusion Materials

.36 ASTM D1457, PTFE Moulding and Extrusion Materials

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

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

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

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

.41 ASTM D4101, Propylene Plastic Injection and Extrusion Materials

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

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

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

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

.46 AWWA C206, Field Welding of Steel Water Pipe

.47 AWWA C207, Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch

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

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

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

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

.52 AWWA C606, Grooved and Shouldered Joints

.53 AWWA C651, Disinfecting Water Mains

.54 AWWA C906, Standard for Polyethylene (PE) Pressure Pipe and Fittings 4 in. Through 63 in., for Water Distribution

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

.56 CGA, Canadian Gas Association Standards

.57 CPC, Canadian Plumbing Code

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

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

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

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

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

.63 MIL-S-8660C, Silicone Compound

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

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

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

.67 SSPC-P3, Canadian Government Standards Board.

.68 SSPC-SP6, Canadian Government Standards Board.

.69 SSPC-SP10, Canadian Government Standards Board

.70 NPC, National Plumbing Code

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

1.4 Submittals

.1 Radiographic Weld Testing: 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 Engineer.

.2 For all pipe 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.

.3 Submit copies of all original submittals and all related correspondence made as part of the regulatory submission required by ACI Central and any submissions required by other regulatory authorities.

.4 Product Samples: Where specified or when directed by the Engineer, provide mill test results or product samples.

.5 Welding: Prior to commencing any welding of stainless steel pipe, prepare and submit to the Engineer 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 stamped and sealed by a Professional Engineer 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.

.6 Radiographic weld test results.

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

1.5 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 15055.

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

.5 Pipe Sleeves: Coordinate with other divisions, prior to construction, to locate and place sleeves in cast-in-place concrete. Also, prior to construction of masonry building elements.

.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.

1.6 Quality Assurance

.1 Welding Certification

.1 All welders to be certified under ACI Central. 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 while working on the stainless steel piping.

.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% 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 Engineer.

.2 For piping required by the applicable Code to be subject to radiographic inspection, or for welds not found satisfactory during the Engineer'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 Engineer.

.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 Engineer.

.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 Engineer.

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

.3 Regulatory Submissions

.1 Complete all regulatory submissions as required ACI Central.

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

1.7 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 Engineer 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 Engineer 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 Engineer.

1.8 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.

1.9 Warranty

.1 Provide the Owner with a materials and labor warranty for the work. See Sections 01400 and 01600. 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 Engineer's inspections, checks, or any other tests or subsequent authorization to proceed with the work, nor Engineer's waiving of Engineer's right to perform such tests, nor Engineer'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. Contractor agrees that Engineer's ability to fully assess the suitability of materials, work procedures, worker qualifications and other relevant issues is limited. 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 labor 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 15055.

.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 mitered elbows greater than 350 mm, to AWWA C208 unless otherwise shown or specified. Use 3-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 in 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 in 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.

2.5 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 ring 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 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.

2.6 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, Gr.A.

.3 Provide stainless steel bolts, nuts and washers for exposed, submerged, buried and concrete encased service; bolts conforming to ASTM A193, Gr.B8, C1.1; nuts conforming to ASTM A194, Gr.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.

2.7 Cathodic Protection

.1 Provide cathodic protection of piping, pipe fittings and appurtenances in accordance with Division 16.

2.8 Structural Element Penetrations

.1 Structural element penetrations are shown and referenced to a detail or Process/Mechanical Standard Details. 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. Century Line HDPE sleeves with water stop collar may be used where applicable.

.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 (o.d.). 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 o.d. of the pipe. For pipes 75 mm and less furnish a pipe sleeve 25 mm larger than the o.d. 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 o.d. For pipes 75 mm and less furnish a pipe sleeve 25 mm larger than the o.d. 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 Owner. Do not use this type of wall penetration below maximum ground water level elevation.

2.9 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 09905.

2.10 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 09905 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 a 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%; 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 3 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 3 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 09905 for details.

2.11 Exterior Finishes - (Coatings) Field Applied

.1 General

.1 Use field applied finishes only for: 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; to repair shop-applied exterior finishes; to make up cutback distances at joints; and for fittings, couplings, valves and other appurtenances.

.2 Refer to Section 09905 for painting requirements for aboveground piping and piping located in tunnels, buildings, pump houses, and other structures. Also refer to Section 09905 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 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 Engineer 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 09905.

2.12 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).

2.13 Grout

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

2.14 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, at no additional expense to the Owner, modify the piping arrangement as necessary.

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

.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 Engineer.

.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 (1/4").

3.3 Sleeves

.1 Unless otherwise noted or approved by the Engineer, 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 tapewrap 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 centre.

.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 ACI Central. 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 15 to 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 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 ND 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 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/or 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 (SMAW), submerged arc (SAW), or inert gas shield arc (GMAW) or gas tungsten arc (GTAW) welding.

.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% 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 a 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 09905.

.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 Testing

.1 Give the Engineer 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 Engineer. Use 5% copper sulphate solution. After 10 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.