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 B16.1, 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, Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids

.98 AWWA C303, Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, 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 in. 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 CISPI 301, Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings

.108 CPC, Canadian Plumbing Code

.109 CSA B52, Mechanical Refrigeration Code

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

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

.112 CSA CAN-Z183, Oil Pipeline Systems

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

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

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

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

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

.118 MIL-S-8660C, Silicone Compound

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

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

.121 MSS SP43, Wrought Stainless Steel Butt Welding Fittings

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

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

.124 SSPC-P3, Canadian Government Standards Board.

.125 SSPC-SP6, Canadian Government Standards Board.

.126 SSPC-SP10, Canadian Government Standards Board

.127 NPC, National Plumbing Code

.128 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 Design Requirements

.1 The design has been completed to the degree necessary for the Contractor to tender the project. It is not fully detailed and will require the Contractor to undertake some design of several 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. ABSA shall be the Code Authority whenever the piping system falls within the Code scope. The Engineer 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 drawing 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 Engineer's 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 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's Engineer, resulting from excessive thrusts and moments in the piping.

.6 Design documentation will be submitted to the Engineer as necessary to indicate compliance with the requirements of the piping systems. The documentation will be stamped and sealed by a Professional Engineer. The Engineer stamping the drawings must provide evidence of experience with such systems.

.7 Note that for large diameter, thin walled (thickness less than 1% 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 15055, 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: 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.

.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 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.

.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 ACI Central and any submissions required by other regulatory authorities.

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

.8 Provide hanger, guide, anchor, support system design details including locations, load information, design calculations and illustrative drawings, stamped and signed by a Professional Engineer. Refer to Section 15052.

.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 precompression, stamped and signed by a Professional Engineer. Refer to Section 15053.

.10 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.

.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 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.

1.7 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.

.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.

1.8 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 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.

1.9 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 Provide the Owner with a materials and labor warranty for the work. See Sections 01400 and 01600. Contractor shall supply new materials an 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.

.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.

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 Insulation

.1 Provide insulation in accordance with Section 15059. 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 15059.

.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.

2.10 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.

.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% sulphuric acid solution at 65°C for a period of ten minutes.

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

.5 Provide sample to Engineer 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% 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 & 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 volt 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 10000 OHMS. The current is applied through a circular sponge which has been wetted using water containing approximately 1% 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% 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 3" of the end), the test personnel shall also make a visual inspection 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% of the total glassed surface (no more than 1-2 pinholes per fitting or an average of 5 or less per 20 foot pipe spool). Rejected pipe shall be evaluated for additional coating with Porcelain Enamel or for total reblasting, reprocessing, and retesting

2.11 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.