

# ***Conrad Cairo Renovation Lobby & Public Areas***

## ***Plumbing & Fire Fighting Works Specifications***

***Bakry Consulting Engineers***

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**DIVISION 21, 22, 23**  
**INDEX**

|    |  | SECTION NO.       |
|----|--|-------------------|
| 1  | METERS AND GAUGES FOR PUMPING WORKS                    | SECTION 22 05 19  |
| 2  | GENERAL-DUTY VALVES FOR PLUMBING PIPING                | SECTION 22 05 23  |
| 3  | PLUMBING FIXTURES                                      | SECTION 22 40 00  |
| 4  | SANITARY WASTE AND VENT PIPES                          | SECTION 22 13 16  |
| 5  | PLUMBING PIPING  | SECTION 22 11 17  |
| 6  | DOMESTIC WATER PIPING                                  | SECTION 22 11 16  |
| 7  | FACILITY WATER DISTRIBUTION PIPING                     | SECTION 22 11 13  |
| 8  | HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT | SECTION 22 05 29  |
| 9  | BUILDER'S WORK   | SECTION 22 05 11  |
| 10 | BASIC MECHANICAL MATERIALS AND METHODS                 | SECTION. 22 00 10 |
| 11 | WATER - BASED FIRE SUPPRESSION SYSTEMS                 | SECTION 2110 00   |

## CONTENTS

### SECTION 22 05 19

#### METERS AND GAUGES FOR PUMPING WORKS

##### **PART 1    GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Related Sections
- 1.4 Submittals
- 1.5 Quality Assurance

##### **PART 2    PRODUCTS**

- 2.1 Manufacturers
- 2.2 Thermometers, General
- 2.3 Liquid-In-Glass Thermometers
- 2.4 Direct-Mounting Filled-System Dial Thermometers
- 2.5 Remote-Reading, Filled-System Dial Thermometers
- 2.6 Thermometer Wells
- 2.7 Bimetal Dial Thermometer
- 2.8 Pressure Gages
- 2.9 Pressure-Gage Accessories
- 2.10 Test Plugs
- 2.11 Flow-Measuring Systems, General
- 2.12 Venturi Flow Elements
- 2.13 Pitot-Tube Flow Elements
- 2.14 Flow-Measuring Meters
- 2.15 Flow Indicators
- 2.16 Electro-Magnetic Flow Meters
- 2.17 Vortex In-Line Flow Meter
  
- 2.18 Water Meter
- 2.19 Btu Meter

##### **PART 3    EXECUTION**

- 3.1 Meter and Gage Applications
- 3.2 Meter and Gage Installation, General
- 3.3 Thermometer Installation
- 3.4 Pressure Gage Installation
- 3.5 Test Plug Installation
- 3.6 Flow-Measuring System, Flow Element and Meter

- Installation
- 3.7 Flow Meter Installation
- 3.8 Btu Meter Installation
- 3.9 Connections
- 3.10 Adjusting and Cleaning

**SECTION 22 05 19**  
**METERS AND GAGES FOR PUMPING WORKS**

**PART 1 GENERAL**

**1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

**1.2 SUMMARY**

This Section includes meters and gages used in mechanical systems.

**1.3 RELATED SECTIONS**

Division-22 piping Sections contain requirements that relate to this Section.

**1.4 SUBMITTALS**

1.4.1 **General:** Submit the following according to the Conditions of the Contract and Division 1 Specifications Group.

1.4.2 Product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.

1.4.3 Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

1.4.4 Maintenance data to include in the "Operating and Maintenance Manuals" specified in Division-1 Section "Project Closeout". Include data for the following:

- A) Test plugs.
- B) Flow measuring systems.
- C) Flow meters.
- D) BTU meters.

**1.5 QUALITY ASSURANCE**

Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

## **PART 2   PRODUCTS**

### **2.1   MANUFACTURERS**

Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal shown in Section 01 62 00.

### **2.2   THERMOMETERS, GENERAL**

2.2.1   **Scale Range:** Temperature ranges for services listed as follows:

- A)   Domestic Hot Water: 0 to 115 deg C, with 1 degree scale divisions.
- B)   Domestic Cold Water: Minus 18 to 38 deg C, with 1 degree scale divisions.
- C)   Hot Water: 0 to 150 deg C, with 1 degree scale divisions.
- D)   Condenser Water: Minus 18 to 70 deg C, with 1 degree scale divisions .
- E)   Chilled Water: Minus 18 to 38 deg C, with 1 degree scale divisions .
- F)   Steam and Condensate: 10 to 205 deg C, with 1 degree scale divisions .

2.2.2   **Accuracy:** Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

### **2.3      LIQUID-IN-GLASS THERMOMETERS**

- 2.3.1      **Description:** ASTM E1, liquid-in-glass thermometer.
- 2.3.2      **Case:** Die-cast and aluminum-finished in baked-epoxy enamel, glass front, spring secured, 230 mm (9") long.
- 2.3.3      **Adjustable Joint:** Finished to match case, 180 degree (3.1rad) adjustment in vertical plane, 360 degree (6.3rad) adjustment in horizontal plane, with locking device.
- 2.3.4      **Tube:** Red-reading mercury-filled with magnifying lens.
- 2.3.5      **Tube:** Red-reading, organic liquid-filled instead of mercury-filled, with magnifying lens.
- 2.3.6      **Scale:** Satin-faced non-reflective aluminum with permanently etched markings.
- 2.3.7      **Stem:** Copper-plated, steel, aluminum, or brass for a separable socket of length to suit installation.

### **2.4      DIRECT-MOUNTING FILLED-SYSTEM DIAL THERMOMETERS**

- 2.4.1      **Description:** Vapor-actuated universal-angle dial thermometer.
- 2.4.2      **Case:** Drawn steel or cast aluminum, with 115 mm diameter glass lens.
- 2.4.3      **Adjustable Joint:** Finish to match case, 180 degree (3.1rad) adjustment in vertical plane, 360 degree (6.3rad) adjustment in horizontal plane, with locking device.
- 2.4.4      **Thermal Bulb:** Copper with phosphor bronze Bourdon pressure tube.
- 2.4.5      **Movement:** Brass, precision geared.
- 2.4.6      **Scale:** Progressive satin-faced non-reflective aluminum et.
- 2.4.7      **Stem:** Copper-plated steel, aluminum, or brass for a separable socket of length to suit installation.

### **2.5      REMOTE-READING, FILLED-SYSTEM DIAL THERMOMETERS**

- 2.5.1      **Description:** Vapor-actuated remote-reading dial thermometer.
- 2.5.2      **Case:** Drawn steel or cast aluminum, with 115 mm diameter glass lens.



- 2.5.3 **Movement:** Brass, precision geared.
- 2.5.4 **Scale:** Progressive satin-faced non-reflective aluminum with permanently etched markings.
- 2.5.5 **Tubing:** Bronze double-braided armor-over-copper capillary of length to suit installation.
- 2.5.6 **Bulb:** Copper with separable socket for liquids; averaging element for air.
- 2.6 THERMOMETER WELLS**
- 2.6.1 **Description:** Stainless-steel thermometer well.
- 2.6.2 **Pressure Rating:** Not less than piping system design pressure.
- 2.6.3 **Stem Length:** To extend to center of pipe.
- 2.6.4 **Extension for Insulated Piping:** 50 mm (2") nominal, but not less than thickness of insulation.
- 2.6.5 **Threaded Cap Nut:** With chain permanently fastened to well and cap.
- 2.7 BIMETAL DIAL THERMOMETER**
- 2.7.1 Hermetically sealed all welded stainless steel construction with glass dial.
- 2.7.2 +/- 1% full span accuracy.
- 2.7.3 76 mm dial face with 13 mm NPT lower stem attachment and 150 mm rod length.
- 2.7.4 Temperature range 0/100.

## **2.8 PRESSURE GAGES**

- 2.8.1 **Description:** ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage, with bottom connection.
- 2.8.2 **Case:** Drawn steel, brass, or aluminum with 115 mm (4-1/2") diameter glass lens.
- 2.8.3 **Connector:** Brass, 6 mm (1/4") NPS.
- 2.8.4 **Scale:** White-coated aluminum, with permanently etched markings.
- 2.8.5 **Accuracy:** Plus or minus 1 percent of range span.
- 2.8.6 **Range:** Conform to the following:
- A) **Vacuum:** 30 inches Hg of vacuum to 15 psig of pressure.
  - B) **Vacuum:** 100 kPa of vacuum to 100 kPa of pressure.
  - C) **Fluids Under Pressure:** 2 times operating pressure.

## **2.9 PRESSURE-GAGE ACCESSORIES**

- 2.9.1 **Syphons:** 6 mm straight coil of brass tubing with threads on each end.
- 2.9.2 **Snubbers:** 6 mm brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

## **2.10 TEST PLUGS**

- 2.10.1 **Description:** Nickel-plated brass-body test plug in 15 mm fitting.
- 2.10.2 **Body:** Length as required to extend beyond insulation.
- 2.10.3 **Pressure Rating:** 3450 kPa (500 psig) minimum.
- 2.10.4 **Core Inserts:** 2 self-sealing valve types, suitable for inserting a 3 mm outside-diameter probe from a dial thermometer or pressure gage.
- 2.10.5 **Core Material:** According to the following for fluid and temperature range:
- A) **Air, Water, Oil, and Gas:** Minus 7 to 93 deg C , neoprene rubber.
  - B) **Air and Water:** Minus 35 to 136 deg C, ethylene-propylene-diene-terpolymer (EPDM) rubber.

- 2.10.6 **Test-Plug Cap:** Gasket and threaded cap, with retention chain.
- 2.10.7 **Test Kit:** Provide test kit consisting of 1 pressure gage and gage adapter with probe, 2 bimetal dial thermometers and a carrying case.
- 2.10.8 **Pressure Gage and Thermometer Ranges:** Approximately 2 times systems operating conditions.
- 2.11 FLOW-MEASURING SYSTEMS, GENERAL**
- 2.11.1 Flow-measuring systems include calibrated flow element, separate meter, hoses or tubing, valves, fittings, and conversion chart that is compatible with flow element, meter, and system fluid.
- 2.11.2 Flow range of flow-measuring element and meter covers operating range of equipment or system where used.
- 2.12 VENTURI FLOW ELEMENTS**
- 2.12.1 **Description:** Venturi differential-pressure-design flow-element fitting made for installation in piping.
- 2.12.2 **Construction:** brass, with brass fittings and attached tag with flow conversion data. Include ends threaded for 50 mm and smaller elements and flanged or welded for 65 mm and larger elements.
- 2.12.3 **Pressure Rating:** 2070 kPa.
- 2.12.4 **Temperature Rating:** 120 deg C.
- 2.13 PITOT-TUBE FLOW ELEMENTS**
- 2.13.1 **Description:** Pitot-tube differential-pressure design with probe made for insertion into piping.
- 2.13.2 **Construction:** Stainless-steel probe of length to span inside of pipe, with brass fittings and attached tag with flow conversion data.
- 2.13.3 **Pressure Rating:** 2070 kPa (300 psig).
- 2.13.4 **Temperature Rating:** 120 deg C (250 deg F).
- 2.14 FLOW-MEASURING METERS**
- 2.14.1 **Permanent Meters:** Suitable for mounting on wall or bracket, 150 mm dial or equivalent with fittings and copper tubing for connecting to flow element.

A) **Scale:** In L/s (gallons/minute) unless otherwise indicated.

B) Accuracy: Plus or minus 1 percent between 20 to 80 percent of range.

2.14.2 **Portable Meters**: Differential-pressure gage and two 3.7 m hoses in carrying case with handle.

A) Scale: In mm of water unless otherwise indicated.

B) Accuracy: Plus or minus 2 percent between 20 to 80 percent of range.

2.14.3 Include complete operating instructions with each meter.

## **2.15 FLOW INDICATORS**

2.15.1 **Description**: Instrument for visual verification of flow made for installation in piping systems that measures flow directly in L/s (gallons/minute).

2.15.2 **Construction**: Bronze or stainless steel body with sight glass and plastic pelton-wheel indicator.

2.15.3 **Pressure Rating**: 860 kPa.

2.15.4 **Temperature Rating**: 93 deg C.

## **2.16 ELECTRO-MAGNETIC FLOW METERS**

2.16.1 For pipe sizes 38 mm and above.

2.16.2 4-20 mA output, isolated with 2 line 20 character alphanumeric LCD display.

2.16.3 Accuracy +/- 1% of full scale.

2.16.4 Enclosure NEMA 4X, 200 V/50 Hz power required.

2.16.5 **Security**: keypad lock-out with access code enable.

2.16.6 **Probe Housing Material**: 316 stainless steel body and PVDF tip with epoxy encapsulation.

A) Electrode: 316 stainless steel

B) Mounting: 1 1/2 MNPT, pipe saddle or female threaded coupling.

## **2.17 VORTEX IN-LINE FLOW METER**

2.17.1 In-line meter with no moving parts accuracy minimum +/-1% of flow rate adjustable response time for liquids, gas or steam.

- 2.17.2 Power requirements 18 to 40 VDC with optional 220 V, 50 Hz.
- 2.17.3 Output signal 4-20 mA current.
- 2.17.4 Stainless steel construction
- 2.17.5 Electronics enclosure shall be corrosion resistant epoxy paint.
- 2.17.6 ANSI B165 Class 150 or 300 as required by system pressures.
- 2.17.7 Single transmitter, single sensor with transmitter remote mounted.

## **2.18 WATER METER**

Turbine, in-line, dry dial, magnetic drive type, manufactured from corrosion resistant materials and suitable for a working pressure of 10 kg/cm<sup>2</sup> and a cold water temperature of up to 50 deg. C. Meter to be sized for the specified flow rate at a maximum head loss of 2.5 m water gauge, and to have the manufacturer's guaranteed accuracy of +/-5% at the minimum flow rate. Dial registration to go up to 1,000,000 cubic meter. Meter to have a combination dial and roller totalizer in a hermetically sealed casing to preclude glass misting, moisture corrosion and tampering, a hot pressed brass body and a hinged cover, with male threaded ends for union connections into the line.

## **2.19 BTU METER**

- 2.19.1 **Description:** Turbine-wheel Btu meter. Include turbine-wheel flow meter, 2 temperature sensors, transmitter, solid-state calculator with integral battery pack, integral stop valves, strainer, and magnetic trap.
- 2.19.2 **Description:** Turbine-wheel or other method-of-operation Btu meter. Include turbine-wheel or other flow meter, or flow-sensor element and meter, 2 temperature sensors, transmitter, solid-state calculator with integral battery pack, integral stop valves, strainer, and magnetic trap.
- 2.19.3 **Construction:** Bronze housing.
- 2.19.4 **Pressure Rating:** 2070 kPa.
- 2.19.5 **Temperature Range:** 5 to 120 deg C.
- 2.19.6 **Data Output:** 6-digit electromechanical counter with readout in kWh or J.
- 2.19.7 **Accuracy:** Plus or minus 1 percent.
- 2.19.8 **Battery Pack:** 5-year lithium battery.

## **PART 3   EXECUTION**

### **3.1   METER AND GAGE APPLICATIONS**

**General:** Where indicated, install meters and gages of types, sizes, capacities, and with features indicated.

### **3.2   METER AND GAGE INSTALLATION, GENERAL**

Install meters, gages, and accessories according to manufacturers' written instructions for applications where used.

### **3.3 THERMOMETER INSTALLATION**

3.3.1 Install thermometers and adjust vertical and tilted positions.

3.3.2 **Install in the following locations and elsewhere as indicated:**

- A) At inlet and outlet of each hydronic zone.
- B) At inlet and outlet of each hydronic boiler and chiller.
- C) At inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
- D) At inlet and outlet of each hydronic heat exchanger.

2.3.3 **Remote-Reading Dial Thermometers:** Install in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tulen.

2.3.4 **Thermometer:** Install in vertical position in piping tees where thermometers are indicated.

- A) Install wells with stem extending minimum of 50 mm into fluid.
- B) Install wells with stem extending to center of pipe.
- C) Fill wells with oil or graphite and secure caps.

### **3.4 PRESSURE GAGE INSTALLATION**

3.4.1 Install pressure gages in piping tee with pressure gage valve located on pipe at most readable position.

3.4.2 **Install in the following locations and elsewhere as indicated:**

- A) At suction and discharge of each pump.
- B) At discharge of each pressure-reducing valve.
- C) At building water service entrance.
- D) At chilled water and condenser water inlets and outlets of chillers.

3.4.3 **Pressure Gage Needle Valves:** Install in piping tee with Snubbers. Install syphon instead of Snubbers for steam pressure gages.

### **3.5 TEST PLUG INSTALLATION**

Install test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.

### **3.6 FLOW-MEASURING SYSTEM, FLOW ELEMENT AND METER INSTALLATION**

3.6.1 **General:** Install flow meters for piping systems located in accessible locations at most readable position.

3.6.2 **Locations:** Install flow measuring elements and meters at discharge of each pump, at inlet of each hydronic coil in built-up central systems, and elsewhere as indicated.

3.6.3 **Differential-Pressure-Type Flow Elements:** Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

3.6.4 Install connection fittings for attachment to portable flow meters in readily accessible locations.

3.6.5 **Permanently Mounted Meters for Flow Elements:** Install meters on walls or brackets in accessible locations.

3.6.6 Install connections, tubing, and accessories between flow elements and meters as prescribed by manufacturer's written instructions.

### **3.7 FLOW METER INSTALLATION**

Include 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 32 mm and smaller pipe. Include 20 pipe diameters upstream and 10 pipe diameters downstream for 40 mm and larger pipe.

### **3.8 BTU METER INSTALLATION**

**Btu Meters:** Install where indicated in hydronic supply piping. Install thermal well in return line for remote sensor. Mount meter on wall if accessible; if not, provide bracket to support meter.

### **3.9 CONNECTIONS**

3.9.1 Piping installation requirements are specified in other Division-22 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.

3.9.2 Install meters and gages adjacent to machines and equipment to allow servicing and maintenance.



- 3.9.3 Connect flow-measuring-system elements to meters.
- 3.9.4 Connect flow-meter transmitters to meters.
- 3.9.5 Connect Btu-meter transmitters to meters.
- 3.9.6 Make electrical connections to power supply and electrically operated meters and devices.

### **3.10 ADJUSTING AND CLEANING**

- 3.10.1 Calibrate meters according to manufacturer's written instructions, after installation.
- 3.10.2 **Adjusting:** Adjust faces of meters and gages to proper angle for best visibility.
- 3.10.3 **Cleaning:** Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

**END OF SECTION 22 05 19**

## CONTENTS

### SECTION 22 05 23

#### GENERAL-DUTY VALVES FOR PLUMBING PIPING

##### **PART 1    GENERAL**

- 1.1    Related Documents
- 1.2    Summary
- 1.3    Submittals
- 1.4    Quality Assurance
- 1.5    Delivery, Storage, and Handling

##### **PART 2    PRODUCTS**

- 2.1    Manufacturers
- 2.2    Valve Features, General
- 2.3    Gate Valves
- 2.4    Ball Valves
- 2.5    Globe Valves
- 2.6    Butterfly Valves
- 2.7    Check Valves
- 2.8    Others

##### **PART 3    EXECUTION**

- 3.1    Examination
- 3.2    Valve Ends Selection
- 3.3    Valve Installations
- 3.4    Solder Connections
- 3.5    Threaded Connections
- 3.6    Flanged Connections
- 3.7    Field Quality Control
- 3.8    Adjusting and Cleaning

## SECTION 22 05 23

### GENERAL-DUTY VALVES FOR PLUMBING PIPING

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SUMMARY**

1.2.1 This Section includes general duty valves common to most mechanical piping systems.

A) Special purpose valves are specified in individual piping system specifications.

1.2.2 Valve tags and charts are specified in Division-22 Section "Mechanical Identification".

##### **1.3 SUBMITTALS**

1.3.1 **General:** Submit the following in accordance with Conditions of Contract and Division 1 Specifications Group.

1.3.2 Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

##### **1.4 QUALITY ASSURANCE**

1.4.1 **Single Source Responsibility:** Provide valves of same type by same manufacturer.

1.4.2 Provide valves with manufacturer's name and pressure rating clearly marked on valve body.

- 1.4.3 **Underwriters' Laboratories and Factory Mutual Compliance:** Provide valves used in fire protection piping which are UL-listed and FM approved.
- 1.4.4 **American Society of Mechanical Engineers (ASME) Compliance:** Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- 1.4.5 **Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance:** Comply with the various MSS Standard Practices referenced.
- 1.5 **DELIVERY, STORAGE, AND HANDLING**
- 1.5.1 **Preparation For Transport:** Prepare valves for shipping as follows:
- A) Ensure valves are dry and internally protected against rust and corrosion.
  - B) Protect valve ends against damage to threads, flange faces, and weld-end preps.
  - C) Set valves in best position for handling. Set globe and gate valves closed to prevent rattling; set ball and plug valves open to minimize exposure of functional surfaces; set butterfly valves closed or slightly open; and block swing check valves in either closed or open position.
- 1.5.2 **Storage:** Use the following precautions during storage:
- A) Do not remove valve end protectors unless necessary for inspection; then reinstall for storage.
  - B) Protect valves from weather. Store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- 1.5.3 **Handling:** Use a sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use hand wheels and stems as lifting or rigging points.

## **PART 2   PRODUCTS**

### **2.1   MANUFACTURERS**

Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal shown in Section 01 62 00.

### **2.2   VALVE FEATURES, GENERAL**

#### **2.2.1   Valve Design:** Rising stem or rising outside screw and yoke stems.

1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

#### **2.2.2   Pressure and Temperature Ratings:** As scheduled and required to suit system pressures and temperatures.

#### **2.2.3   Sizes:** Same size as upstream pipe, unless otherwise indicated.

#### **2.2.4   Operators:** Provide the following special operator features:

- A) Hand wheels, fastened to valve stem, for valves other than quarter turn.
- B) Lever handles, on quarter-turn valves 150 mm and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
- C) Chain-wheel operators, for valves 65 mm and larger, installed 1.8 m or higher above finished floor elevation. Extend chains to an elevation of 1.5 m above finished floor elevation.
- D) Gear drive operators, on quarter-turn valves 200 mm and larger.

#### **2.2.5   Extended Stems:** Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

#### **2.2.6   Bypass and Drain Connections:** Comply with MSS SP-45 bypass and drain connections.

#### **2.2.7   End Connections:** As indicated in the valve specifications.

- A) Threads: British Standard Taper Pipe Thread.
- B) Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
- C) Solder-Joint: Comply with ANSI B16.18.

- Caution: Where soldered end connections are used, use solder having a melting point below 450°C for gate, globe, and check valves; below 216°C for ball valves.

## **2.3 GATE VALVES**

2.3.1 **Gate Valves, 50 mm and Smaller:** MSS SP-80; PN 16, body and union bonnet of ASTM B62 cast bronze; with threaded or solder ends, solid disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron hand wheel. Do not use solder end valves for hot water heating or steam piping applications. Provide PN 32 valves where system pressure require.

2.3.2 **Gate Valves, 65 mm and Larger:** MSS SP-70; PN 16 iron body, bronze mounted, with body and bonnet conforming to ASTM A126 Class B; with flanged ends, "Teflon" impregnated packing, and two-piece backing gland assembly. Provide PN 32 valves where system pressure require.

## **2.4 BALL VALVES**

2.4.1 **Ball Valves, 25 mm and Smaller:** Rated for 1030 kPa saturated steam pressure, 2760 kPa WOG pressure; two-piece construction; with bronze body conforming to ASTM B62, standard (or regular) port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout-proof stem, and vinyl-covered steel handle. Provide solder ends for condenser water, chilled water, and domestic hot and cold water service; threaded ends for heating hot water and low-pressure steam. Provide PN 16 valves where system pressure require.

2.4.2 **Ball Valves, 32 mm to 50 mm:** Rated for 1030 kPa saturated steam pressure, 2760 kPa WOG pressure; 3 piece construction; with bronze body conforming to ASTM B62, conventional port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for condenser water, chilled water, and domestic hot and cold water service; threaded ends for heating hot water and low-pressure steam. Provide PN 32 valves where system pressure require.

## 2.5 GLOBE VALVES

2.5.1 **Globe Valves, 50 mm and Smaller:** MSS SP-80; PN 16; body and screwed bonnet of ASTM B62 cast bronze; with threaded or solder ends, brass or replaceable composition disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron hand wheel. Provide PN 32 valves meeting the above where system pressure requires.

2.5.2 **Globe Valves, 65 mm and Larger:** MSS SP-85; PN 16 iron body and bolted bonnet conforming to ASTM A126, Class B; with outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing, and two-piece backing gland assembly. Provide PN 32 valves where system pressure require.

## 2.6 BUTTERFLY VALVES

**Butterfly Valves, 65 mm and Larger:** MSS SP-67; rated at 1600 kPa; ductile-iron body conforming to ASTM A126, Class B. Provide valves with field replaceable EPDM sleeve, nickel-plated ductile iron disc (except aluminum bronze disc for valves installed in condenser water piping), stainless stem, and EPDM O-ring seals. Provide lever operator with locks for sizes 50 mm through 150 mm and gear operators with position indicator for sizes 200 mm through 600 mm. Provide lug or wafer type as indicated. Drill and tap valves on dead-end service or requiring additional body strength. Provide PN 32 valves where system pressures require. Use motor operated valves for valves indicated on Drawings.

## 2.7 CHECK VALVES

2.7.1 **Swing Check Valves, 50 mm and Smaller:** MSS SP-80; PN 16, cast-bronze body and cap conforming to ASTM B62; with horizontal swing, Y-pattern, and bronze disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line. Provide PN32 valves meeting the above specifications, with threaded end connections, where system pressure requires.

2.7.2 **Swing Check Valves, 65 mm and Larger:** MSS SP-71; PN 16 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, and bronze disc or cast-iron disc with bronze disc ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line. Provide PN 32 valves where system pressures require.

2.7.3 **Wafer Check Valves:** PN 16, cast-iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure. Provide PN 32 valves where system pressures require.

2.7.4 **Lift Check Valves, 50 mm and Smaller:** PN 16; cast-bronze body and cap conforming to ASTM B62; horizontal or angle pattern, lift-type valve, with stainless steel spring, bronze disc holder with renewable "Teflon" disc, and threaded ends. Provide valves capable of being refitted and ground while the valve remains in the line. Provide PN 32 valves where system pressures require.

## 2.8 **OTHERS**

2.8.1 **General:** unless specified elsewhere in this document for specific applications use the following valves as shown on Drawings.

### 2.8.2 **Pressure Sustaining Check Valve:**

- A) **Design:** furnish and install pump discharge line where shown on plans. Valve is to sustain a pre-determined, minimum adjustable pressure against the pump. Valve is to prevent the pump from running past a predetermined point on its curve and to provide adjustable opening and closing speed to minimize pump start-up and shut-down surges. Valve is to provide adjustable emergency closing speed control to prevent pump reversal on electrical power failure.
- B) **Type:** valve is to be hydraulically operated, type globe valve controlled by solenoid pilot valves. Valve is to have a protected resilient renewable seat.
- C) **Control Panel:** pre-wired electric control panel is to be provided, to start-stop pump and function inter-wired electric solenoids.
- D) **Construction:** valve is to have cast iron body with bronze trim, PN16 flanged ends, interconnecting stainless steel tubing and unics, bronze pilots and Y-bronze strainers. Valve to be supplied completely piped ready for installation and wiring



### 2.8.3 **Balancing Valve / Circuit Setters**

- A) **Type**: double regulating variable orifice and globe pattern valve, with throttling disc and two pressure test points for regulation and measurement of system pressure drop and water flow. Valve hand wheel to have above eight turns capacity between fully open and closed positions to give a large and exact preset balancing range.
- B) **Construction**: valve body to be dezincification resistant copper alloy for threaded valves up to 50 mm diameter, and cast iron for flanged valves with diameter larger than or equal to 65 mm. Bonnet, disk, gland and gland nut and stem to be dezincification resistant copper alloy. Valve to have PTFE seat ring for a completely positive shut-off. Working pressure to be 16 bars and working temperature to be 150 deg. C. Valve to be factory tested for seat sealing and overall leak tightness.

### 2.8.4 **Dynamic Balancing Valves**

- A) **Automatic Flow Control Valves**: PN25, brass housing for sizes up to 32 mm, ductile iron body for sizes 40 mm and larger, with stainless steel operating parts including field adjustable cartridge. Cartridge shall be easily replaced and accessible without removing the valve or piping connections. Valve shall have threaded connections for sizes up to 50 mm and flanged connections for sizes 65 mm and larger. Factory set to automatically control flow rates within plus or minus 5 percent design while compensating for system operational pressure differential. Valves internal control mechanism shall be able to absorb pressure variation within the specified range to keep the flow constant.

Differential pressure range shall be as follow:

15 – 410 kPa for sizes 15 mm to 40 mm

15 – 880 kPa for sizes 50 mm to 150 mm.

Provide quick disconnect valves for flow measuring equipment. Provide a metal identification tag with chain for each valve, factory marked with the zone identification, valve model number, and rate flow in m<sup>3</sup>/hr (GPM).

### 2.8.5 **Triple Duty (Multi-Purpose) Valves**

- A) **Triple Duty Valve**: heavy duty cast iron body, angle or straight pattern type designed to perform the functions of an isolating valve, non-slam check valve, and calibrated balancing valve factory supplied with measuring orifice, suitable for a working pressure 1190 kPa rating and temperature of 120°C.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- 3.1.1 Examine valve interior through the end ports for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.
- 3.1.2 Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the shipping position.
- 3.1.3 Examine threads on both the valve and the mating pipe for form (i.e., out-of-round or local indentation) and cleanliness.
- 3.1.4 Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- 3.1.5 Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.
- 3.1.6 Replace defective valves with new valves.

### **3.2 VALVE ENDS SELECTION**

Select valves with the following ends or types of pipe/tube connections:

- Copper Tube Size, 50 mm and Smaller: Solder ends, except provide threaded ends for heating hot water and low-pressure steam service.
- Steel Pipe Sizes, 50 mm and Smaller: threaded.
- Steel Pipe Sizes 65 mm and Larger flanged.

### **3.3 VALVE INSTALLATIONS**

- 3.3.1 **General Application:** Use gate, ball, and butterfly valves for shut-off duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specifications Group for specific valve applications and arrangements.
- 3.3.2 Locate valves for easy access and provide separate support where necessary.
- 3.3.3 Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- 3.3.4 Install three-valve bypass around each pressure-reducing valve using throttling-type valves.

- 3.3.5 Provide manual drain valves at all low points of water piping systems whether shown on the Drawings or not. Drain valves to be gate, ball, or globe valves.
- 3.3.6 Provide manual or automatic air vents at all high points of water piping systems whether shown on Drawings or not. Manual vent valves to be of the gate or globe type.
- 3.3.7 Provide isolating valves on all water piping system branches. Isolating valves to be gate, ball or butterfly type.
- 3.3.8 Install valves in horizontal piping with stem at or above the center of the pipe.
- 3.3.9 Install valves in a position to allow full stem movement.
- 3.3.10 **Installation of Check Valves:** Install for proper direction of flow as follows:
- A) **Swing Check Valves:** Horizontal position with hinge pin level.
  - B) **Wafer Check Valves:** Horizontal or vertical position, between flanges.
  - C) **Lift Check Valve:** With stem upright and plumb.
- 3.3.11 Provide PN 16 or higher valves on pipes, systems or parts of systems with 50 m or more of static head.

#### **3.4 SOLDER CONNECTIONS**

- 3.4.1 Cut tube square and to exact lengths.
- 3.4.2 Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket in same manner.
- 3.4.3 Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- 3.4.4 Open gate and globe valves to full open position.
- 3.4.5 Remove the cap and disc holder of swing check valves having composition discs.
- 3.4.6 Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.
- 3.4.7 Apply heat evenly to outside of valve around joint until solder will melt upon contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

### **3.5      THREADED CONNECTIONS**

- 3.5.1      Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve. To avoid damage to valve seat do not screw pipe too far into valve.
- 3.5.2      Align threads at point of assembly.
- 3.5.3      Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
- 3.5.4      Exercise great care in installing threaded valves to avoid straining valve body. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. When attaching pipe to valve in place, use second wrench to hold valve while pipe is being tightened.

### **3.6      FLANGED CONNECTIONS**

- 3.6.1      Align flange surfaces parallel.
- 3.6.2      Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- 3.6.3      For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

### **3.7      FIELD QUALITY CONTROL**

**Tests:** After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

### **3.8      ADJUSTING AND CLEANING**

**Cleaning:** Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

**END OF SECTION 22 05 23**

## CONTENTS

### SECTION 22 40 00

#### PLUMBING FIXTURES

##### **PART 1    GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Related Sections
- 1.4 Submittals
- 1.5 Quality Assurance
- 1.6 Delivery, Storage, and Handling
- 1.7 Extra Material

##### **PART 2    PRODUCTS**

- 2.1 Plumbing Fixtures, General
- 2.2 Faucets
- 2.3 Fittings, Except Faucets
- 2.4 Flush meters
- 2.5 Toilet Seats
- 2.6 Plumbing Fixture Supports
- 2.7 Water Closets
- 2.8 Lavatories

##### **PART 3    EXECUTION**

- 3.1 Examination
- 3.2 Application
- 3.3 Installation of Plumbing Fixtures
- 3.4 Connections
- 3.5 Field Quality Control
- 3.6 Adjusting and Cleaning
- 3.7 Protection
- 3.8 Fixture Schedule

## SECTION 22 40 00

### PLUMBING FIXTURES

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SUMMARY**

This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

##### **1.3 RELATED SECTIONS**

- Division-22, Basic Mechanical Materials and Methods, Piping Section and Hangers and Supports.

##### **1.3.1 Products installed but not furnished under this Section include:**

- A) Accessories, appliances, appurtenances, and equipment specified in other sections, requiring plumbing services or fixture-related devices, as indicated.

##### **1.4 SUBMITTALS**

1.4.1 **General:** Submit the following in accordance with Conditions of Contract and Division 1 Specifications Group.

1.4.2 Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.

1.4.3 Wiring diagrams for field-installed wiring of electrically operated units.

## **1.5 QUALITY ASSURANCE**

- 1.5.1 **Regulatory Requirements:** Comply with requirements of ANSI Standard A117.1, "Buildings and Facilities -- Providing Accessibility and Use ability for Physically Handicapped People", with respect to plumbing fixtures for the physically handicapped.
- 1.5.2 **Listing and Labeling:** Provide electrically operated fixtures specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
- 1.5.3 **Design Concept:** The Drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Engineer. Burden of proof for equality of plumbing fixtures is on the Contractor.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- 1.6.1 Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.
- 1.6.2 Store plumbing fixtures on elevated platforms in a dry location.

## **1.7 EXTRA MATERIAL**

Deliver extra materials to Employer. Furnish extra materials described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.

- Faucet Washers and O-rings: Furnish quantity of identical units not less than 10 percent of amount of each installed.
- Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.
- Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.
- Provide a hinged-top wood or metal box, or individual metal boxes, having a separate compartment for each type and size of above extra materials.
- Water Closet Tank Repair Kits: Furnish quantity of identical flush valve units not less than 5 percent of amount of each type installed.
- Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type toilet seat installed.

## **PART 2 PRODUCTS**

### **2.1 PLUMBING FIXTURES, GENERAL**

Provide plumbing fixtures and trim, fittings, other components, and supports as specified.

### **2.2 FAUCETS**

2.2.1 **Faucets General:** Unless otherwise specified, provide faucets that are cast brass with polished chrome-plated finish.

2.2.2 **Lavatory Faucets, Type 1:** ASME A112.18.1M, center set fitting, with cold self-closing valves, 200 mm center set, vandal-resistant similar to Bradley Model 90-75 or approved equal.

2.2.3 **Mop Basin Faucet, Type 1:** ASME A112.18.1M, rough chrome finish, cast brass, with stops in shanks, and wall brace, integral vacuum breaker, pail hook, and garden hose thread on spout.

### **2.3 FITTINGS, EXCEPT FAUCETS**

2.3.1 **Fittings General:** Unless otherwise specified, provide fittings fabricated of brass, with a polished chrome plated finish.

2.3.2 **Lavatory Supplies and Stops, Type 1:** Loose-key angle stop, having 15 mm (1/2") NPS inlet with wall flange and 9. mm (3/8") by 305 mm (12") long flexible tubing riser outlet.

2.3.3 **Lavatory Traps, Type 1:** Cast-brass, 32 mm (1-1/4") NPS adjustable P-trap with cleanout, 17 gage tubular waste to wall, and wall flange.

2.3.4 **Water Closet Supplies and Stops, Type 2:** Wheel handle angle stop, having 15 mm (1/2") NPS inlet with wall flange and 15 mm (1/2") by 305 mm (12") long flexible tubing riser outlet with collar.

2.3.5 **Escutcheons:** Wall flange with set screw.

2.3.6 **Escutcheons:** Polished chrome-plated, sheet steel wall flange with friction clips.

2.3.7 **Deep Pattern Escutcheons:** Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.3.8 Provide fittings specified as part of a fixture description, in lieu of fitting requirements above.



## **2.4 FLUSHOMETERS**

2.4.1 Provide flush meters compatible with fixtures, with features and of consumption indicated.

2.4.2 **Construction:** Cast-brass body, brass or copper pipe or tubing inlet with wall flange and tailpiece with spud, screwdriver check stop, vacuum breaker, and brass lever handle actuation except where other variations are specified. Type shall be diaphragm operation except where other type is specified.

2.4.3 **Finish:** Exposed metal parts shall be polished chrome-plated, except components installed in a concealed location may be rough brass or unfinished.

2.4.4 **Water Closet Flush meters, Type 1:** Furnish with following features.

- A) Exposed, chromic finish
- B) Non-hold-open feature.
- C) Wheel handle stop.
- D) Metal push button actuation.
- E) Seat bumper on stop.
- F) Hydraulic push-button actuator.
- G) Bedpan washer diverter valve, spray head, and support.
- H) Sensor operation
- I) Automatic flushing system
- J) Trap primer connection.
- K) Furnish flush meters with factory-set or field-adjusted maximum water consumption per cycle:
  - Consumption: 11.4 liters (3.0 U.S. gallons) per flushing cycle.

## 2.5 TOILET SEATS

2.5.1 **General:** Provide toilet seats compatible with water closets, and of type, color, and features as approved.

2.5.2 **Toilet Seats, Type 1:** Extra heavy-duty, commercial/industrial type, elongated, open front, solid plastic, with check hinge.

## 2.6 PLUMBING FIXTURE SUPPORTS

2.6.1 **Supports:** ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.

## 2.7 WATER CLOSETS

2.7.1 **Water Closet type WC-1:** WC to be white vitreous china floor mounted, ASME/ANSI A112.19.2M, elongated bowl, siphon jet flush action for use with flush valve, 11.4 L per flush, wall outlet. Water closet dimensions to be 375 mm wide, 635 mm front back and 330 mm height. WC complete with the following accessories and trims from the same manufacturer:

- A) **Seat:** commercial, extra heavy duty, solid plastic, open front less cover, integrally molded bumpers, concealed check hinge with stainless steel post. Seat shall be posture contoured body design. Color shall be white.
- B) **Fittings and Accessories:** Gaskets - neoprene; bolts with chromium plated caps nuts and washers.
- C) **Flush valve:** WC Flushometer type 1.
- D) 10 mm angle valve with 300 mm long tube, blue index.

## 2.8 LAVATORIES

2.8.1 **Lavatory type LAV-1:** Oval type for installation under marble countertops, ASME/ANSI A112.19.2M, vitreous china, self-rimming, approximately 560 x 420 mm. Lavatory to be complete with the following accessories:

- A) **Faucet:** Lavatory faucet type 1.
- B) **Drain:** Cast brass with flat grid strainer, offset tailpiece, chrome plated.
- C) **Stops:** Angle type. Lavatory supplies and stop type 1

- D) Trap: Cast copper alloy, 40 by 32 mm P-trap, adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extension to wall. Set trap parallel to the wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Trap to be lavatory trap type 1.

### **PART 3    EXECUTION**

#### **3.1        EXAMINATION**

- 3.1.1        Examine roughing-in for cold water and hot water supplies and soil, waste, and vent piping systems to verify actual locations of piping connections prior to installing fixtures.
- 3.1.2        Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- 3.1.3        Do not proceed until unsatisfactory conditions have been corrected.

#### **3.2        APPLICATION**

- 3.2.1        Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.
- 3.2.2        Install supports for plumbing fixtures in accordance with categories indicated, and of type required:

A)    Chair carriers for the following fixtures:

- Hanging urinals.
- Hanging lavatories and sinks.
- Hanging drinking fountains and electric water coolers.

B)    Heavy-duty chair carriers for the following fixtures:

- Accessible lavatories.
- Fixtures where specified.

#### **3.3        INSTALLATION OF PLUMBING FIXTURES**

- 3.3.1        Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in Drawings, and referenced standards.
- 3.3.2        Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.
- 3.3.3        Install floor-mounted, back-outlet water closets with fittings and gasket seals.
- 3.3.4        Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.

- 3.3.5 Install wall-hanging, back-outlet urinals with gasket seals.
- 3.3.6 Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- 3.3.7 Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- 3.3.8 Fasten wall-mounted fittings to reinforcement built into walls.
- 3.3.9 Fasten counter-mounting-type plumbing fixtures to casework.
- 3.3.10 Secure supplies behind wall or within wall pipe space, providing rigid installation.

### **3.4 CONNECTIONS**

Piping installation requirements are specified in other sections of Division-22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

- Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division-22.
- Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

### **3.5 FIELD QUALITY CONTROL**

- 3.5.1 Inspect each installed fixture for damage. Replace damaged fixtures and components.
- 3.5.2 Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

### **3.6 ADJUSTING AND CLEANING**

- 3.6.1 Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- 3.6.2 Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.

- 3.6.3 Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.
- 3.6.4 Replace washers of leaking and dripping faucets and stops.
- 3.6.5 Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.
- 3.6.6 Review the data in Operating and Maintenance Manuals. Refer to Division1 Section "Project Closeout".

### **3.7      PROTECTION**

- 3.7.1      Provide protective covering for installed fixtures and fittings.
- 3.7.2      Do not allow use of fixtures for temporary facilities, except when approved in writing by the Employer.

### **3.8      FIXTURE SCHEDULE**

Provide plumbing fixtures as scheduled on the following "Data Sheets". Each Data Sheet begins with a new page.

**END OF SECTION 22 40 00**

## CONTENTS

### SECTION 22 13 16

#### SANITARY WASTE AND VENT PIPES

##### **PART 1    GENERAL**

- 1.1    Related Documents
- 1.2    Scope of Work

##### **PART 2    PRODUCTS**

- 2.1    Materials and Products - General
- 2.2    Basic Pipes and Pipe Fittings
- 2.3    Basic Piping Specialties
- 2.4    Basic Supports and Anchors
- 2.5    Expansion Joints
- 2.6    Drainage Piping Products - General
- 2.7    Cleanouts
- 2.8    Floor Drains
- 2.9    Vent Caps
- 2.10   Grating and Frame
- 2.11   Manhole Covers and Frames
- 2.12   Gulley Trap
- 2.13   Inspection Chambers

##### **PART 3    EXECUTION**

- 3.1    Inspection
- 3.2    Installation of Above Ground Piping
- 3.3    Installation of Building Drain Piping
- 3.4    Installation of Piping Specialties
- 3.5    Installation of Supports and Anchors
- 3.6    Installation of Cleanouts
- 3.7    Installation of Flashing Flanges
- 3.8    Installation of Vent Flashing Sleeves
- 3.9    Installation of Vent Caps
- 3.10   Installation of Floor Drains
- 3.11   Piping Connections to Plumbing Fixtures and Drains
- 3.12   Testing
- 3.13   Cleaning and Inspection
- 3.14   Grease or Oil Interceptor
- 3.15   Protection of Underground Structures
- 3.16   Inspection and Testing of Underground Piping



## SECTION 22 13 16

### SANITARY WASTE AND VENT PIPES

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

- Division-22 Specifications Group apply to work of this section.
- Division-22 Plumbing piping section apply to work of this section.

##### **1.2 SCOPE OF WORK**

- 1.2.1 Extent of soil and waste systems work is indicated on Drawings and schedules, and by requirements of this section.
- 1.2.2 Exterior sanitary sewer system required in conjunction with soil and waste systems, up to the inspection chambers outside the building, is work of this section.
- 1.2.3 Trenching and backfilling required in conjunction with underground building drain piping is specified in applicable Division-22 sections, and is included as work of this section.
- 1.2.4 Flashings required in conjunction with soil and waste systems are included as work of this section.
- 1.2.5 Refer to other Division-22 sections for sewage pumps; not work of this section.

#### **PART 2 PRODUCTS**

##### **2.1 MATERIALS AND PRODUCTS - GENERAL**

- 2.1.1 Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated.
- 2.1.2 Provide materials and products of sizes and types to match piping and equipment connections.

- 2.1.3 Provide fittings of materials which match pipe materials used in soil and waste systems; preferably the product of same manufacturer.

## **2.2 BASIC PIPES AND PIPE FITTINGS**

Provide pipes and pipe fittings complying with Division-22 section "Domestic Water Piping", and "Plumbing Piping" Sections and with section Special Pipes

## **2.3 BASIC PIPING SPECIALTIES**

Provide piping specialties complying with Division-22 section "Piping Specialties", in accordance with the following listing:

- Pipe Escutcheons
- Mechanical Sleeve Seals
- Fire Barrier Penetration Seals
- Drip Pans
- Pipe Sleeves
- Sleeve Seals

## **2.4 BASIC SUPPORTS AND ANCHORS**

Provide supports and anchors complying with Division-22 "Hangers and Supports for Plumbing" and "Plumbing Piping" sections.

## **2.5 EXPANSION JOINTS**

- 2.5.1 Provide cast-iron body expansion joints with adjustable bronze sleeve, bronze bolts with wing nuts; for vertical installation only.

- 2.5.2 Subject to compliance with requirements, provide expansion joints, as approved.

## **2.6 DRAINAGE PIPING PRODUCTS - GENERAL**

Provide factory-fabricated drainage piping products of size and type indicated.

## **2.7 CLEANOUTS**

- 2.7.1 Cleanouts on pipes to be full size, with round head. Cleanouts shall be easily accessible. Provide a minimum clearance of 600 mm for the rodding.
- 2.7.2 Cleanouts at base of stacks to be extra heavy Y-branch or tee branch cleanout with full size PVC plug.
- 2.7.3 Cleanouts in suspended soil pipe shall consist of PVC tapered screw plug.
- 2.7.4 Floor cleanouts to be No-Hub outlet. Floor cleanouts shall have PVC body and frame with square adjustable scoriated secured nickel bronze top. Unit shall be vertically adjustable for a minimum of 50 mm. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts. Cleanouts shall consist of "Y" fittings and 3 mm bends with PVC screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, provide carpet cleanout markers
- 2.7.5 Floor cleanouts to be carefully set at locations and elevations indicated on the Drawings. Set level and square with floor construction.
- 2.7.6 Cleanouts in finished areas to be adjustable cleanout with square nickel bronze top.
- 2.7.7 Cleanouts in floors to be provided with carpeting to be as specified for finished areas with carpet marker.

## **2.8 FLOOR DRAINS**

- 2.8.1 Provide a screwed or no hub outlets for connection to PVC pipe, and side outlet when shown. Provide membrane clamp and extensions if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe.
- 2.8.2 FD-1 to have 150 mm round flat strainer with outlet 50 m.
- 2.8.3 FD-2: To have 150 mm round flat strainer with outlet 75 mm.

2.8.4 FD-3: To have 150 mm round flat strainer with outlet 110 mm.

## **2.9 VENT CAPS**

2.9.1 Provide uPVC vandal-proof vent caps, full size of vent pipe.

2.9.2 Subject to compliance with requirements, provide vandal-proof vent caps as approved:

## **2.10 GRATING AND FRAME**

300 or 600 mm wide, medium or heavy duty grating and frame or brick house approved equal.

## **2.11 MANHOLE COVERS AND FRAMES**

Manhole covers and frames to be to BS 497, Grade B, medium duty, with square frame and circular cover, coated at factory with tar or bitumen base composition.

## **2.12 GULLEY TRAP**

2.12.1 **Construction:** in situ reinforced concrete, with opening in top recessed to accommodate cast iron manhole cover and frame.

2.12.2 **Walls:** plaster internally with two coats cement and sand (1 : 3) to total thickness of 15 mm.

2.12.3 **Inlet and Outlet:** Difference in elevation between inlet and outlet is to be 30 mm. Outlet is to have trap and cleanout.

2.12.4 **Cover and Frame:** Replace if found to rattle under traffic. Plugging, burning in or filling to obtain tight cover will not be allowed. Recess for cover in concrete is to be accurately made to dimensions of frame. Embed frame in mortar and set frame and cover level and to proper grade.

## **2.13 INSPECTION CHAMBERS**

2.13.1 **Construction:** In situ reinforced concrete.

2.13.2 **Access:** Opening in top with recess to accommodate cast iron cover and frame.

2.13.3 **Floors:** Form by hand with cement mortar to size and shape of sewer. Changes in sewer size to be gradual and even. Floors to have gradual slope from side walls to central channel. Half pipe inverts may be used in straight through inspection chambers.

- 2.13.4 **Inlets:** Main and side inlets are to have drop of 50 to 80 mm above invert of central channel.
- 2.13.5 **Walls:** Plaster internally with two coats cement and sand (1:3) to total thickness of 15 mm.
- 2.13.6 **Steps:** Galvanized pipe steps set in place during construction, properly embedded, beginning 600 mm at bottom and spaced at approximately 35 mm.
- 2.13.7 Caulk and repair leaks if approved or remove entire work and rebuild at no extra cost.
- 2.13.8 Keep groundwater level below bottom of inspection chamber until concrete has obtained adequate set.
- 2.13.9 Covers are to fit frames. Replace if found to rattle under traffic. Plugging, burning in or filling to obtain tight covers will not be allowed.
- 2.13.10 Recess in concrete for covers is to be neatly and accurately made to dimensions of frame. Thoroughly embed frame in mortar and set frame and cover level and to proper grade.
- 2.13.11 **Drop Inspection Chamber:** Provide where conditions necessitate free vertical drop exceeding 450 mm.

### **PART 3   EXECUTION**

#### **3.1   INSPECTION**

Examine substrates and conditions under which soil and waste systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

#### **3.2   INSTALLATION OF ABOVE GROUND PIPING**

- 3.2.1 Install soil and waste piping in accordance with Division-22 "Domestic Water Piping", and "Plumbing Piping" sections.
- 3.2.2 Lay horizontal pipes at uniform slope of not less than 1% and not more than 3%.
- 3.2.3 Changes of direction in pipes are to be gradual using long sweep fittings and 45 degree fittings.
- 3.2.4 Avoid unnecessary turns and offsets and run wastes as direct as possible from sanitary fixtures to vertical stacks.
- 3.2.5 Vent sanitary fixtures to prevent siphonage of traps and air binding.
- 3.2.6 Slope vent pipes and connect to drip back into soil or waste pipe by gravity.
- 3.2.7 Where connected to a horizontal soil or waste pipe connect vent pipe above centerline of soil or waste pipe. Vent pipe is to rise vertically or at an angle of not more than 45 degrees from vertical to a point at least 150 mm above flood level rim of fixture before offsetting horizontally or before connecting to branch vent.
- 3.2.8 All gravity waste drain lines inside the building with vertical drops over 6 m shall be provided with joint restraint on the vertical drop and horizontal offset or branch below the vertical drop. Joint restraint shall be accomplished by threaded, soldered, or grooved joints or a combination of pipe clamps and tie-rods as detailed in NFPA 24. Vertical joint restraint shall be provided from the fitting at the bottom of the vertical drop through every joint up to the riser clamp at the floor penetration of the floor above. Horizontal joint restraint shall be provided from the same fitting at the bottom of the vertical drop through every joint on the horizontal offset or branch for a minimum of 18 m or to anchoring point from the building structure. Joint restraint below ground shall be accomplished by thrust blocks detailed in NFPA 24.
- 3.2.9 **Penetrations:** Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against

the spread of fire, smoke and gases. Completely fill and seal clearances between raceways and openings with the fire stopping materials. Material to expend during fire to seal masonry or concrete wall penetration.

- 3.2.10 At floor penetrations, completely seal clearances around the pipe and make watertight with sealant.
- 3.2.11 Connect vent pipes to vent stack at least 150 mm above flood level rim of highest fixture served by vent.
- 3.2.12 Vent pipes above roof are to pass through flashed and waterproofed sleeves.

### **3.3 INSTALLATION OF BUILDING DRAIN PIPING**

- 3.3.1 Lay underground building drains beginning at low point of systems, true to grades alignment indicated with unbroken continuity of invert.
- 3.3.2 Place bell ends of piping facing upstream.
- 3.3.3 Install required in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.
- 3.3.4 Clean interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.
- 3.3.5 Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- 3.3.6 Install soil and vent piping pitched to drain at minimum slope of one percent (1%).
- 3.3.7 Lay pipes on good foundation to prevent settlement. Pipes laid in trenches to have solid uniform bearing throughout their length.
- 3.3.8 Lay pipes in trenches supported along their length on layer of clean compacted sand.
- 3.3.9 Lay pipes to uniform slope not exceeding 3% and true to line and grade.
- 3.3.10 Lay pipes at not less than 600 mm below finished grade and not closer than 1 m to bearing walls and footings.
- 3.3.11 Free vertical drop of sewer pipe into manhole is not to exceed 450 mm from invert of pipe to invert of manhole.

- 3.3.12 Make connections to manholes, city sewers or other underground structure in a watertight approved manner. Full circle of pipe is to be visible at manhole.
- 3.3.13 Make connections to existing systems with minimum disturbance to existing lines. Existing pipes or structures damaged whilst making connections are to be replaced or reconstructed to the Engineer's satisfaction at no extra cost.
- 3.3.14 Groundwater: Keep trenches dry during pipe laying by pumping, use of well points, under drains or other approved means. Make pipe joints in the dry.
- 3.3.15 Join concrete pipes by inserting a layer of jute or hemp dipped in Portland cement slurry into joint base. Fill remaining space with cement mortar (1:2), ram and trowel mortar to form 45 degree taper with pipe barrel. Clean pipe interior to remove mortar.

### **3.4 INSTALLATION OF PIPING SPECIALTIES**

Install piping specialties in accordance with Division-22 section "Piping Specialties".

### **3.5 INSTALLATION OF SUPPORTS AND ANCHORS**

Install supports and anchors in accordance with Division-22 "Hangers and Supports" and "Plumbing Piping" sections.

### **3.6 INSTALLATION OF CLEANOUTS**

- 3.6.1 Install cleanouts in above ground piping and building drain piping as indicated; as required by the American Standard National Plumbing Code; at each change in direction of piping greater than 45 deg.; at minimum intervals of 15 m for piping 100 mm and smaller and 30 m for larger piping; and at base of each vertical soil or waste stack.
- 3.6.2 Install floor and wall cleanout covers for concealed piping. Select type to match adjacent building finish.
- 3.6.3 Cleanouts on uPVC pipes to be fitted to pipe or fitting at end of pipe and to be same size as pipe.
- 3.6.4 Cleanouts on exposed pipes to be installed directly on pipe and those on concealed pipes extended through and terminated flush with finished floor or wall and concealed with floor or wall cleanout covers.

### **3.7 INSTALLATION OF FLASHING FLANGES**

Install flashing flanges and clamping device with each stack and cleanout passing through waterproof membranes.



### **3.8      INSTALLATION OF VENT FLASHING SLEEVES**

Install vent-flashing sleeves on stacks passing through roof.

### **3.9      INSTALLATION OF VENT CAPS**

3.9.1      Provide vandal-proof vent caps at the terminations of all vent stacks and vent pipes outside the building.

3.9.2      Secure over stack flashing in accordance with manufacturer's instructions.

### **3.10     INSTALLATION OF FLOOR DRAINS**

3.10.1     Provide floor drains of size and location as indicated on Drawings; and type, including features, as specified herein.

3.10.2     Install floor drains in accordance with manufacturer's written instructions.

3.10.3     Coordinate with soil and waste piping as necessary to interface floor drains with drainage piping systems.

3.10.4     Floor drains to be carefully set at locations and elevations indicated on the Drawings. Set level and square with the floor construction.

3.10.5     Floor drains to be provided with deep seal P-traps except where noted on the Drawings or in the Specifications.

3.10.6     Coordinate flashing work with work of waterproofing and adjoining substrate work.

3.10.7     Install drain flashing collar or flange so that no leakage occurs between floor drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

3.10.8     Floor drains in floors above grade with membrane waterproofing to be flashed with 1.8 kg sheet lead and secured with flashing clamps.

3.10.9     Position floor drains so that they are accessible and easy to maintain.

### **3.11     PIPING CONNECTIONS TO PLUMBING FIXTURES AND DRAINS**

3.11.1     Provide soil and waste piping runouts to plumbing fixtures and drains with approved trap, of sizes indicated.

3.11.2     Locate piping runouts as close as possible to bottom of floor slab supporting plumbing fixtures or drains.

### **3.12      TESTING**

Test soil and waste systems in accordance with Division-22 section, Testing, Adjusting, and Balancing and "Plumbing Piping" section.

### **3.13      CLEANING AND INSPECTION**

Clean, flush, and inspect soil and waste piping in accordance with requirements of Division-22 "Domestic Water Piping" and "Plumbing Piping" sections.

### **3.14      GREASE OR OIL INTERCEPTOR**

3.14.1      Provide two separate vent pipes terminating above roof at least 300 mm above each other to assure optimum recirculation and as safety factor against fouling or clogging of a single vent.

3.14.2      Install flow control with cleanout to facilitate servicing.

### **3.15      PROTECTION OF UNDERGROUND STRUCTURES**

Protect incompleting work from floating. Lines or structures not stable against uplift during construction are to be well braced or otherwise protected.

### **3.16      INSPECTION AND TESTING OF UNDERGROUND PIPING**

3.16.1      **Inspection:** Completed underground lines are to be inspected and approved by the Engineer.

3.16.2      **Testing:** as mentioned under "Plumbing Piping" section.

3.16.3      Repair or replace defective work as directed.

**END OF SECTION 22 13 16**

## CONTENTS

### SECTION 22 11 17

#### PLUMBING PIPING

#### **PART 1    GENERAL**

- 1.1    Related Documents
- 1.2    Summary
- 1.3    Related Sections
- 1.4    System Performance Requirements
- 1.5    Submittals
- 1.6    Quality Assurance

#### **PART 2    PRODUCTS**

- 2.1    Pipes and Tubes
- 2.2    Pipe Fittings and Tube Fittings
- 2.3    Joining Materials
- 2.4    Valves

#### **PART 3    EXECUTION**

- 3.1    Excavation
- 3.2    Preparation of Foundation for Buried Piping
- 3.3    Pipe and Fittings Applications
- 3.4    Valve Applications
- 3.5    Piping Installation, General
- 3.6    Drainage and Vent Piping Installation
- 3.7    Installation of Valves
- 3.8    Hangers and Supports Installation
- 3.9    Connections
- 3.10   Field Quality Control
- 3.11   Cleaning
- 3.12   Commissioning
- 3.13   Protection

## **SECTION 22 11 17**

### **PLUMBING PIPING**

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SUMMARY**

This Section includes plumbing piping systems to a point 1.5 m outside the building. Systems include the following:

- Water distribution systems, including cold and hot water supply and hot water circulation.
- Drainage and vent systems, including sanitary and storm water.

##### **1.3 RELATED SECTIONS**

The following sections contain requirements that relate to this Section:

- Division-22 Section "Domestic Water Piping" for piping joining materials, joint construction, and installation requirements not specified in this Section.
- Division-22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.

##### **1.4 SYSTEM PERFORMANCE REQUIREMENTS**

Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, except where indicated otherwise:

- Water Distribution Systems, Below Ground: 1720 kPa .
- Water Distribution Systems, Above Ground: 860 kPa or 1720 kPa for pipes subjected to high static head.
- Soil, Waste, and Vent Systems: 3 m head of water.
- Storm Water Drainage Systems: 3 m head of water.
- Sanitary Sewage, Pumped Piping Systems: 172 kPa.
- Storm Water, Pumped Piping Systems: 172 kPa.

## 1.5 SUBMITTALS

**General:** Submit the following in accordance with Conditions of Contract and Division-1 Specifications Group:

- Product data for plumbing piping products.
- Water samples, test results, and reports specified in "Field Quality Control" and "Cleaning" Articles.
- Shop and coordination Drawings, drawn accurately to scale and coordinating penetrations.

## 1.6 QUALITY ASSURANCE

- 1.6.1 Comply with the provisions of ASME B31.9 "Building Services Piping" for materials, products, and installation.
- 1.6.2 Provide listing/approval stamp, label, or other marking on piping made to specified standards.

## PART 2 PRODUCTS

### 2.1 PIPES AND TUBES

- 2.1.1 **General:** The application of the following pipe, tube, and fitting materials and joining methods required for plumbing piping systems are indicated in "Pipe and Fittings Applications".
- 2.1.2 **Polypropylene (PP-R):** for all domestic cold and hot water pipes.
- 2.1.3 **Non pressure uPVC:** pipes for all drain pipes inside buildings
- 2.1.4 **Ductile Iron:** for waste water force main from sewage pump up to slow down chamber.

## **2.2 PIPE FITTINGS AND TUBE FITTINGS**

- 2.2.1 **Wrought-Copper, Solder-Joint Pressure Fittings:** ASME B16.22.
- 2.2.2 **Cast-Copper-Alloy, Solder-Joint Pressure Fittings:** ASME B16.18.
- 2.2.3 **Wrought-Copper and Bronze, Grooved-End Fittings:** ASTM B75 Tube and ASTM B584 Bronze Castings.
- 2.2.4 **Copper Tube, Grooved-End Mechanical Fittings:** ASTM B75, copper tube and ASTM B584 bronze castings.
- 2.2.5 **Bronze Flanges:** ASME B16.24, Classes 150 and 300.
- 2.2.6 **Copper Unions:** ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends.
- A) **Threaded Ends:** Threads conforming to ASME B1.20.1.
- 2.2.7 **Malleable-Iron Unions:** ASME B16.39, Classes 150 and 300, hexagonal stock, with ball-and-socket joint, metal-to-metal bronze seating surfaces, and female threaded ends having threads conforming to ASME B1.20.1.
- 2.2.8 **Cast-Iron Threaded Flanges:** ASME B16.1, Classes 125 and 300.
- 2.2.9 **Ductile-Iron and Gray-Iron Gasketed Fittings:** AWWA C110 standard pattern or ductile-iron AWWA C153 compact pattern, 1720 kPa minimum pressure rating, with AWWA C104 cement-mortar lining and AWWA C111 rubber gaskets.
- 2.2.10 **Ductile-Iron and Gray-Iron Flanged Fittings:** AWWA C110, 1720 kPa minimum pressure rating, with AWWA C104 cement-mortar lining.
- 2.2.11 **Ductile-Iron, Flexible Expansion Joints:** Compound fitting with combination of flanged and mechanical-joint ends conforming to AWWA C110 or AWWA C153. Units have 2 gasketed ball-joint sections and 1 or more gasketed sleeve sections, rated for 1720 kPa minimum working pressure and with FDA-approved epoxy interior coating, for offset and expansion indicated.
- 2.2.12 **No-Hub, Cast-Iron Soil Pipe Fittings:** ASTM A74, Service Class, or BS416, medium class for above ground installation and BS437, heavy class for underground installation.
- 2.2.13 **Fittings used for non-pressure PVC pipes:** use couplers or mechanical joints with rubber seating rings.

2.2.14 **Seating rings on PVC pipes:** where used to provide for expansion and contraction to be rubber to BS 2494: Part 2.

2.2.15 Fittings used for CPVC shall be machine welded all pressure fittings shall be 100% fiberglass reinforced (except couplings, reducer couplings or reducer bushings).

## **2.3 JOINING MATERIALS**

2.3.1 **Cast-Iron Soil Pipe and Fittings:** ASTM C564 neoprene rubber gaskets and lubricant.

2.3.2 **Ductile-Iron Pipe and Ductile-Iron or Cast-Iron Fittings:** The following materials apply:

- A) **Push-on Joints:** AWWA C111 rubber gaskets and lubricant.
- B) **Mechanical Joints:** AWWA C111 ductile-iron or gray-iron glands, high-strength steel bolts and nuts, and rubber gaskets.
- C) **Flanged Joints:** AWWA C115 ductile-iron or gray-iron pipe flanges, rubber gaskets, and high-strength steel bolts and nuts.

2.3.3 Solvent cement shall conform to ASTM D-2564 welding roof shall conform to ASTM-1784 cell class 23447 B.

## **2.4 VALVES**

2.4.1 Refer to Division-22 Section "General-Duty Valves for Plumbing Piping" for gate, globe, ball, butterfly, and check valves.

2.4.2 Refer to Division-22 Section "Plumbing Specialties" for special-duty valves.

## **PART 3   EXECUTION**

### **3.1   EXCAVATION**

Excavation, trenching, and backfilling are specified in Division-31 Section "Earthwork", and in Division-22 Sub-section of "Common Work Results for Plumbing".

### **3.2   PREPARATION OF FOUNDATION FOR BURIED PIPING**

- 3.2.1   Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.
- 3.2.2   Remove unstable, soft, and unsuitable materials at surface on which piping is to be laid and backfill with clean sand or pea gravel to indicated level.
- 3.2.3   Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig bell holes at each pipe joint to relieve bells of loads and to ensure continuous bearing of pipe barrel on foundation.

### **3.3   PIPE AND FITTINGS APPLICATIONS**

- 3.3.1   **General:** Use pipe, tube, fittings, and joining methods for piping systems according to the following applications.
- 3.3.2   **Water Distribution Piping Below and above Ground:**
  - A)   Cold Water: Polypropylene.
  - B)   Domestic Hot Water: Polypropylene.
- 3.3.3   **Soil, Waste, and Vent Piping Below Ground:** Use the following:
  - A)   Underground: Non pressure uPVC.
- 3.3.4   **Soil, Waste, and Vent Rainwater Piping Above Ground:** Non Pressure uPVC.
- 3.3.5   **Storm Water Drainage Piping Below Ground:** Non Pressure uPVC.
- 3.3.6   **Storm Water Drainage Piping Above Ground:** Non Pressure uPVC.
- 3.3.7   **Sewage or Storm Water Force Mains Underground:** Ductile-iron pipe, ductile-iron or gray-iron fittings, rubber gaskets, and push-on or mechanical joints.
- 3.3.8   **Sewage or storm water drainage outside building:** Use the following:



- A) Pipes and fittings: non pressure uPVC.

### **3.4 VALVE APPLICATIONS**

- 3.4.1 Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

- A) Shutoff Duty: Use gate or ball for sizes up to 50 mm, use gate for sizes above 50 mm and up to 150 mm and butterfly valves for sizes larger than 150 mm.
- B) Throttling Duty: Use globe, ball, or butterfly valves.
- C) Valve construction shall match pressure rating of piping system it is installed in. Piping applications with higher ratings (PN16).

### **3.5 PIPING INSTALLATION, GENERAL**

- 3.5.1 Basic piping installation requirements are specified in Division-22 Section "Domestic Water Piping".

- 3.5.2 Sizes indicated on floor plans are inside pipe sizes.

### **3.6 DRAINAGE AND VENT PIPING INSTALLATION**

- 3.6.1 Make changes in direction for drainage and vent piping using appropriate Y-branches, Y-branches with 1/8 bends, and long-sweep 1/4, 1/5, 1/6, 1/8, and 1/16 bends. Sanitary tees and short-sweep quarter bends may be used on vertical stacks of drainage lines where change in direction of flow is from horizontal to vertical. Use long-turn double-Y-branch and 1/8-bend fittings where 2 fixtures are installed back to back or side by side and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Make no change in direction of flow greater than 90 degrees. Where different sizes of drainage pipes and fittings are connected, use proper size standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- 3.6.2 Lay buried building drains beginning at low point of each system, true to grades and alignment indicated, with unbroken continuity of invert. Place hub or bell ends of piping facing upstream. Install required gaskets according to manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in piping and pull past each joint as completed.
- 3.6.3 Install drainage and vent piping at the following minimum slopes, except where another slope is indicated:

- A) Sanitary Building Drain: 2 percent for piping 80 mm and smaller; 1 percent for piping 100 mm and larger.
- B) Horizontal Sanitary Drainage Piping: 2 percent.
- C) Storm Water Building Drain: 1 percent.
- D) Horizontal Storm Water Drainage Piping: 2 percent.
- E) Vent Piping: 1 percent.

3.6.4 Install PVC piping and fittings for drainage according to ASTM D-2665.

3.6.5 Install underground plastic drainage piping according to ASTM D-2321.

### **3.7 INSTALLATION OF VALVES**

3.7.1 **Sectional Valves**: Install sectional valves close to main on each branch and riser serving 2 or more plumbing fixtures or equipment connections and where indicated. Use gate or globe valves for sectional valves.

3.7.2 **Shutoff Valves**: Install shutoff valves on inlet to each plumbing equipment item, on each supply to each plumbing fixture not having stops on supplies, and elsewhere as indicated. For shutoff valves 50 mm and smaller, use gate or ball valves; for shutoff valves 65 mm and larger, use gate or butterfly valves.

3.7.3 **Drain Valves**: Install drain valves specified in Division-22 Section "Plumbing Specialties" on each plumbing equipment item located to drain equipment for service and repair. Install drain valve at base of each riser, at low points of horizontal runs, and where required to drain water distribution piping system.

A) Install hose-end drain valves at low points in water mains, risers, and branches.

B) Install stop and waste drain valves where indicated.

3.7.4 **Check Valves**: Install swing check valve on discharge side of each pump and elsewhere as indicated. Use MSS SP-80, Class 125, cast-bronze body for 50 mm and smaller piping and MSS SP-71, Class 125, cast-iron body for 65 mm and larger piping.

3.7.5 **Balance Valves**: Install valve in each hot water circulating loop, discharge side of each pump, and elsewhere as indicated. Use ball valve for 50 mm and smaller piping and butterfly valve for 65 mm and larger piping.

### **3.8 HANGERS AND SUPPORTS INSTALLATION**

- 3.8.1 Hanger and support devices are specified in Division-22 Section "Hangers and Supports".
- 3.8.2 **Pipe Attachments:** Install the following:
- A) Riser Clamps: MSS Type 8 or Type 42 for vertical runs.
  - B) Adjustable Steel Clevis Hangers: MSS Type 1 for individual straight horizontal runs 30 m and less.
  - C) Adjustable Roller Hangers: MSS Type 43 for individual straight horizontal runs longer than 30 m.
  - D) Spring Cushion Rolls: MSS Type 49, where indicated, for individual straight horizontal runs longer than 30 m.
  - E) Pipe Rolls: MSS Type 44 for multiple straight horizontal runs 30 m or longer. Support pipe rolls on trapeze.
  - F) Spring Hangers: MSS Type 52 for support of base of vertical runs.
- 3.8.3 Support cast-iron soil pipe and fittings not included in table, at maximum horizontal spacing of 1.5 m, except 3 m sections of pipe may be supported at 3 m spacing and at maximum vertical spacing of 4.6 m .
- 3.8.4 Support plastic pipe and tubing not included in table according to manufacturer's recommendations.
- 3.9 CONNECTIONS**
- 3.9.1 Supply Runouts to Fixtures: Install hot and cold water supply piping runouts, but not smaller than required by plumbing code to fixtures.
- 3.9.2 Drainage Runouts to Fixtures: Provide drainage and vent piping runouts, with approved trap, of sizes indicated, but not smaller than required by plumbing code, to plumbing fixtures and drains.
- 3.9.3 Locate drainage piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.
- 3.9.4 **Mechanical Equipment Connections:** Connect hot and cold water supply piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. Use flanges instead of unions for connections 65 mm and larger.
- 3.9.5 **PVC DWC pipe:** joint PVC drainage pipe and fittings according to ASTM D2665.

3.9.6 **Handling of Solvent Cements, Primers and Cleaners:** comply with procedures in ASTM-F402 for safe handling during joining of plastic pipe and fittings with solvent cements.

**3.10 FIELD QUALITY CONTROL**

**3.10.1 Inspect water distribution piping as follows:**

- A) Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the Engineer.
- B) During progress of the installation, notify the Engineer at least 24 hours prior to time inspection must be made. Perform tests specified below in presence of the Engineer.
  - Roughing-In Inspection: Arrange for inspection of piping system before concealed or closed-in after system roughing-in and prior to setting fixtures.
  - Final Inspection: Arrange for final inspection by the Engineer to observe tests specified below and to ensure compliance with requirements of plumbing code.
- C) **Reinspections:** When the Engineer finds that piping system will not pass test or inspection, make required corrections and arrange for reinspection by the Engineer.
- D) **Reports:** Prepare inspection reports signed by the Engineer.

**3.10.2 Test water distribution piping as follows:**

- A) Test for leaks and defects in new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of system tested.
- B) Leave uncovered and unconcealed in new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved for testing.
- C) Cap and subject the piping system to a static water pressure of 345 kPa (50 psig) above the operating pressure without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
- D) Repair leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.

- E) Prepare reports for tests and required corrective action.

3.10.3 **Inspect drainage piping as follows:**

- A) Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the Engineer and the authority having jurisdiction.
- B) During progress of installation, notify the Engineer at least 24 hours prior to time such inspection must be made. Perform tests specified below in presence of the Engineer.
  - Roughing-In Inspection: Arrange for inspection of piping system after system roughing-in, before concealing, and prior to setting fixtures.
  - Final Inspection: Arrange for final inspection by the Engineer to observe tests specified below and to ensure compliance with requirements of the plumbing code.
- C) **Reinspections:** Make required corrections and arrange for reinspection by the Engineer when piping system fails to pass test or inspection.
- D) **Reports:** Prepare inspection reports signed by the Engineer.

3.10.4 **Drainage and Vent Piping System Tests:** Test drainage and vent systems according to procedures of authority having jurisdiction or, in absence of published procedure, as follows:

- A) Test for leaks and defects in new drainage and vent piping systems and parts of existing systems that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
- B) Leave uncovered and unconcealed in new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose for testing work that has been covered or concealed before it has been tested and approved.
- C) **Rough Plumbing Test Procedure:** Except for outside leaders and perforated or open-jointed drain tile, test piping of plumbing drainage and venting systems on completion of roughing-in piping installation. Tightly close all openings in piping system and fill with water to point of overflow, but not less than 3 m head of water. Water level shall not drop during the period from 15 minutes before inspection starts through completion of inspection. Inspect joints for leaks.
- D) **Finished Plumbing Test Procedure:** After plumbing fixtures have been set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it

leaves the building and introduce air into the system equal to pressure of 25 mm water column. Use a U-tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

- E) Repair leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
- F) Prepare reports for tests and required corrective action.

### **3.11 CLEANING**

#### **3.11.1 Clean and disinfect water distribution piping as follows:**

- A) Purge new water distribution piping systems and parts of existing water systems that have been altered, extended, or repaired prior to use.
- B) Use purging and disinfecting procedure prescribed by authority having jurisdiction or, if a method is not prescribed by that authority, the procedure described in either AWWA C651 or AWWA C652 or as described below:
  - Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - Fill system or part thereof with water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) and allow to stand for 24 hours.
  - Drain system or part thereof of previous solution and refill with water/chlorine solution containing at least 200 parts per million of chlorine. Isolate and allow to stand for 3 hours.
  - Flush system with clean, potable water until chlorine does not remain in water coming from system following allowed standing time.
  - Submit water samples in sterile bottles to the Engineer or authority having jurisdiction. Repeat procedure if biological examination made by the authority shows evidence of contamination.

3.11.2 Prepare and submit reports for purging and disinfecting activities.

3.11.3 Clean interior of piping system. Remove dirt and debris as work progresses.

### **3.12 COMMISSIONING**

3.12.1 Fill water systems. Check compression tanks to determine that they are not air bound and that system is completely full of water.

#### **3.12.2 Before operating systems, perform these steps:**

- A) Close drain valves, hydrants, and hose bibs.

- B) Open shutoff valves to full open position.
  - C) Open throttling valves to proper setting.
  - D) Remove plugs used during testing of piping systems and plugs used for temporary sealing of piping during installation.
  - E) Remove and clean strainer screens. Close drain valves and replace drain plugs.
  - F) Remove filter cartridges from housings and verify that cartridges are as specified for application where used, clean, and ready for use.
- 3.12.3 Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- 3.12.4 Check plumbing specialties and verify proper settings, adjustments, and operation.
- 3.12.5 Energize pumps and verify proper operation.
- 3.13 PROTECTION**
- 3.13.1 Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- 3.13.2 Place plugs in ends of uncomplete pipes at the end of the day or when work stops.
- 3.13.3 **Exposed ABS or PVC Piping:** Protect plumbing vents exposed to sunlight with 2 coats of a water-based latex paint.

**END OF SECTION 22 11 17**



## CONTENTS

### SECTION 22 11 16

#### DOMESTIC WATER PIPING

##### **PART 1    GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Related Sections
- 1.4 Definitions
- 1.5 Performance Requirements
- 1.6 Submittals
- 1.7 Quality Assurance

##### **PART 2    PRODUCTS**

- 2.1 General Requirements
- 2.2 Piping Materials
- 2.3 Steel Piping
- 2.4 Iron Pipes and Fitting
- 2.5 Non Iron Pipes and Fittings
- 2.6 Pipe Encasement
- 2.7 Valves

##### **PART 3    EXECUTION**

- 3.1 General
- 3.2 Inspection of Steel Pipes
- 3.3 Installation of Ductile Iron Pipes
- 3.4 Installation of Non Iron Pipes and Fittings
- 3.5 General Requirements for Joints
- 3.6 Building Pipes in and Through Structures
- 3.7 Hanger and Supports Installation
- 3.8 Installation of Valves
- 3.9 Connections
- 3.10 Field Quality Control
- 3.11 Adjusting
- 3.12 Cleaning

## SECTION 22 11 16

### DOMESTIC WATER PIPING

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SUMMARY**

This Section includes domestic water piping from locations indicated to fixtures and equipment within the site premises and inside the building.

##### **1.3 RELATED SECTIONS**

Requirements of the following Division 22:

- Section 22 00 10 Basic Mechanical Materials and Methods.
- Sub-sections of Section 22 05 00 Common Work Result for Plumbing.

##### **1.4 DEFINITIONS**

|      |   |  |
|------|---|--|
| CPVC | : | Chlorinated Polyvinyl Chloride Plastic |
| PA   | : | Polyamide (Nylon) Plastic              |
| PE   | : | Polyethylene Plastic                   |
| PEX  | : | Cross-linked Polyethylene Plastic      |
| PP   | : | Polypropylene Plastic                  |
| PVC  | : | Polyvinyl Chloride Plastic             |

##### **1.5 PERFORMANCE REQUIREMENTS**

Provide components and installations capable of producing domestic water piping systems with the following minimum working – pressure ratings, unless other wise indicated:

|  |   |      |
|--|---|------|
| Fire – protection water distribution piping    | : | 85 m |
| Domestic water service and distribution piping | : | 60 m |
| Domestic water distribution piping             | : | 40 m |

##### **1.6 SUBMITTALS**

###### **1.6.1 Product Data:** For pipe, tube, fittings, and couplings.

Conrad Cairo Renovation  
Lobby & Public Areas

Section 22 11 16  
Domestic Water Piping  
Page 2 of 24

1.6.2 **Water Samples:** As Specified.

1.6.3 **Field Test Reports:** Indicate and interpret test results for compliance with performance requirements.

## 1.7 **QUALITY ASSURANCE**

Piping materials shall bear label, stamp, or other markings of specified testing agency.

Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances", and NSF 61, "Drinking Water System Components-Health Effects".

Comply with NSF 14, "Plastics Piping Components and Related Materials", for plastic, potable domestic water piping and components.

Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9", for potable domestic water piping and components.

## **PART 2 PRODUCTS**

### 2.1 **GENERAL REQUIREMENTS**

All pipe work, valves, and fittings shall be to a class in excess of the maximum pressure they attain in service including any surge pressure and shall be supplied by an approved manufacturer.

Metric DIN / BSS flanges shall be used throughout. Welded flanges shall be welded – neck or slip – on flanges. The raised face shall be machined. Flange adaptors or detachable couplings shall be included in the connecting pipe work of all items of plant to facilitate dismantling and provision shall be made for double flexible joint arrangement adjacent to all structures.

Adaptors on pump delivery branches shall be upstream of their non-return valves.

Flange adaptors and unions shall be supplied and fitted in the pipe work nons wherever necessary.

### 2.2 **PIPING MATERIALS**

2.2.1 Refer to Part (3) "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

- 2.2.2 **Transition Couplings for Aboveground Pressure Piping:** Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- 2.2.3 **Transition Couplings for Underground Pressure Piping:** Metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- 2.3 **STEEL PIPING**
- 2.3.1 **Steel pipes, tubes and fittings shall comply with the following BS standards and/or equivalent DIN and Egyptian Standard, as approved by the Engineer:**
- BS 534 : Steel pipes, fittings and specials for water, gas, and sewage.  
BS 1387 : Steel tubes and tubulars suitable for screwing to BS 21 tubing pipe threads.  
BS : Galvanized steel pipes, tubes and fittings.
- 2.3.2 **Steel-Piping, Expansion Joints:** Compound, galvanized, steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.
- 2.3.3 **Steel-Piping, Double Expansion Joints:** Compound, galvanized, steel fitting with telescoping body and two slip-pipe sections. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

## **2.4      IRON PIPES AND FITTING**

Iron pipes and fittings shall comply with the following BS standards and/or equivalent DIN and Egyptian Standards as approved by the Engineer.

BS 4772:                      Specifications for ductile iron pipes and fittings.  
BS 143, BS 1256:        Malleable cast iron and cast copper alloy screwed pipe fittings for steam, air, water, gas and oil.

Unless waived by the Engineer, ductile iron pipes and fittings shall be mortar lined, in double thickness.

Ductile iron for fire – suppression applications shall be listed for fire – protection service.

## **2.5      NON IRON PIPES AND FITTINGS**

Non iron pipes and fittings shall comply with the following BS standard, and/or equivalent DIN and Egyptian Standards as approved by the Engineer.

BS 3505:    Un-plasticized PVC pipes for cold water services.  
BS 3284:    Polythene pipes for cold water services.  
BS 287:     Copper tubes for water, gas, and sanitation.

CPVC Schedule 40 Pipe and Fitting:    ASTM F 441/F 441M, ASTM F 438, socket type.

CPVC Schedule 80 Pipe and Fittings: ASTM F 441/F 441M, ASTM F 439, socket.

## **2.6      PIPE ENCASEMENT**

Underground Metal Piping shall be encased using PE Encasement having (0.20 mm) minimum thickness, tube or sheet.

## **2.7      VALVES**

2.7.1      **General:**    The following clauses set-out the general requirements and specifications for standard valves including gate valves, check valves, non-return valves, butterfly valves, air valves, float valves, sluice gates, hand stops, head tocks, electrical actuators, ... etc.

The valves shall comply with the following BS standards and/or equivalent DIN and Egyptian Standards as approved by the Engineer:

BS 5150:    Cast iron wedge and double disk gate valves for general purpose  
BS 3153:    Cast iron check valves for general purpose

BS 5155: Cast iron and carbon steel butterfly valves for general purpose  
BS 1010: Draw off taps and stop valves for water services.  
BS 1212: Specifications for float operated valves.

All valves and sluice gates shall be best water works quality and suitable for use with water to water at a temperatures upto 45°C. Special valves used for steam and or hot water control shall be supplied and shall be temperature rated suitable for their respective use.

All valves shall be leak-proof in either flow direction, except for check (non-return) valves, when the nominal test pressure is applied.

All pressure reduction valves, safety valves and similar components shall be workshop-tested and provided with a works certificate.

Valve bodies shall bear the following information:-

- a) Manufacturer's name;
- b) Hydraulic test pressure;
- c) Size of valve;
- d) Direction of flow "arrow".

The operating gear of valves and sluice gates shall be such that one man can open and close the valve against an unbalanced head 15 % in excess of the maximum to be encountered in service. Where necessary, arrangements shall be provided with gearing to achieve this requirement. The maximum couple which can be exerted by one man shall be taken as 130 Nm and the maximum force as 250 N. Where specified, valves 400 mm nominal bore and over shall be fitted with bypasses with isolating valves.

Gate valves shall be provided with renewable seats and it shall be possible to remove the gates without removing the valve body from the pipe-work.

The operation of all valves shall be such that turning the hand-wheel or tee-key in a clockwise direction closes the valves.

All materials shall comply with the appropriate BS Standards and shall be subject to the Engineer's approval. All castings shall be free of blowholes and other defects.

Gate valves and butterfly valves shall be suitable for flow in either direction.

All standard valves shall be suitable for frequent operation and for infrequent operation after long periods in the open or closed condition.

Packed glands shall be arranged for easy replacement of the packing, which shall be accessible without removal of the valve from the pipe. Precautions shall be taken to prevent corrosion of the valve spindles in contact with the gland packing.

Each valve or sluice gate or its operating equipment, shall bear an approved brass nameplate stating its function in English and Arabic.

Valves, cocks and operating spindles, which are for submerged operation, shall be independent of external lubrication.

2.7.2 **Tee-key Operation Valves:** Tee-key operation of valves and sluice gates shall not be adopted unless so specified. Where so provided the spindles shall be fitted with a cast iron detachable cap manufactured to and of identical shape to the valve spindle caps dimensioned in BSS.

2.7.3 **Sluice Gates and Valves of 50 mm Nominal Bore and Over:** Sluice gates and valves of 50 mm nominal bore and over shall be fitted with mechanical position indicators to show the amount which the valve or penstock gate is open or closed in relation to its full travel.

2.7.4 **Hand Wheels:** Operating hand-wheels for gate valves and penstocks shall be cast iron.

All hand-wheels on valves over 50 mm diameter shall be fitted with a circular inscribed brass disc with an arrow indicating the clockwise direction of closing and the words "CLOSE" in English and Arabic. Plates on hand-wheels for valves over 150 mm diameter shall in addition, have a simple bilingual inscription denoting the function, e.g., "Inlet".

External hand-wheels shall be fitted with a purpose made integral locking device to prevent operation by unauthorized persons. A padlock and chain will not be acceptable.

2.7.5 **Materials of Valves and Gates:** For the various valve types the following materials shall be used:-

Gate Valves

- |    |               |   |  |
|----|---------------|---|--|
| a) | Body          | : | Ductile cast iron Meehanite                  |
| b) | Bonnet, Cover | : | Ductile cast iron Meehanite                  |
| c) | Stuffing Box  | : | Ductile cast iron Meehanite                  |
| d) | Wedge         | : | Ductile cast iron Meehanite or rubber coated |
| e) | Seat on Body  | : | Brass or stainless steel                     |
| f) | Seat on Wedge | : | Brass or rubber coated                       |
| g) | Stem          | : | Stainless steel                              |
| h) | Stem Nut      | : | Bronze.                                      |

Butterfly Valves, Shut-off Type and Non-Return Type

- |    |       |   |   |
|----|-------|---|---|
| a) | Body  | : | Ductile cast iron Meehanite or fabricated steel |
| b) | Disc. | : | Ductile cast iron Meehanite or fabricated       |

- |    |                 |   |   |
|----|-----------------|---|---|
| c) | Peripheral Seal | : | steel   |
|    |                 | : | Sealing ring of non-ageing rubber, e.g. ethylene propylene ter rubber |
| d) | Body Seat Face  | : | Nickel weld overlay, micro-finished or hard rubber micro-finished     |
| e) | Shaft           | : | Stainless steel   |
| f) | Bushes          | : | Bronze or NiCr stainless steel  |
| g) | Gearing         | : | Irreversible norm gear or norm/ spur gear.                            |

#### Check Valves

- |    |                    |   |   |
|----|--------------------|---|---|
| a) | Body               | : | Cast iron with lamellar graphite                                    |
| b) | Inside Shaft       | : | Stainless steel   |
| c) | Body and Door Seat | : | Stainless steel / Stainless steel or rubber / Stainless steel seal. |

#### Air Valves

- |    |                     |   |   |
|----|---------------------|---|---|
| a) | Body                | : | Ductile cast iron Meehanite                                 |
| b) | Seatrings           | : | Brass   |
| c) | Floats              | : | Plastics epoxy resin or stainless steel, soft rubber coated |
| d) | Shut-off Valve Disc | : | Brass or steel C15, seat hard-faced with stainless steel    |
| e) | Stem                | : | Stainless steel.  |

#### Float Valves

- |    |             |   |   |
|----|-------------|---|---|
| a) | Body        | : | Meehanite cast iron with guide bush brass |
| b) | Valve Seal  | : | Soft seal on metal                        |
| c) | Piston Seal | : | Guide ring brass O-ring seal              |
| d) | Float Lever | : | Welded steel                              |
| e) | Float Ball  | : | Copper sheet, tinned or stainless steel   |

#### Sluice Gates (Penstocks)

- |    |                             |   |  |
|----|-----------------------------|---|--|
| a) | Frame, Gate Guide Rails     | : | Cast iron GG – 20  |
| b) | Threaded Stem               | : | X12 Cr Mo S17, ISO metric trapezoidal single acme thread |
| c) | Stem extension              | : | Steel St 50 – 2  |
| d) | Stem Nut                    | : | Bronze   |
| e) | Gate and Frame Clamps       | : | Cast iron GG – 20  |
| f) | Gate Sealing Face           | : | Sewage and sea water resistant, finished                 |
| g) | Frame Sealing Face          | : | Cast iron, finished                                      |
| h) | Seal Between Wall and Frame | : | Round sealing ring                                       |

2.7.6 **Gate Valves:** Gate valves shall be of the double-flanged type.



Stem seals shall be of the stuffing box and gland form arranged for easy replacement of packing and shall be accessible for maintenance without removal of the valve from service.

Extension spindles, headstocks and foot brackets shall be provided where necessary. Extended spindle installations shall include all necessary brackets, intermediate supports etc.

Head-stocks for non-rising spindle installations shall incorporate a valve position indicator.

Extension spindles shall be of stainless steel and shall conform with the requirements for valve stems with the exception of non-threaded sections which may be of mild steel. Extension spindle couplings shall be of the muff type and shall be drilled and provided with a nut and bolt for securing the spindle to the valve stem which shall likewise be drilled to accept the bolt.

Materials used in the manufacture of the gate valves shall conform to specifications in sub-clause (2.7.5) above.

- 2.7.7 **Check Valves, Non-Return Valves:** Check valves shall be double flanged. They shall be of the quick acting non-slam single or multi door type designed to minimize slam on closure. The valves shall be fitted with renewable door sealing faces, which shall be positively fixed.

All check valves shall be suitable for operating in the horizontal plane unless otherwise specified.

Covers shall be provided to allow ample access for cleaning and service and shall be supplied complete with tapped bosses fitted with air release cocks.

Non-return valves on main pump delivery branches shall be of the internal damper type and shall achieve the largest possible closing angle before the water column returns.

The free swing motion of the tilting disc shall be assured for the closing stroke until approximately 10 % before the closed end position is reached. The last 10 % of the closing stroke shall be damped.

Materials used in the manufacture of the check valves, non-return valves shall conform to specifications in sub-clause (2.7.5) above.

- 2.7.8 **Butterfly Valves:** All butterfly valves shall be resilient seated and shall give tight closure against unbalanced water pressure in either direction. The unbalanced water pressure shall be the design pressure rating of the valve.

The manufacturer's preferred direction of flow for the valve shall be clearly marked on the body.

The valve seat shall be absolutely corrosion-proof and wear resistant nickel weld overlay, micro-finished, or hard rubber coated and micro-finished.

The valve disc shall rotate through an angle of 90° from the fully open to the fully closed position. The peripheral seal shall be an endless profile sealing ring of EPDM (ethylene propylene ter rubber) and shall be adjustable and/or exchangeable without removing the disc. The seal retaining segments and screws shall be of stainless steel.

Butterfly valve shaft shall be horizontal when mounted.

The shaft may be in one piece or attached as two stub ends on opposite sides of the disc. The means of attachment of the shaft to the corrosion-resistant materials shall be of a pattern which precludes the assembly becoming loose in operational service. Grub screws, pins (parallel or taper) or clamps will not be acceptable. The shaft and disc fixing shall be capable of safety factor of five. Shaft seals, when used, shall be of the self-adjusting chevron type.

When all the seat retention members are in place, the finished edges shall fit closely and the surface shall be smooth with all fastenings set flush in the water passage so as to offer the least resistance possible to the flow of water through the valve.

Valve seats which extend over the face of the flanges to secure the seat in place, or which require surface grinding and/or hand fitting of the disc; or designs which require the adjoining pipe flange to retain the seat in place and resist line pressure, will not be acceptable.

Operating gear for butterfly valves shall be of the fully enclosed type. Valves shall be suitable for operation by one man at all pressure conditions that can apply. A valve position indicator shall be provided. Where a hand-wheel is used for operating the valve, the indicator shall be clearly visible from the hand-wheel operating position.

All butterfly valves shall be tested the manufacturer's works and under "open-end" conditions. The seat test shall be for tight closure under maximum unbalanced water test pressure in either direction. The maximum permissible leakage for each valve shall be 0.5 litre per hour per 100 mm nominal diameter of the valve.

The Contractor shall provide details of the materials of manufacture and design of butterfly valves, and shall provide evidence to show that the proposed seating materials and seating designs have given satisfactory performance in similar conditions to those applying under the Contract.

Valves shall carry identification marks and/or plates in accordance with the DIN Standards and those for use on process plant shall carry an additional brass plate carrying a valve identification and a brief description of its function.

Materials used in the manufacture of butterfly valves shall conform to specifications in sub-clause (2.7.5) above.

- 2.7.9 **Flap Valves:** Flap valves shall be round or rectangular, single door bitumen coated, double hung tidal type flap valves, with the clear opening dimensions designed to pass the required discharge. Flap valves shall be fitted with phosphate or bronze or stainless steel or similar approved corrosion-resistant metal faces and hinge pins and shall have a galvanized mild steel lifting eye.

Flap valves shall be designed to withstand a working pressure equivalent to 8.0 m of water and shall be tested after installation with a feeler gauge to a non-acceptance of 0.05 mm between sealing faces when closed.

- 2.7.10 **Pressure Control Valves:** Pressure control valves for pipes ND 80 mm diameter and above used for pressure reduction, pressure sustaining or pressure relief shall be of the double flanged type and shall operate by use of an integral auxiliary actuating mechanism suitable for the application. For bores less than 80 mm diameter a direct spring controlled valve may be used.

The valves shall be adequately sized to control the flow and pressure differential required for the application with an accuracy of  $\pm 2.5\%$  of the set value. They shall be capable of operating at a sustained pressure 20 % in excess of the nominal declared working pressure.

Valves shall be sized to ensure that their full capacity will be more than adequate to accept the desired maximum flow at the minimum required differential pressure.

The main pressure control valve operation shall be actuated by a hydraulic differential pressure system in balance with a spring loaded bellows type diaphragm, the reference pressure being bled from the inlet and outlet of the main valve.

The diaphragm spring shall be adjustable by a screw to cover the range of pressure adjustment specified for the valve application.

The control circuit bleeds shall be controlled by isolating cocks to enable the system connections to be removed without disturbing the main valve.

The detail connections and application of reference pressure shall be arranged to suit the requirement, whether for pressure reduction, pressure relief, to sustain a constant pressure, or regulate flows.

Monitoring orifices shall be protected suitably by fine mesh strainers on the pipeline side, the elements, strainers, pipe-work and fittings being in suitable corrosion-resistant materials.

A pressure gauge shall be fitted to indicate the regulated pressure.

Where required a needle valve shall be incorporated in the connection from the relay valve to the main valve piston cylinder to adjust the valve setting.

When the main relay valves are closed, the main valve seating shall be “drop tight” under the inherent hydraulic pressure.

- 2.7.11 **Air and Gas Relief Valves:** Air and gas relief valves shall be of the double orifice pattern. The valves shall be adequately sized for the release of gas from the pipeline (or other container) without restriction of rate of filling or flow due to back pressure and also to allow admission of air during pipeline emptying at a rate sufficient to prevent excessive depression of pressure in the pipe.

Valves shall be designed to prevent the operating elements being in contact with the pipeline liquid by approved means such as the provision of an auxiliary float and chamber sufficiently large to isolate the orifice valves and seats throughout the rated operational range.

Air valves shall be fitted with an isolating gate valve and gearing shall be provided where necessary to facilitate operation.

In applications where the pipeline characteristics may lead to liquid column separation with consequent possibility of surge, a vented non-return valve shall be provided which allows air to enter freely on separation but controls expulsion of air/gas as the liquid column rejoins.

Materials used in the manufacture of the air relief valves shall conform to specifications in sub-clause (2.7.5) above.

- 2.7.12 **Sluice Gates:** Sluice gates shall be of the rising spindle type, the frame and guide in one piece cast construction or with the guides dowelled and bolted to the frame.

Frames shall incorporate a rectangular or circular opening with integral spigot on the back.

The gate shall be of one piece cast construction with vertical and horizontal ribs, a reinforced pocket to receive a gunmetal thrust nut, pads to receive wedges and reinforced periphery around the backside.

Guide rails shall be of such length as to retain at least one half of the vertical heights of the slide when in the fully open position. Grooves running the full length of the guide rail shall be accurately matched to receive slide tongues.

The manufacture and assembly shall be such as to ensure accuracy in making the frame and door faces and tight closure while maintaining freedom of gate movement during operation and minimizing sliding wear of the sealing faces. They shall incorporate adjustable wedges or swiveling cams and actuating pegs manufactured from a corrosion-resistant material.

Metal sealing faces of the frame and gate shall be sewage and sea water resistant and finished.

Unless otherwise stated each sluice gate shall be provided with a suitable hand-wheel of adequate diameter for the duty required, or gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel or geared handle does not exceed 250 N.

Gearboxes or hand-wheels shall have cast on them the direction of closing which shall be clockwise and vandal and weather-proof covers shall be securely fitted to protect the threads of rising spindles. Each tube shall be clearly and permanently engraved to indicate the position of the penstock to which it is fitted.

Spindles shall have machine cut robust trapezoidal form threads. Extension spindle couplings shall be of the muff type and they shall be drilled and provided with a nut and bolt for securing the spindle to the penstock spindle head which shall likewise be drilled to receive the bolt.

Where sluice gates are specifically required to be operated by tee-keys, spindle caps of the specified type shall be fitted. The caps shall be drilled and each provided with nut and bolt for securing to the spindle which shall also be drilled.

All hand-wheels, headstocks, foot brackets and guide brackets shall be of cast iron. Guide brackets shall be adjustable.

All sluice gates shall be delivered with a temporarily attached template in order to facilitate accurate installation of the frame and fittings.

Materials used in the manufacture of the sluice gates shall conform to specifications in sub-clause (2.7.5) above.

- 2.7.13 **Hand-stops:** Hand-stops shall be manufactured in cast iron with frames of cast iron and doors of galvanized mild steel.

Where special hand-stops are required with seating faces the hand-stop shall comply with the requirements herein for cast iron penstocks.

- 2.7.14 **Hand Operated Rising Spindle Head-stocks:** Hand operated rising head-stocks shall be purpose made spindle enclosing pedestal pillars manufactured in close grained cast iron, either of the hand-wheel or the single or double gear crank operated type.

Lift nuts shall be in cast bronze threaded to fit the rising stem.

Spindle thrusts shall; be taken on ball or roller bearings provided above and below the flange on the lift nut and designed to take five times the maximum thrust developed in opening and closing the gate.

Gears shall be of cast bronze, accurately machined with cut teeth, and smooth running with similar shafts in bronze sleeve bearings or roller bearings of ample size. The gear box shall be covered by a removable flanged cast iron cover dome.

All gears and bearings shall be enclosed in the cast-iron housing. Fittings shall be provided so that all gears and bearings can be periodically lubricated. The removable cast iron crank shall be fitted with a brass rotating handle, set with its axis approximately 0.8 m above ground or floor level. The maximum crank radius shall be 250 mm, the effort required less clockwise to close. The direction of opening shall be marked and annotated on the headstock casting.

The rising stem unit shall be provided with spindle cover of sufficient diameter and length to permit full travel of the threaded stem without obstruction. The top of the stem shall be capped and the bottom flanged to suit the housing or adaptor plate. Each penstock shall be provided with a brass position indicator to show the position of the gate at all times. Indication shall be in the support stem through a brass faced and calibrated slot.

Head-stocks shall be vertical. All mountings shall be through a rigid rectangular plate with at least 4 fixing holes.

Base fixings shall be designed for the peak thrust with a factor of safety of 5. The design thrust shall be stated on the Contractor's Drawings.

- 2.7.15 **Hand Operated Non-Rising Spindle Head-stocks:** Non-rising spindle headstocks for valves shall be purpose made vertical spindle enclosing pedestal pillars, fitted with a valve position indicator mechanism, hand-wheel and suitably fitted with robust bearings and bushes, and suitable for prolonged external exposure.

All mountings shall be through a rigid rectangular base plate with at least 4 fixing holes. Hand-wheels shall be horizontal, approximately 0.8 m above ground or floor level.

- 2.7.16 **Electric Operation of Valves and Sluice Gates:** Electrically operated actuators for gate valves, butterfly valves and sluice gates shall be sized to guarantee closure at the maximum possible differential pressure across the door. The safety margin of solenoid and motor power available for unseating the door shall be at least 50 % in excess of maximum closing torque at the nominal supply voltage.



The operating speed shall be such that gate valve closing and opening at approximately 200 – 300 mm per min unless otherwise specified. The opening and closing time of the butterfly valves for the sand filter operation shall be less than 0.5 minimum

Motor burn-out protection shall be provided by direct sensing of motor temperature by three thermostats connected in series and placed in the starter winding. The trip shall be self re-setting and shall include a changeover volt-free contact for remote indication of motor tripped.

The actuator gearbox shall be of cast iron and of the totally enclosed oil bath or grease lubricated type and shall assure long term, trouble free service. The drive shall incorporate a lost motion hammer blow feature to open a jammed or rarely operated valve. The output shafts shall be hollow to accept rising or non-rising valve stems.

Thrust bearings of the ball or roller type shall be provided in such a way that the gear case can be opened for inspection or disassembled without releasing the stem thrust or taking the valve or sluice gate out of service.

A hand-wheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand-wheel drive shall be mechanically independent of the motor drive, and gearing shall be such as to permit emergency manual operation in reasonable time, e.g. one turn at the hand-wheel corresponds to one turn of the hollow output shaft.

The valve or sluice gate actuator shall be furnished with a drive bushing easily detachable for machining to suit the spindle or gearbox input shaft. The drive bushing shall preferably be positioned to enable standard length stems to be used.

Electric actuators shall be provided with open and close torque and position limit switches with changeover volt-free contacts at each end of travel for remote indication and interlocking. Means shall be provided to prevent the open torque switch tripping while the initial unseating hammer blow effect is applied.

Provision shall be made in the design for two extra sets of limit switches to be available if required comprising at least three switches per set, each set independently adjustable to any door position.

A mechanical dial indicator shall be provided to indicate whether the valve is fully open, fully closed or in an intermediate position.

Provision shall be made in the design for the addition of a sealed potentiometer for continuous remote position transmission where required by the Specification.

When so fitted, the mechanical dial indicator shall also show continuous valve movement.

The reversing contactor starter and local controls shall be integral with the valve actuator. The starter shall comprise mechanically and electrically interlocked reversing contactors of appropriate rating to the motor size, for control voltage 110 or 220 V, 50 Hz.

Local controls shall comprise pushbutton switches for “open”, “close” and “stop”, and a “local/remote” selector switch pad lockable in any of the four positions:-

- A) “Local” control only;
- B) “Local and remote” control;
- C) “Remote” control plus “local stop” only;
- D) “Stop locked off” – no electrical operation.

Internal wiring shall be of tropical grade PVC insulated stranded cable of 5 amps minimum rating for control circuits and of appropriate size for the motor three-phase power.

Each wire shall be clearly numbered and identified at each end. The terminals shall be of the stud type and the three-phase power terminals compartment shall be designed so that the integral controls are not adversely affected by heavy rainfall while the terminals cover is off for wiring in exposed locations. Cable entries shall be suitable for PVC/SWA/PVC cables. A separate terminal box shall be provided for the heater.

The starter housing shall be complete with an integral anti-condensation heater, for 110 or 220 V AC operation.

The actuator shall be weatherproof and watertight to IP 67 and NEMA6, (4 hour submergence under 3 m head) with sealing “O” rings. The terminal compartment shall be separately sealed from the rest of the enclosure so that wiring and integral controls are not adversely affected by water while the cover is removed for site cabling and maintenance.

## **PART 3    EXECUTION**

### **3.1        GENERAL**

The pipe work installation shall be so arranged to offer ease of dismantling and removal of pumps and other major items of equipment pump delivery pipe work shall join pumping station bus mains horizontally.



The ends of pipes for use with flange adaptors and couplings shall be sized to the tolerances required by the manufacturer of the couplings. All pipe work shall be second to fixed flanges by suitable tie bolts. Flange adaptors and unions shall be supplied and fitted in the pipe work runs wherever necessary to permit the simple disconnection of flanges, valves and equipment without the need to spring long runs to remove valves, equipment and the like.

The Contractor shall note the necessity for providing flexibility in the pipe work at joints in the main structures to allow for differential settlement and thermal stresses which shall not be transferred to the anchor blocks. Flexible joints or collars shall also be allowed on all pipe work where necessary to allow for some margin of error in the building work.

The pipe work system installation shall be so designed that anchorage at work ends, bends, tees, and valves is kept to a minimum.

### **3.2 INSPECTION OF STEEL PIPES**

Steel pipes shall be used for Domestic water distribution and service.

Steel pipe work shall be in accordance with the appropriate BSS (or DIN, Egyptian equivalent) as follows:

Stress calculations of steel pipes shall be in accordance with the appropriate BSS, "Steel Pipes under Internal Pressure" or with "AD-Merk-blatter; German Association of Manufacturers of Pressure Vessels, Memos". In no case, the superimposed stress of bending, tension compression, etc., calculated to shape variation hypothesis, shall exceed 0.7 of the yield point at maximum exerted load at any point of the piping.

The maximum exerted load shall take into account test pressure, water hammer pressure waves, thermal forces, dead weight, etc. On request of the Engineer, a calculation on pipe stresses shall be submitted by the Contractor at no extra cost. The requested calculation will be subject to the Engineer's approval.

The minimum steel pipe wall thickness shall be at least the "normal" or "standard" wall thickness as stated in the applicable standards.

Steel pipe work above DN 80 shall be either coated externally and security wrapped where laid underground or painted externally when laid above ground or in ducts. In both cases pipe work shall be internally lined at the manufacturer's works, according to painting specifications in the Clause "Protection against Corrosion". The internal lining shall be continuous across joints as far as is practicable according to size of pipe.

Steel pipe work below DN 80, excepting that for conveying oil, shall be galvanized in accordance with stipulations in the Clause "Protection against

Corrosion". Branches shall be performed and welded before the pipe is erected.

All bends made from pipe shall be formed so that at any point along the bend joviality will not reduce the bore by more than 2.5 %. Radii of hot formed bends for all pipes shall be not less than five times the outside diameter.

Gusseted, "cut and shut" and wrinkle bends shall not be used on pipes smaller than 150 mm diameter.

Flexible joints shall be bolted gland or detachable flexible coupling as necessary.

Galvanized steel pipes shall be with screwed threads. Pipe fittings shall be wrought iron.

### **3.3 INSTALLATION OF DUCTILE IRON PIPES**

Ductile iron pipes shall be used for distribution of fire suppressing water. Ductile iron pipe work shall follow appropriate BS standards and in general installation shall apply the appropriate clause in the proceeding sub-clause (3.1)

### **3.4 INSTALLATION OF NON IRON PIPES AND FITTINGS**

Polyethylene pipes for cold water services, plastic pipes (PVC) and unplasticized PVC pipes shall only be used for water and drainage purposes with the expressed approval of the Engineer. Where authorized, they shall comply with BS 3234 unless higher pressure ratings are called for or improved corrosion resistance is required.

UPVC pipes shall have mechanical joints of a type suitable for the liquid to be carried by the pipe work. Small – bore pipe work shall be jointed with PVC "hand tight" screwed fittings of standard manufacture.

### **3.5 GENERAL REQUIREMENTS FOR JOINTS**

Before making any joint the Contractor shall ensure that the interior of each pipe or valve is clean and that it remains clean. Immediately before starting a joint the Contractor shall clean the end of each pipe to be jointed and shall otherwise specially prepare the ends of jointing as may be necessary for the particular kind of joint. All mechanical joints shall be cleaned and have their paintwork or coating made good before assembly.

The Contractor shall use only the proper jointing parts as specified and obtained through the suppliers of pipes or valves. All joints shall be accurately made and shall be capable of passing tests for individual joints and for the completed pipeline.

After completing a joint any protective paint or other coating shall be made good, and any metal joint which is not already coated shall be cleaned and painted according to painting specifications, the Clause "Protection against Corrosion". Internal lining and additional external protection of the joints shall be carried out as specified.

### **3.6 BUILDING PIPES IN AND THROUGH STRUCTURES**

Steel structures, walkways, platforms, stairs and ladders over large diameter pipes with the upper pipe edge higher than 600 mm above ground level shall be provided and the costs included in the Tender Price.

The installed piping shall be sloped to prevent trapping of air bubbles, unless relieved by air valves. The lowest point of a pipe sling shall be provided with a drain or flushing valve.

Adequate clearance shall be given to parallel pipes to allow for easy maintenance without disturbing other lines. All overhead piping shall have a minimum clearance of 2 m from operating floors and platforms.

Generally pressurized pipes should not be embedded in concrete. When embedding such pipes, the approval of the Engineer is required.

Where pipes pass through a concrete wall or structure they shall project from the external face(s) of the structure by 300 mm for pipes of DN 500 or less and by 500 mm for pipes in excess of DN 500 the surface of such pipes shall be prepared to the approval of the Engineer to ensure a satisfactory bond between pipes and concrete.

The first pipe in open ground leaving a structure shall be a short length of either spigot and socket or double socket to suit the flow direction. The length of this pipe shall be one and a half times the nominal diameter of 600 mm whichever is greater.

Puddle flanged fittings for building into the walls may be of the single-flanged type or of the double-flanged type.

Where the single-flanged type is used it shall be positioned so that the puddle flange is in the center of the wall.

Where the double-flanged type is used it shall be positioned so that the outside face of each flange is flush with the face of the wall. Pipe support blocks shall be provided by the Contractor where necessary in chambers to support the pipe adequately, both during and after construction.

Surfaces of cast-iron or steel pipes which are to have concrete cast against them shall be clean and free of deleterious matter and loose rust at the time of

concreting. The paint protection system, to be applied to the permanently exposed faces of these pipes before the pipes are built in, shall be continued for 50 mm as marginal stripes along the contact surface. No paint containing aluminum in metallic form shall be allowed to come into direct contact with the concrete.

### 3.7 HANGER AND SUPPORTS INSTALLATION

3.7.1 Refer to Sub-sections of Section 22 05 00 "Common Work Result for Plumbing".

3.7.2 Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameter:

|                   |   |                        |
|-------------------|---|------------------------|
| DN 32 and Smaller | : | 2100 mm with 10 mm rod |
| DN 40             | : | 2700 mm with 10 mm rod |
| DN 50             | : | 3000 mm with 10 mm rod |
| DN 65             | : | 3400 mm with 13 mm rod |
| DN 80 and DN 90   | : | 3700 mm with 13 mm rod |
| DN 100 and DN 125 | : | 3700 mm with 16 mm rod |
| DN 150            | : | 3700 mm with 19 mm rod |
| DN 200 to DN 300  | : | 3700 mm with 22 mm rod |

3.7.3 Install supports for vertical steel piping every 4500 mm.

3.7.4 Install hangers for UPVC piping with the following maximum horizontal spacing and minimum rod diameters:

|                   |   |                        |
|-------------------|---|------------------------|
| DN 20 and Smaller | : | 900 mm with 10 mm rod  |
| DN 32 to DN 50    | : | 1200 mm with 10 mm rod |
| DN 65 to DN 90    | : | 1200 mm with 13 mm rod |
| DN 100 and DN 125 | : | 1200 mm with 16 mm rod |
| DN 150            | : | 1200 mm with 19 mm rod |
| DN 200            | : | 1200 mm with 22 mm rod |

3.7.5 Install supports for vertical UPVC piping every 1500 mm for DN 25 and smaller and every 1800 mm for DN 32 and larger

3.7.6 Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameter:

|                   |   |                        |
|-------------------|---|------------------------|
| DN 20 and Smaller | : | 1200 mm with 10 mm rod |
| DN 65 to DN 90    | : | 1200 mm with 13 mm rod |
| DN 100 and DN 125 | : | 1200 mm with 16 mm rod |
| DN 150            | : | 1200 mm with 19 mm rod |
| DN 200            | : | 1200 mm with 22 mm rod |

3.7.7 Install supports for vertical PVC pipes every 1200 mm.

3.7.8 Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameter:

|                   |   |                        |
|-------------------|---|------------------------|
| DN 20 and Smaller | : | 1500 mm with 10 mm rod |
| DN 25 to DN 32    | : | 1800 mm with 10 mm rod |
| DN 40 to DN 50    | : | 2400 mm with 10 mm rod |
| DN 65             | : | 2700 mm with 13 mm rod |
| DN 80 to DN 125   | : | 3000 mm with 13 mm rod |
| DN 150            | : | 3000 mm with 16 mm rod |
| DN 200            | : | 3000 mm with 19 mm rod |

3.7.9 Install supports for vertical copper tubing every 3 m.

3.7.10 Install hangers and supports for piping and tubing not listed above according to manufactures written instructions.

### **3.8 INSTALLATION OF VALVES**

Unless otherwise specified, all valves shall be located and orientated in readily accessible positions with hand-wheels conveniently arranged for ease of operation.

Where this requirement is impracticable or would lead to undue complication in the works, operating spindles shall be taken vertically to headstocks for manual operation.

Chain operated wheels shall not be incorporated in the arrangements.

Knuckling of spindle extensions and remote operation through miter geared linkages shall be avoided wherever possible.

### **3.9 CONNECTIONS**

3.9.1 Drawings indicate general arrangement of piping, fittings, and Specialties.

3.9.2 Install piping adjacent to equipment and machines to allow service and maintenance.

3.9.3 Connect header of fire fighting to distribution loops and branches through sluice valves.

3.9.4 Connect header of filter feed pumps to the water carrier pipe. Use transition fittings to join dissimilar piping material.

3.9.5 Connect header of cold filtered / disinfected water to the distribution pipes of cold water through sluice valves.

- 3.9.6 Connect header of hot filtered / disinfected water to the distribution pipes of hot water through sluice valves.

### **3.10 FIELD QUALITY CONTROL**

#### **3.10.1 Inspect Domestic Water Piping as Follows:**

- A) Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- B) During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
  - Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- C) Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- D) Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

#### **3.10.2 Test Domestic Water Piping as Follows:**

- A) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
- B) Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- C) Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- D) Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
- E) Prepare reports for tests and required corrective action.

### **3.11 ADJUSTING**

Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

- Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
- Adjust calibrated balancing valves to flows indicated.

### **3.12 CLEANING**

#### **3.12.1 Clean and Disinfect Potable [and Nonpotable] Domestic Water Piping as Follows:**

- A) Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
- B) Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
  - Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - Fill and isolate system according to either of the following:
    - . Fill system or part thereof with water / chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
    - . Fill system or part thereof with water / chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
  - Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

3.12.2 Prepare and submit reports of purging and disinfecting activities.

3.12.3 Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

**END OF SECTION 22 11 16**



## CONTENTS

### SECTION 22 11 13

#### FACILITY WATER DISTRIBUTION PIPING

##### **PART 1    GENERAL**

- 1.1    Related Documents
- 1.2    Scope of Work

##### **PART 2    PRODUCTS**

- 2.1    Materials and Products - General
- 2.2    Basic Identification
- 2.3    Basic Pipes and Pipe Fittings
- 2.4    Basic Piping Specialties
- 2.5    Basket Strainers
- 2.6    Basic Supports and Anchors
- 2.7    Basic Valves
- 2.8    Backflow Preventers
- 2.9    Pressure Reducing Valves
- 2.10   Basic Expansion Compensation
- 2.11   Basic Meters and Gages
- 2.12   Relief Valves
- 2.13   Drinking Water Filters
- 2.14   Silcock
- 2.15   Cleaning Hose

##### **PART 3    EXECUTION**

- 3.1    Inspection
- 3.2    Installation of Basic Identification
- 3.3    Installation of Water Distribution Piping
- 3.4    Installation of Exterior Water Piping
- 3.5    Installation of Piping Specialties
- 3.6    Installation of Supports and Anchors
- 3.7    Installation of Valves
- 3.8    Installation of Backflow Preventers
- 3.9    Installation of Pressure Regulating Valves
- 3.10   Installation of Expansion Joints
- 3.11   Installation of Meters and Gages
- 3.12   Installation of Water Meter
- 3.13   Piping Connections to Fixtures and Equipment
- 3.14   Testing
- 3.15   Cleaning, Flushing, Inspecting and Disinfecting
- 3.16   Balancing

## SECTION 22 11 13

### FACILITY WATER DISTRIBUTION PIPING

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

- Division-1 Specifications Group, apply to work of this section
- Division-22 Plumbing Piping section apply to work of this section.

##### **1.2 SCOPE OF WORK**

- 1.2.1 Extent of cold, hot and potable water distribution systems work is indicated on Drawings and schedules, and by requirements of this section and design guideline where applicable.
- 1.2.2 Refer to other Division-22 sections for insulation required in conjunction with hot water piping; not work of this section.
- 1.2.3 Refer to other Division-22 sections for plumbing equipment; not work of this section.
- 1.2.4 Refer to other Division-22 sections for plumbing fixtures; not work of this section.
- 1.2.5 Refer to other Division-22 sections for plumbing pumps; not work of this section.
- 1.2.6 Trenching and backfill required in conjunction with exterior water piping is specified in other Division-22 sections, and is included as work of this section.
- 1.2.7 Trenching and backfill required in conjunction with water piping inside of building foundations is specified in other Division-22 sections, and is included as work of this section.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS AND PRODUCTS - GENERAL**

- 2.1.1 Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection to comply with installation requirements.
- 2.1.2 Provide materials and products of sizes and types to match piping and equipment connections.
- 2.1.3 Provide fittings of materials as specified, which match pipe materials used in water distribution systems.

### **2.2 BASIC IDENTIFICATION**

Provide identification complying with Division-22 section "Basic Mechanical Materials and Methods".

### **2.3 BASIC PIPES AND PIPE FITTINGS**

Provide pipes and pipe fittings complying with Division-22 Basic Mechanical Materials and Methods section "Domestic Water Piping", and "Plumbing Piping" sections.

### **2.4 BASIC PIPING SPECIALTIES**

Provide piping specialties complying with Division-22 section "Piping Specialties", in accordance with the following listing:

- Pipe escutcheons.
- Low-pressure Y-type strainers.
- Dielectric unions.
- Mechanical sleeve seals.
- Fire barrier penetration seals.
- Drip pans.
- Pipe sleeves.
- Sleeve seals.

## **2.5 BASKET STRAINERS**

- 2.5.1 Provide basket strainers as indicated, with cast-iron body, 860 kPa (125 psi) flanges, bolted type or yoke type cover. Provide 1725 kPa minimum for pipes with 50 m static head or more.
- 2.5.2 Furnish strainers with removable, non-corrosive perforated strainer basket, with 3 mm perforations and lift-out handle.

## **2.6 BASIC SUPPORTS AND ANCHORS**

Provide supports and anchors complying with Division-22 "Hangers and Supports" and "Plumbing Piping" sections.

## **2.7 BASIC VALVES**

Provide valves complying with Division-22 "General Duty Valves for Plumbing Piping" and "Plumbing Piping" sections.

## **2.8 BACKFLOW PREVENTERS**

- 2.8.1 Provide a backflow prevention device at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. Device shall be certified by the American Society of Sanitary Engineers (ASSE). Listed below is a partial list of connection to the potable water system which shall be protected against backflow or back siphonage.

### **2.8.2 Reduced Pressure Backflow Preventer: ASSE 1013.**

- A) Water make-up to heating systems, cooling tower, chilled water system, and generators.
- B) Water service entrance from loop system.

### **2.8.3 Atmospheric Vacuum Breaker: ASSE 1001**

- A) Hose bibs and sinks w/threaded outlets.
- B) Disposers.
- C) Showers (telephone type).
- D) All kitchen equipment, if not protected by air gap.
- E) Ventilating hoods w/wash down system.

2.8.4 Provide backflow preventers of the reduced pressure principle type, consisting of assembly including shutoff valves on inlet and outlet, and strainer on inlet.

2.8.5 Backflow preventers to include test cocks and pressure-differential relief valve located between two positive seating check valves.

## **2.9 PRESSURE REDUCING VALVES**

2.9.1 Provide pressure regulating valves as indicated, of the single seated for dead end service for 200 to 850 range on low pressure side, direct operated type, bronze body, integral strainer, complying with requirements of ASSE Standard 1003. Composition diaphragm and stainless steel springs, bronze body with threaded connections for sizes 15 to 50 mm, cast iron or semi-steel body with bronze trimmings and flanged connections for sizes larger than 50 mm.

2.9.2 Size pressure regulating valves for maximum flow rate and inlet and outlet pressures indicated on Drawings.

2.9.3 **Operation:** Diaphragm and spring to act directly on valve stem. Delivered pressure shall vary not more than one kPa for each 10 kPa variation on inlet pressure.

2.9.4 **Setting:** Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the Drawings.

2.9.5 **Connections Valves and Strainers:** Install shut off valve on each side of reducing valve and full sized bypass with shut off valve. Install strainer on inlet side of, and same size as pressure reducing valve. Install pressure gage on low pressure side of line.

## **2.10 BASIC EXPANSION COMPENSATION**

2.10.1 Provide expansion joints complying with Division-22.

2.10.2 Provide expansion loops on straight runs of pipes longer than 30 m.

2.10.3 Provide anchors and guides to control expansion of pipes as required.

## **2.11 BASIC METERS AND GAGES**

Provide meters and gages complying with Division-22 "Basic Mechanical Materials and Methods" and "Meters and Gages".

## **2.12 RELIEF VALVES**

2.12.1 Provide relief valves as indicated, of size and capacity as selected by Contractor for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

2.12.2 **Combined Pressure-Temperature Relief Valves:** Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 99 deg. C, and pressure relief at 1030 kPa or 1725 kPa per system requirements.

### **2.13 DRINKING WATER FILTERS**

2.13.1 Drinking water filters to be renewable cartridge, sterilizing, pressure type, to fit directly on any water tap feed pipe, minimum rated capacity 50 liters per hour at pressure of 200 kPa and good for working pressure of 800 kPa.

2.13.2 Filters to have cast iron housing finished with white enamel internally and externally, chrome plated brass swiveling spout, inlet valve, drain cock and removable cover for easy cartridge removal without need for tools.

2.13.3 Cartridge to be special filtering material designed to retain bacteria and impurities and remove objectionable tastes, colors and odors.

### **2.14 SILCOCK**

Silcock to be flush type 75 mm wall hydrant, with flush wall box, key locked hinged cover, integral vacuum breaker, hose thread nozzle, bronze or brass parts throughout, female key operated valve with composition washer and removable seat.

## **2.15 CLEANING HOSE**

Hose reel, 25 mm hose, 30 m long rubber hose, adjustable spray brass nozzle, hose drum. The cleaning hose shall be provided with isolating valve. Drum to retract hose after use.

## **PART 3 EXECUTION**

### **3.1 INSPECTION**

Examine areas and conditions under which potable water systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION OF BASIC IDENTIFICATION**

Install mechanical identification in accordance with Division-22.

### **3.3 INSTALLATION OF WATER DISTRIBUTION PIPING**

3.3.1 Install water distribution piping in accordance with Division-22 "Domestic Water Piping" and "Plumbing Piping" sections.

3.3.2 Install piping with 1/4% downward slope towards drain point.

3.3.3 Locate groups of pipes parallel to each other, spaced to permit applying full inservicing.

3.3.4 Install air vents at all high points of piping systems.

3.3.5 Install drain valves at all low points of piping systems.

### **3.4 INSTALLATION OF EXTERIOR WATER PIPING**

3.4.1 Install underground piping at least 3 m away from any sewer line. Protect from contamination from any source.

3.4.2 Protect underground galvanized steel pipes by wrapping with special self-adhesive polyethylene tape, wound spirally and firmly around pipe, with adequate overlap. Pay particular attention to protection at the threaded joints.

3.4.3 Install exterior water service piping system in compliance with local governing regulations.

3.4.4 **Street Main Connection:** Arrange and pay for tap in water main, of size and in location indicated. Cut into and install new tee for water service in existing water main, at location indicated, in accordance with local Water Utility Company requirements. Provide curb valve and curb box as indicated.

3.4.5 **Water Service Piping:** Extend water service piping of size and in location indicated to water service entrance at building. Provide sleeve in foundation wall for water service entry; make entry watertight. Provide shutoff valve at water service entry inside building; strainer, pressure gage, test tee with valve.

### 3.5 **INSTALLATION OF PIPING SPECIALTIES**

Install piping specialties in accordance with Division-22 "Plumbing Piping" sections.

### 3.6 **INSTALLATION OF SUPPORTS AND ANCHORS**

Install supports and anchors in accordance with Division-22 Basic Mechanical Materials and Methods section "Hangers and Supports".

### 3.7 **INSTALLATION OF VALVES**

3.7.1 Install valves in accordance with Division-22 Basic Mechanical Materials and Methods section "Valves".

3.7.2 **Sectional Valves:** Install on each branch and riser, close to main, at branch out to each floor and where branch or riser serves two or more plumbing fixtures or equipment connections, and elsewhere as indicated.

3.7.3 **Shutoff Valves:** Install on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated.

3.7.4 **Drain Valves:** Install on each plumbing equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain potable water system.

3.7.5 **Check Valves:** Install on discharge side of each pump, and elsewhere as indicated.

3.7.6 **Balance Cocks:** Install in each hot water recirculating loop, and elsewhere as indicated.

### 3.8 **INSTALLATION OF BACKFLOW PREVENTERS**

3.8.1 Install backflow preventers where indicated, and where required whether indicated on Drawings or not.



3.8.1 Locate in same room as equipment being protected.

3.8.1 Pipe relief outlet to nearest floor drain.

**3.9 INSTALLATION OF PRESSURE REGULATING VALVES**

Install pressure regulating valves where indicated. Provide inlet and outlet shutoff valves, and throttling valve bypass. Provide pressure gage on valve outlet.

**3.10 INSTALLATION OF EXPANSION JOINTS**

Install expansion joints on hot water and hot water recirculating piping in accordance with Division-22 "Materials and Methods".

**3.11 INSTALLATION OF METERS AND GAGES**

Install meters and gages in accordance with Division-22 section "Meters and Gages".

**3.12 INSTALLATION OF WATER METER**

3.12.1 Install water meter in accordance with local utility companies' installation instructions, and comply with requirements.

3.12.2 Set meter on concrete pad.

### **3.13      PIPING CONNECTIONS TO FIXTURES AND EQUIPMENT**

3.13.1      **Piping Runouts to Fixtures:** Provide hot and cold water piping runouts to fixtures of sizes indicated.

3.13.1      **Mechanical Equipment Connections:** Connect hot and cold water piping system to mechanical equipment as indicated, and comply with equipment manufacturer's installation instructions. Provide shutoff valve and union for each connection. Provide drain valve on drain connection.

### **3.14      TESTING**

Test water distribution piping in accordance with testing requirements of Division-22 "Domestic Water Piping" and "Plumbing Piping" sections.

### **3.15      CLEANING, FLUSHING, INSPECTING AND DISINFECTING**

Clean, flush, inspect and disinfect water distribution systems in accordance with requirements of Division-22 " Domestic Water Piping" and "Plumbing Piping" sections.

### **3.16      BALANCING**

After putting system into operation, completely balance the hot water distribution piping system by correctly setting all balancing valves on return pipes to give adequate quantity of hot water flowing in different circuits to obtain immediate hot water flow from each hot water tap in system. After balancing remove handles of balancing valves.

**END OF SECTION 22 11 13**

## CONTENTS

### SECTION 22 05 29

#### HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

##### **PART 1    GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Mss Standard (Manufacturers Standardization Society of The Valve and Fitting Industry) Compliance
- 1.4 Seismic Performance Requirements
- 1.5 Submittals
- 1.6 Quality Assurance

##### **PART 2    PRODUCTS**

- 2.1 Hangers and Supports - General
- 2.2 Manufactured Units
- 2.3 Miscellaneous Materials

##### **PART 3    EXECUTION**

- 3.1 Hanger and Support Applications
- 3.2 Hanger and Support Installation
- 3.3 Spacing of Pipe Hangers and Supports
- 3.4 Equipment Supports
- 3.5 Metal Fabrication
- 3.6 Adjusting
- 3.7 Painting

## SECTION 22 05 29

### HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SUMMARY**

This Section includes hangers and supports for mechanical systems piping and equipment.

1.2.2 Approved types of pipe hangers, supports and anchors are shown on the Drawings, and described in this section. Contractor may provide other types subject to approval by the Engineer.

1.2.3 Pipe supports and anchors are to be provided following the requirements of this section and other Division-22 sections irrespective of whether they are indicated on the Drawings or not.

##### **1.3 MSS STANDARD (MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTING INDUSTRY) COMPLIANCE**

1.3.1 Terminology used in this Section is defined in MSS SP-90.

1.3.2 Provide pipe hangers and supports complying with MSS SP-58.

1.3.3 Select and apply pipe hangers and supports complying with MSS SP-69.

1.3.4 Fabricate and install pipe hangers and supports complying with MSS SP-89.

#### **1.4      SEISMIC PERFORMANCE REQUIREMENTS**

- 1.4.1      Design seismic restraint hangers and supports for piping and equipment suitable for seismic zone of project.
- 1.4.2      Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- 1.4.3      Design and obtain approval from the Engineer for seismic restraint hangers and supports for piping and equipment suitable for seismic zone of the project. Upon application of seismic forces of computed intensity, piping shall remain fully connected into operable systems and shall not be displaced sufficiently to damage adjacent or connecting equipment, or building members. Thermal expansion flexibility shall not be impaired. Seismic rate shall be as follows:
- A)      Project seismic zone is 2A with a zone factor of 0.15
- B)      Building Importance Factor: 1.0
- 1.4.4      All hangers and supports installation details and any cutting and drilling in structural elements shall be approved by the Engineer.

#### **1.5      SUBMITTALS**

- 1.5.1      **General:** Submit the following according to the Conditions of the Contract and Division 1 Specifications Group.
- 1.5.2      Product data for each type of hanger and support.
- 1.5.3      Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- 1.5.4      Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- 1.5.5      Shop Drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

## **1.6 QUALITY ASSURANCE**

- 1.6.1 **NFPA Compliance:** Comply with NFPA 13 for hangers and supports used as components of fire protection systems.
- 1.6.2 **Listing and Labeling:** Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.

## **PART 2 PRODUCTS**

### **2.1 HANGERS AND SUPPORTS - GENERAL**

- 2.1.1 Hangers and supports are to allow adjustment of slope of piping and removal without dismantling pipes.
- 2.1.2 Hangers and supports to be designed and tested to sustain load times actual supported load.
- 2.1.3 Hangers and supports to be steel with smooth flat bearing surfaces, to carry weight of piping and contents without sagging, swaying, vibrating or deforming, and to allow free movement of pipes due to expansion and contraction without noise or damage to piping or construction.
- 2.1.4 Hangers and supports to be complete with all necessary structural steel, rods, bolts, nuts, turnbuckles and other components.
- 2.1.5 Select only one type by one manufacturer for each piping service.
- 2.1.6 Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.
- 2.1.7 Provide copper-plated hangers and supports for copper-piping systems.

### **2.2 MANUFACTURED UNITS**

- 2.2.1 **Hangers, Supports, and Components:** Factory-fabricated according to MSS SP-58.
- A) Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
- B) Pipe attachments include non-metallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

2.2.2 **Thermal-Hanger Shield Inserts:** 690 kPa (100 psi) average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

2.2.3 **Powder-Actuated Drive-Pin Fasteners:** Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.2.4 **Mechanical-Anchor Fasteners:** Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.

2.2.5 **Pipe Anchor and Guides:** 20 mm diameter U-bolts to fit around pipe loosely for guides and welded to pipe for anchors.

### 2.3 **MISCELLANEOUS MATERIALS**

2.3.1 **Structural Steel:** ASTM A36/A36M, steel plates, shapes, and bars, black and galvanized.

2.3.2 **Bolts and Nuts:** ASME B18.10 or ASTM A183, steel, hex-head, track bolts and nuts.

2.3.3 **Washers:** ASTM F844, steel, plain, flat washers.

2.3.4 **Grout:** ASTM C1107, Grade B, non-shrink, non-metallic.

A) Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, non-corrosive, nongaseous and is recommended for both interior and exterior applications.

B) **Design Mix:** 34.5 MPa, 28-day compressive strength.

C) **Water:** Potable.

D) **Packaging:** Premixed and factory-packaged.

## PART 3 **EXECUTION**

### 3.1 **HANGER AND SUPPORT APPLICATIONS**

3.1.1 Specific hanger requirements are specified in the Section specifying the equipment and systems.

- 3.1.2 Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping Specifications Group.
- 3.1.3 Install hangers and supports of same type and style as installed for adjacent similar piping.
- 3.1.4 Do not use wire, rope, wood, chain, strap or perforated metal to support piping, and do not support piping from other piping.

### **3.2 HANGER AND SUPPORT INSTALLATION**

- 3.2.1 **General:** Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure. Provide intermediate steel where required to transfer loads to areas of structure where they can be safely accommodated.
- 3.2.2 Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Keep pipes in position with U-bolts. Lines subject to extreme thermal expansion to be free to slide or roll. (Provide rollers on trapeze hangers)
- 3.2.3 Install supports with maximum spacing complying with MSS SP-69, and the requirements of this section. Specified maximum spans are for straight runs of pipe.
- 3.2.4 Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers. Support vertical pipe risers independently of adjacent horizontal hangers.
- 3.2.5 Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
- 3.2.6 Install concrete inserts in new construction prior to placing concrete.
- 3.2.7 Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Install fasteners according to powder-actuated tool manufacturer's operating manual. Do not use in lightweight concrete slabs or in concrete slabs less than 100 mm thick.
- 3.2.8 Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written



instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 100 mm thick or in post tensioned slabs.

- 3.2.9 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- 3.2.10 **Heavy-Duty Steel Trapezes:** Field-fabricate from ASTM A36 steel shapes selected for loads being supp. Weld steel according to AWS D-1.1.
- 3.2.11 Support fire protection systems piping independent of other piping.
- 3.2.12 Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- 3.2.13 **Load Distribution:** Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment. Support piping independently of equipment.
- 3.2.14 **Pipe Slopes:** Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- 3.2.15 **Anchors:** Weld U-bolts to pipes at points of contact and bolt to structural angle frame securely fixed to structure.
- 3.2.16 **Insulated Piping:** Protect pipe insulation at hangers and supports from weight or movement of pipe. Provide firm attachment to pipe. Comply with the following installation requirements.
- A) **Clamps:** Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
- B) **Saddles:** Install protection saddles MSS Type 39 where insulation without vapor barrier. Fill interior voids with segments of insulation that match adjoining pipe insulation.
- C) **Shields:** Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields to span an arc of 180 degrees (3.1 rad) and have dimensions in mm not less than the following:

| Pipe Size<br>mm | Length<br>mm | Thickness<br>mm |
|-----------------|--------------|-----------------|
| 8 to 90         | 300          | 1.22            |

| Pipe Size<br>mm | Length<br>mm | Thickness<br>mm |
|-----------------|--------------|-----------------|
| 100             | 300          | 1.52            |
| 125 and 150     | 450          | 1.52            |
| 200 to 350      | 600          | 1.91            |
| 400 to 600      | 600          | 2.67            |

- D) Pipes 200 mm and Larger: Include wood inserts.
- E) Insert Material: Length at least as long as the protective shield.
- F) Thermal-Hanger Shields: Install with insulation of same thickness as piping.

### 3.3 SPACING OF PIPE HANGERS AND SUPPORTS

#### 3.3.1 Cast Iron Pipe Supports:

- A) Support horizontal cast iron pipes at every joint, at base of each vertical stack, at each change in direction, at each branch connection and at not more than 1.5 m spaces on straight runs.
- B) Support vertical cast iron pipes at a minimum of each storey height.

#### 3.3.2 Ductile Iron Pipe Supports: Support ductile iron pipes with at least one support per length of pipe and at intervals not exceeding 3.5 m with hanger preferably located adjacent to joint.

#### 3.3.3 Steel Pipe Supports:

- A) Support horizontal steel pipes at intervals not exceeding maximum support spacing and by hanger rod of minimum size as follows:

| Pipe Diameter<br>(mm) | Maximum Support Spacing<br>(m) | Minimum Size of Hanger Rod<br>(mm) |
|-----------------------|--------------------------------|------------------------------------|
| 15                    | 1.5                            | 10                                 |
| 20                    | 1.8                            | 10                                 |
| 25                    | 2.0                            | 10                                 |
| 32                    | 2.5                            | 10                                 |
| 40                    | 2.7                            | 10                                 |
| 50                    | 3.0                            | 10                                 |
| 65                    | 3.3                            | 13                                 |
| 80                    | 3.6                            | 13                                 |
| 100                   | 4.2                            | 16                                 |
| 125                   | 4.2                            | 16                                 |
| 150                   | 4.2                            | 22                                 |
| 200                   | 4.8                            | 25                                 |

| Pipe Diameter<br>(mm) | Maximum Support Spacing<br>(m) | Minimum Size of Hanger Rod<br>(mm) |
|-----------------------|--------------------------------|------------------------------------|
| 250                   | 4.8                            | 25                                 |
| 300                   | 4.8                            | 25                                 |
| 350                   | 6.0                            | 25                                 |
| 400                   | 6.0                            | 28                                 |
| 450                   | 6.0                            | 32                                 |
| 500                   | 6.0                            | 32                                 |
| 550                   | 6.0                            | 38                                 |
| 600                   | 6.0                            | 38                                 |

B) Support vertical steel pipes at a minimum of every storey height.

#### 3.3.4 **Copper Pipe Supports:**

A) Support copper pipes at intervals not exceeding maximum support spacing and by hanger rod of minimum size as follows:

| Pipe Diameter<br>(mm) | Maximum Support Spacing |                       | Minimum Diameter<br>of Rod Hanger<br>(mm) |
|-----------------------|-------------------------|-----------------------|---|
|                       | Horizontal Pipes<br>(m) | Vertical Pipes<br>(m) |   |
| 42 and smaller        | 1.8                     | 1.2                   | 10  |
| 54                    | 3.0                     | each storey           | 10  |
| 67                    | 3.0                     | "                     | 13  |
| 76.1                  | 3.0                     | "                     | 13  |
| 108                   | 3.0                     | "                     | 16  |

B) Line iron supports with felt between pipe and support to prevent electrolytic corrosion.

3.3.5 **CPVC:** Support CPVC pipes at intervals exceeding maximum support spacing and by hanger rod of minimum size as follows:

| Pipe Diameter<br>(mm) | Maximum Horizontal<br>Spacing<br>(m) | Maximum Vertical<br>Spacing<br>(m) | Minimum Rod<br>Diameter<br>(mm) |
|-----------------------|--------------------------------------|------------------------------------|---------------------------------|
| 25 and smaller        | 0.9                                  | 1.5                                | 10                              |
| 32 to 50              | 1.2                                  | 1.8                                | 10                              |
| 65 to 90              | 1.2                                  | 1.8                                | 13                              |
| 100 and 125           | 1.2                                  | 1.8                                | 16                              |
| 150                   | 1.2                                  | 1.8                                | 19                              |
| 200                   | 1.2                                  | 1.8                                | 22                              |

3.3.6 **uPVC:** Support uPVC pipes at intervals exceeding maximum support spacing and by hanger rod of minimum size as follows:

| Pipe Diameter<br>(mm) | Maximum Horizontal<br>Spacing<br>(m) | Maximum Vertical<br>Spacing<br>(m) | Minimum Rod<br>Diameter<br>(mm) |
|-----------------------|--------------------------------------|------------------------------------|---------------------------------|
| 15                    | 0.6                                  | 1.2                                | 10                              |
| 20                    | 0.7                                  | 1.4                                | 10                              |
| 25                    | 0.75                                 | 1.5                                | 10                              |
| 32                    | 0.8                                  | 1.6                                | 10                              |
| 40                    | 0.9                                  | 1.8                                | 10                              |
| 50                    | 1.05                                 | 2.1                                | 10                              |
| 82                    |                                      |                                    | 13                              |
| 110                   |                                      |                                    | 16                              |
| 160                   |                                      |                                    | 19                              |

### 3.4 **EQUIPMENT SUPPORTS**

3.4.1 Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

3.4.2 **Grouting:** Place grout under supports for equipment. and make a smooth bearing surface.

### **3.5 METAL FABRICATION**

3.5.1 Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

3.5.2 Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

3.5.3 Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:

- A) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
- B) Obtain fusion without undercut or overlap.
- C) Remove welding flux immediately.
- D) Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

### **3.6 ADJUSTING**

Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

### **3.7 PAINTING**

3.7.1 **Touching Up:** Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

- A) Apply by brush or spray to provide a minimum dry film thickness of 0.05 mm

3.7.2 **Touching Up:** Cleaning and touch-up painting of field welds, bolted connections. and abraded areas of shop paint on miscellaneous metal is specified in Division 9 Section "Painting".

- 3.7.3 **Galvanized Surfaces:** Clean welds, bolted connections. and abraded areas and apply galvanizing-repair paint to comply with ASTM A ~'SC'.

**END OF SECTION 22 05 29**

## CONTENTS

### SECTION 22 05 11

#### BUILDER'S WORK

#### **PART 1    GENERAL**

- 1.1    Related Documents
- 1.2    Scope of Work

#### **PART 2    PRODUCTS**

- 2.1    Sundries

#### **PART 3    EXECUTION**

- 3.1    Excavation
- 3.2    Equipment Bases and Supports
- 3.3    Hangers and Supports
- 3.4    Pipes Passing Through Walls and Slabs
- 3.5    Joinery
- 3.6    Waterproofing
- 3.7    Cleaning and Painting

## SECTION 22 05 11

### BUILDER'S WORK

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SCOPE OF WORK**

Builder's Work in connection with all mechanical works such as equipment bases and supports, cutting and patching of walls and slabs for passage of pipes and ducts, repatching, fixing of pipe hangers and supports to structures, excavation and backfilling, scaffolding, rigging, hoisting, waterproofing, cleaning and painting are to be provided as specified under this Section.

Materials are to conform to requirements included in Division-3 of the Specification.

#### **PART 2 PRODUCTS**

##### **2.1 SUNDRIES**

- 2.1.1 Pipe Sleeves for pipes passing through walls, floors and roof to be galvanized steel pipe, two nominal pipe sizes larger than pipe passing through for bare pipes, and of sufficient size to permit pipe insulation to pass through for insulated pipes.
- 2.1.2 Escutcheon Plates to be nickel-plated, split ring type, sized to match pipe that it is to conceal. Plates for pipes passing through sleeves, which extend above floor surfaces to be deep recessed type to conceal sleeve.
- 2.1.3 **Flashing Sleeves:** Coated cast iron, caulking type, size specifically to fit pipe and as manufactured by Josam, No. 1840 or approved equal.
- 2.1.4 **Hangers and Supports Fasteners:** Power driven masonry expansion bolts with steel threaded studs or internally threaded studs and couplings as required.



- 2.1.5 **Above Ground Fuel Tank Ladder:** Fabricated from 25 mm diameter galvanized steel pipe.

### **PART 3 EXECUTION**

#### **3.1 EXCAVATION**

- 3.1.1 Excavate and Backfill as necessary, including shoring, sheet piling, bracing, pumping, restoring and protection of persons and property.
- 3.1.2 **Trenches:** Avoid excessive length of open trench.
- 3.1.3 Trenches For Underground Pipes to be of adequate width. Carry excavation 200 mm below pipe invert. Bed bottom of trench with clean dry sand and trim by hand to receive pipes. Dig bell hole at each joint to allow for making up joint. After pipe is tested and accepted carefully backfill with selected clean earth.
- 3.1.4 Backfill Trenches in 100 mm thick layers to 600 mm above pipe and in 300 mm layers thereafter. Tamp each layer carefully and thoroughly before placing next layer. Exercise care not to damage or misalign pipes.
- 3.1.5 **Underground Fuel Tank:** Place in pit so that top of tank is at least 600 mm below finished grade and tank is not closer than 3 m to any building. Slope of pit side walls to be 45 degrees. Bed bottom of pit with minimum 150 mm thick layer of clean, dry, well compacted, evenly distributed sand, free from boulders, stones, cinder or organic material. Tank to rest uniformly on bed to prevent uneven settling or undue stresses on tank walls. Backfill with same quality sand to minimum 300 mm above top of tank and with clean tamped earth for remainder of excavation. Where tank floatation can occur provide concrete ballast pad under tank and fix tank to pad with anchor bolts hooked around pad reinforcement and bolted to structural angle supports welded to tank. Separate tank from pad with minimum 150 mm thick sand layer. Provide reinforced concrete manholes around tank access, fill connection and sounding line connection. Support manholes on structural steel channel frames welded to tank and extend manholes to finished grade. Cover manholes with standard 600 x 600 mm cast iron roadway manhole covers and frames.

### **3.2 EQUIPMENT BASES AND SUPPORTS**

- 3.2.1 **Shop Drawings:** Submit for approval showing dimensions, arrangement and size of reinforcement and locations of anchor bolts.
- 3.2.2 Foundations for Rotating and Reciprocating Equipment at ground level to be carried independently to solid ground or rock and isolated from floor slab with 50 mm thick layer of cork board and mastic filler to prevent transmission of vibration.
- 3.2.3 **Equipment on Intermediate Floors or Roof:** Mount on its support on vibration isolators. Alternatively, support is to include substantial layer of corkboard between it and structure to reduce transmission of vibration to a minimum.
- 3.2.4 **Vibration Isolation Mounts:** position in accordance with weight distribution of equipment and as recommended by manufacturer of equipment or mounts. Secure embedded mounts during concreting.
- 3.2.5 Align and Level Equipment on bases and supports over entire length and width and shim where necessary to facilitate leveling.
- 3.2.6 Concrete Bases and Supports to be 150 mm larger all around than equipment, of height to suit equipment and with top edge chamfered. Plaster and paint or finish as adjacent and surrounding flooring.
- 3.2.7 **Anchor Bolts:** Set in oversized sleeves with washers and nuts at bottom. Bolts to project at least 6 mm above nuts when equipment is fixed to allow for shimming. Secure during concreting.
- 3.2.8 **Suspended Cradles and Wall Brackets:** test to sustain a load eight times actual operating weight of equipment supported.

### **3.3 HANGERS AND SUPPORTS**

- 3.3.1 **Fasteners:** Install in accordance with manufacturer's instructions.
- A) Fasteners to penetrate 6 to 8 times shank diameter.
  - B) **Embedded Attachments:** fix during concreting.
  - C) Test fasteners in ceilings and walls to sustain a load eight times operating weight of piping, ducting or equipment supported.
- 3.3.2 **Additional Framing:** Provide where structure is inadequate to give suitable support. Design is to be approved.

### **3.4 PIPES PASSING THROUGH WALLS AND SLABS**

- 3.4.1 **Structural Members:** Do not cut without approval. Any approved cutting to be done only as directed.
- 3.4.2 Sleeves to be provided for all pipes passing through walls, floors and roofs. Locate before walls etc. are constructed and fasten securely to prevent displacement during construction. Plug ends during construction.
- 3.4.3 Sleeves to terminate flush with finished walls and ceilings and to project 20 mm above finished floors and 250 mm above rough concrete of roof.
- 3.4.4 Escutcheon Plates to be provided for all exposed uninsulated pipes passing through walls, floors and ceilings.

### **3.5 JOINERY**

- 3.5.1 **Access Doors:** Provide in false ceilings, walls or other construction to permit access to equipment, controls, etc. requiring periodic operation, inspection or maintenance.

### **3.6 WATERPROOFING**

- 3.6.1 Openings in External Walls, Roofs and Walls Below Ground to be made watertight with sleeves, caulking, caulking fittings and flashings. Openings in external walls, particularly at and below ground level and in roofs to be plugged and caulked with oakum and lead between pipe and sleeve.
- 3.6.2 **Waterproofed Construction:** Method of installing work piercing waterproofed construction to be subject to review and approval.
- 3.6.3 Pipes Through Roofs to be further waterproofed with metal flashing fixed to pipe with flashing sleeve and extended under roof waterproofing membrane 300 mm all round.

### **3.7 CLEANING AND PAINTING**

- 3.7.1 Clean equipment, material, ductwork and piping etc. inside and outside by effective and approved methods to remove loose mill scale, blisters, sand, plaster, paint droppings, debris, dirt, oil, grease, labels and all foreign matter. Clean and brush work in stages as directed before painting or concealing.
- 3.7.2 **Surfaces To Be Painted:** Clean with wire brush and cleaning solution. Do not apply paint to wet or damp surfaces.
- 3.7.3 Black Steel Piping including flanges, bolts, nuts, cast iron valves and accessories, valve wheels and all ferrous parts are to be painted with two coats of zinc chromate primer whether or not they are to be insulated. When bare or exposed to view, they are to be further painted with two coats of approved oil paint.
- 3.7.4 Piping run in trenches, shafts, underground or outdoors, including flanges, bolts, nuts, valves and all ferrous parts to be painted with two coats of zinc chromate primer and two coats of heavy bituminous solution paint.
- 3.7.5 **Piping:** When directed by the Engineer piping in machine room is to be painted to conform to ASME Color Co. All the pipes to show, sizes and direction of flow. Insulated pipes to be color coded and stenciled over the external jacket.
- 3.7.6 **Ductwork:** Paint inside or outside with one coat dull black fire resistant paint where visible through registers and grilles.
- 3.7.7 Areas in ceiling spaces visible from occupied spaces above open grilles (ceiling plenum) shall be painted black including ducts, pipes, conduits, slab and insulation.
- 3.7.8 Hangers and Supports including clamps, rods, bolts, nuts etc. to be painted with two coats of zinc chromate primer and where exposed to view with two additional coats of approved oil paint.
- 3.7.9 Damaged Surfaces of equipment to be restored to original condition by cleaning and painting as directed.
- 3.7.10 Unfinished Surfaces to be painted as directed.
- 3.7.11 Hot Surfaces to be painted with approved heat resistant paint.
- 3.7.12 Apply Paint in strict accordance with manufacturer's instructions and recommendations.

END OF SECTION 22 05 11

## CONTENTS

### SECTION 22 00 10

#### **BASIC MECHANICAL MATERIALS AND METHODS**

##### **PART 1 GENERAL**

- 1.1 Related Documents
- 1.2 Summary
- 1.3 Definitions
- 1.4 Drawings, Instructions and Samples
- 1.5 Access Doors and Frames
- 1.6 Labels, Tags and Charts
- 1.7 Operations and Maintenance Manuals
- 1.8 Operations and Maintenance Training Program
- 1.9 Initial Operation of Systems
- 1.10 Noise and Vibration
- 1.11 Guarantee
- 1.12 Quality Assurance
- 1.13 Welding
- 1.14 Delivery, Storage, and Handling
- 1.15 Sequencing and Scheduling
- 1.16 General

##### **PART 2 PRODUCTS**

- 2.1 Pipe and Pipe Fittings
- 2.2 Joining Materials
- 2.3 Dielectric Fittings
- 2.4 Flexible Connectors
- 2.5 Mechanical Sleeve Seals
- 2.6 Piping Specialties
- 2.7 Grout

##### **PART 3 EXECUTION**

- 3.1 Piping Systems - Common Requirements
- 3.2 Equipment Installation - Common Requirements
- 3.3 Painting and Finishing
- 3.4 Concrete Bases
- 3.5 Erection of Metal Supports and Anchorage
- 3.6 Demolition
- 3.7 Cutting and Patching
- 3.8 Grouting

## SECTION 22 00 10

### BASIC MECHANICAL MATERIALS AND METHODS

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

##### **1.2 SUMMARY**

1.2.1 This Section includes the following basic mechanical materials and methods to complement other Division-22 Sections.

- A) Piping materials and installation instructions common to most piping systems.
- B) Concrete base construction requirements.
- C) Escutcheons.
- D) Dielectric fittings.
- E) Flexible connectors.
- F) Mechanical sleeve seals.
- G) Equipment nameplate data requirements.
- H) Labeling and identifying mechanical systems and equipment is specified in Division-22 Section "Mechanical Identification."
- I) No shrink grout for equipment installations.
- J) Field-fabricated metal and wood equipment supports.
- K) Installation requirements common to equipment Specifications Group.
- L) Mechanical demolition.
- M) Cutting and patching.

N) Touchup painting and finishing.

1.2.2 Pipe and pipefitting materials are specified in Division-22 piping system Sections.

1.2.3 This section also includes other requirements to complement other sections in Division-22.

### **1.3 DEFINITIONS**

1.3.1 **Finished Spaces:** Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

1.3.2 **Exposed, Interior Installations:** Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

1.3.3 **Exposed, Exterior Installations:** Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.3.4 **Concealed, Interior Installations:** Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

1.3.5 **Concealed, Exterior Installations:** Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

#### **1.3.6 The Following Are Industry Abbreviations for Plastic Materials:**

- A) **ABS:** Acrylonitrile-butadiene-styrene plastic.
- B) **CPVC:** Chlorinated polyvinyl chloride plastic.
- C) **NP:** Nylon plastic.
- D) **PE:** Polyethylene plastic.
- E) **PVC:** Polyvinyl chloride plastic.
- F) **uPVC:** unplasticized polyvinyl chloride plastic.
- G) **RTRP:** Reinforcement thermosetting resin pipe.



- H) GRE: Glass reinforced epoxy pipe.
- I) GRP: Glass reinforced plastic pipe.

1.3.7 **The Following Are Industry Abbreviations for Rubber Materials:**

- A) CR: Chlorosulfonated polyethylene synthetic rubber.
- B) EPDM: Ethylene propylene diene terpolymer rubber.

**1.4 DRAWINGS, INSTRUCTIONS AND SAMPLES**

- 1.4.1 **Equipment and Materials Lists:** Approximately 15 days after award of Contract, submit lists of equipment and materials with names+ of proposed manufacturers and Drawings of interrelated items. All submissions are to show submission dates.
- 1.4.2 **Shop and Installation Drawings:** Two months prior to commencement submit for approval detailed shop and installation Drawings showing to-scale dimensions of equipment, ducts, pipes etc. in plan and elevation and in relation of same to space assigned.
- 1.4.3 **Shop and Installation Drawings:** Prepare composite installation Drawings and sections to a scale of not less than 1/50 showing clearly how work will be installed in relation to the work of other trades.
- 1.4.4 Shop and Installation Drawings of equipment and material are to include manufacturer's detailed Drawings, cuts of catalogues and descriptive literature showing type, performance characteristics, construction, component parts, dimensions, arrangement, operating clearances, capacity, electrical characteristics, power requirements, motor, drive and testing information.
- 1.4.5 **Shop and Installation Drawings:** Submit manufacturer's certified Drawings, templates and installation instructions to be furnished for all equipment showing operating weights, weight distribution, location of any vibration isolation mounts, size and location of anchor bolts, drains and other required openings and all other pertinent data to assist in design of bases and supports.
- 1.4.6 **Shop and Installation Drawings:** Mark clearly in ink catalogues, pamphlets and Drawings for proper identification of item proposed and indicate, with reasons, deviations from the Specification and the Drawings.
- 1.4.7 **Shop and Installation Drawings Lists etc.:** Submit five copies.
- 1.4.8 **Shop and Installation Drawings:** Submit for approval in letter form, materials not covered by Drawings, e.g. pipes, fittings and incidentals, giving ratings and names of manufacturers.

- 1.4.9 **Shop and Installation Drawings:** No equipment or materials to be purchased or delivered to Site until Drawings etc. are approved.
- 1.4.10 **Further Drawings:** During the progress of the work, submit shop-Drawings, to 1/20 or 1/10 scale, as required by the Engineer and as specified elsewhere.
- 1.4.11 Engineer's Drawings are generally diagrammatic and not to be scaled. Measurements are to be made from established benchmarks.
- 1.4.12 **Engineer's Drawings:** Check all architectural, structural and electrical Drawings in laying out work to verify adequacy of space in which work is to be installed. Notify the Engineer where space appears inadequate.
- 1.4.13 **Substitution of Equipment and Material:** Reference to equipment and material by name, make or catalogue number, and lists of approved manufacturers are to be interpreted as establishing standard of quality and performance and are not intended to eliminate equivalent products of other manufacturers.
- 1.4.14 Minor Changes and Modifications may be made in layout to prevent conflict with work of other trades or for proper execution of the work.
- 1.4.15 Cooperate with other trades to permit their work to be installed satisfactorily and with minimum interference or delay.
- 1.4.16 Coordinate space conditions where work will be installed in close proximity to and may interfere with work of other trades, and accept responsibility for the sufficiency of shafts and chases, clearance in double partitions, suspended ceilings etc. for proper installation of the work.
- 1.4.17 Furnish to other trades templates, patterns, setting out plans and shop details necessary for proper installation and coordination of adjacent work.
- 1.4.18 **Protection:** Close open ends of work with temporary covers or plugs during storage and construction.
- 1.4.19 **Samples:** Submit for approval samples of proposed materials and workmanship.
- 1.5 ACCESS DOORS AND FRAMES**
- 1.5.1 **Access:** Install work to be readily accessible for operation, maintenance and repair. Approved deviations from the Drawings may be made to accomplish this.

- 1.5.2 Group together as practically as possible concealed valves and devices to be easily accessible through access doors.
- 1.5.3 **Purpose:** Access doors are to be provided for the operation of concealed dampers, damper quadrants, controls, valves, traps, vents, drains, cleanouts, motors, air filters etc.
- 1.5.4 **Details:** Access doors and frames are to be provided by others. Provide details, dimensions and locations of access doors required and submit for approval in sufficient time to enable access doors to be installed during normal course of work.
- 1.6 LABELS, TAGS AND CHARTS**
- 1.6.1 **Identification:** Excess doors are to be identified to indicate location of concealed work. Method and schedule for identification of access doors is to be approved.
- 1.6.2 **Nameplates:** Each piece of equipment to have a certified nameplate at a conspicuous location, permanently attached at factory, printed or stamped with name and address of manufacturer, equipment model number, serial number, date of manufacture, electrical characteristics, performance rating or duty, pressure, temperature or other limitations and other pertinent data.
- 1.6.3 Label and Identify equipment, instruments, controls, electrical devices, valves etc. as to duty, service or function. Label controls and electrical devices to indicate clearly what they control.
- 1.6.4 **Labels:** Attach to equipment etc. or to adjacent permanent surfaces in an approved permanent manner.
- 1.6.5 **Labels:** Laminated Bakelite with different colors for and surface, core and incised lettering in English.
- 1.6.6 Tag controls and instruments that cannot be easily identified with Bakelite labels.
- 1.6.7 Tag valves and controls, except equipment shut off valves located at equipment.
- 1.6.8 **Labels and Tags:** Submit for approval a schedule of equipment and devices to be labeled and tagged, with suggested nomenclature.
- 1.6.9 Charts are to be prepared of schematic flow diagrams of each piping system with location and function of each valve and with type and size of each essential feature of the system.

1.6.10 **Charts:** Prepare schedules for equipment lubrication and maintenance and essential operating instructions.

1.6.11 **Charts:** Submit for approval.

1.6.12 **Charts:** Mount on wooden plaques or 6 mm Masonite boards, cover with heat bonded clear plastic laminate or frame under glass, and permanently fix with four brass screws at approved locations.

## **1.7 OPERATIONS AND MAINTENANCE MANUALS**

1.7.1 **Instruction Manuals:** Provide six copies in bound booklet form containing the following information:

- A) Brief description of each system and piece of equipment with basic operating features
- B) Descriptive literature of equipment and components with manufacturer's name, model number, capacity rating and operating characteristics
- C) Service manual prepared by manufacturer for every major piece of equipment giving operating and maintenance instructions, starting and shut-down instructions, lubrication instructions and list of possible breakdown and repairs
- D) Manufacturer's list of general spare parts for every piece of equipment with unit prices
- E) Manufacturer's list of recommended spare parts for one year of operation of each piece of equipment with unit prices
- F) Detailed and simplified one line color coded flow diagram of each system with tag number, location and function of each valve and instrument
- G) Detailed and simplified color coded as-installed wiring diagrams of motor controllers and automatic controls with tag number, location and function of each instrument and electrical device with description of sequence of operation and interlocks.

1.7.2 **Instruction Manuals:** Submit in draft form for review and approval prior to final issue at least four weeks in advance of completion date of the system.

1.7.3 **Record Drawings:** Submit an approved complete set of as-built Drawings and electrical wiring diagrams in tracing or other reproducible form.

1.7.4 **Overall Purpose:** Provide a general overview of the original design intent.

1.7.5 **Description:** Provide the followings:

Type of system.  
System location and what it serves.  
What the system depends upon in order to function.  
Design data, basic design parameters, basic assumptions made during design.  
Reasons for selecting particular plant.  
Expected service life (where available).  
Planned operational efficiency.

1.7.6 **Equipment Schedule:** The type, model number and serial number of all component items within the system should be listed, together with the names of their respective manufacturers or suppliers.

1.7.7 **Parts Identification and Recommended Spares:** This should comprise a parts identification list detailing and identifying replaceable assemblies, sub-assemblies and components. It should include supplier's recommendation for both spares and "running spare" (i.e. parts required for scheduled replacement due to wear or deterioration), recommend stocking level of spare parts and manufacturing and shipping time required for imported spare parts.

1.7.8 **Commissioning Data:**

Measured Data.  
Measurement Points.  
Test Equipment used  
Calibration Certificate details.  
Test Certificates  
Safety and Fire Certificates (where applicable)  
A statement of whether design requirements.

1.7.9 **Operation:** Instructions must be given for the safe and efficient operation, under both normal and emergency conditions. These will be in addition to manufacturer's literature for Plant Items and should include:

A recommended strategy for operation and control.  
An outline of the general operating mode.  
Control data (location, effect, object, sequence, limits of capability, modes, set points).  
Procedure and sequences for start-up, running and shutdown, under both normal and emergency conditions.  
Interlocks between plant items  
Operating procedure for standby plant.  
Precautions necessary to overcome known hazards.  
The means by which any potentially hazardous plants may be made safe.  
Target figures of both energy consumption and energy costs.

Forms for recording plant running hours, energy consumption and energy costs.

- 1.7.10 **Maintenance:** The manufacturer's recommendations and instructions for maintenance for each item of plant and equipment. Clear distinction should be made between planned tasks (preventative maintenance) and work done on corrective basis. Instructions should be given on each of the following as appropriate:

The isolation and return of plant and equipment.  
Adjustments, calibration and testing.  
Dismantling and re-assembly.  
The exchange of components and assemblies  
Dealing with hazards, which may arise during maintenance.  
The nature of deterioration and the defects to be looked for.  
Special tools, test equipment and ancillary services.

- 1.7.11 **Maintenance Schedules:** Should be provided for preventative maintenance tasks and should be based on manufacturer's recommendations and other authoritative sources and should include:

Inspections  
Examinations  
Tests  
Adjustments  
Calibration  
Lubrication  
Periodic Overhaul  
Procedure for the logical diagnosis and correction of faults should be provided.

- 1.7.12 **Modification Information:** Information on permitted plant or system modification's allowed for by the manufacturers of system designers should be included for each system. Space must be provided in the name for the recording of all modifications and changes as they occur.

- 1.7.13 **Disposal Instructions:** Where relevant, information should be provided detailing:

Any known dangers likely to arise during the disposal of specific items of plant or equipment together with the necessary precautions and safety measures.

Methods for safely disposing of or destroying the equipment or any parts thereof, including packaging, insulation and fluids.

Sources from which further advice can be obtained.

- 1.7.14 **Names and Addresses of Manufacturers:**

Name equipment / item  
Name of manufacturer  
Address  
Telephone number and telex/fax number  
Name of local supplier/agent  
Address  
Telephone number and telex/fax number.

- 1.7.15 Index of Plans and Drawings: an index should be provided of all “as fitted” Drawings supplied during the course of the installation work, identified by number and title. Index should also include a schedule of all Drawings issued by the manufacturers and suppliers during the course of the installation work e.g. control panel-wiring diagrams.

- 1.7.16 **Emergency Information:** Should include names, addresses, telephone and telex/fax numbers of the appropriate contacts in the event of the fire, theft or burglary, and fuel, gas, electricity or water failure/leaks. It should also list those firms or staff to contact in the event of the failure or breakdown of such plant as lifts, plants, etc.

- 1.7.17 **Manufacturers Literature:** A complete set of all manufacturers’ literature should be provided for the plant and equipment installed and assembled. The literature should provide the following information:

Description of the product as purchased  
The cost and date of purchase  
Performance – behavioral characteristics of the equipment in use  
Applications – suitability for use  
Operation and maintenance  
Resources of labor, plant, material and space required  
Methods of Operation and Control  
Clearing and maintenance requirements  
Protective measures  
Labor, safety and welfare associated with the equipment  
Public safety considerations.



## **1.8 OPERATIONS AND MAINTENANCE TRAINING PROGRAM**

- 1.8.1 Manufacturers guarantees and warranties: include copies of all manufacturers guarantees and warranties.
- 1.8.2 Contractor – furnished training program: to provide trained operation and maintenance (O and M) personnel for the Employer's Operations and Maintenance Program, Contractor shall develop and implement a program for the training of Employer nominated staff in operating and maintaining the facilities and systems/subsystems constructed and installed. Two copies of submittals required by this Attachment to the Special Conditions shall be supplied to Authorized Representative for review not later, than ninety (90) days prior to scheduled start of each formal training course. Thirty (30) days shall be allowed for such review. Training shall be performed only in accordance with such reviewed and approved training program submittals. All training aids proposed for use in the program shall be available for inspection prior to commencement of training. Upon completion of the training program, the training aids, tools, test equipment, training manuals and other materials relating to the program shall be handed over to the Employer. When short familiarization courses are offered to Contractor by the equipment manufacturer/vendor as a common industry practice at no extra cost to Contractor, then Contractor shall make arrangements for the Government nominated staff to attend such courses at the no additional cost to the Government.
- 1.8.3 **Description:** This section covers the requirements for preparing, administrating and conducting a training program in English and Arabic for Employer, nominated operator, maintenance, supervisor and instructor trainees in operation, maintenance and computer software programming of the system. Training shall be of sufficient scope and depth to ensure that all operations, maintenance and computer software trainees who complete the training program will be fully qualified, certified and capable of operating and/or maintaining the system/subsystems as installed under this Contract. The program shall provide the training, orientation and familiarization necessary to ensure a smooth transition between system installation and operations activities.
- 1.8.4 **Scope:** Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems and facilities furnished and installed under this Contract, and to ensure a smooth transition between construction and operation activities.
- 1.8.5 **Scope:** Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training. Each training course shall usually include classroom (theoretical)



training and on-the-job (hands-on) training to provide practical experience. Where system/subsystem interfaces occur, such as with equipment or facilities furnished under other Contracts, the Contractor shall co-operate with and assist the Construction Manager in coordinating timing and scheduling of training so that trainees can be made familiar with the operation and maintenance of the system/subsystem as a complete, in-place, operating unit.

1.8.6 **Language:** Training shall be conducted in English and Arabic.

1.8.7 **Submittals:** The following should be submitted:

- A) A training program stating all program courses and activities, and their individual duration's sequence, and interrelationships.
- B) A narrative description of each course, including its purpose, technical scope and the number of hours from start of course to trainee certification.
- C) Current resumes of training and technical personnel who will be assigned to the classroom and/or on-the-job (hands-on) phases of training. Resumes shall be identified by course.
- D) The ratio of training and technical personnel to trainees for both classroom and on-the-job phases of each course.
- E) A narrative (verbal) and graphic (pictorial) explanation of the system's operational scheme and features which will be covered in the Operations-related courses.
- F) A narrative (verbal) and graphic (pictorial) explanation of the system's operational and maintenance schemes which will be covered in the maintenance-related courses.
- G) A comprehensive training manual for each course in the form and content which will be used in both classroom and on-the-job phases of training. In addition to other information, the manual shall contain an agenda, the hours devoted to each topic/subject, and the objectives for each lesson. Such manual shall be prepared in English.
- H) A descriptive listing, by course, of all training aids to be used during both classroom and on-the-job phases of training.
- I) A narrative description of the practices to be followed to measure, record and report each trainee's progress and proficiency on completion of formal training. Also, a description of the method(s) to be used to certify trainees as being capable to operate and/or maintain the system/subsequent.

- J) Samples of written examinations to be used for each course.
  - K) A narrative description of the methods proposed to provide make-up instruction for trainees who miss training sessions due to illness of approved absences.
  - L) A bibliography containing a listing of reference publications to be used in conjunction with classroom and on-the-job training.
- 1.8.8 **Employer Nominated Staff:** Employer will nominate staff to receive training. Such trainees may be expected to be familiar with the fundamental concepts of the operation and maintenance of similar system and be basically qualified in both written and spoken English. Each trainee will be designated by Employer in one of three categories (trainees, supervisor-trainee, or instructor trainee) for operations, maintenance or computer software training.
- 1.8.9 **Assistance to Key Technical Personnel:** All key technical personnel of Contractor shall have a general responsibility to assist Employer non-nominated trainees in conducting training for the operation and maintenance of the system/subsystem. Such assistance shall be a part of their duties and shall be included in their job descriptions.
- 1.8.10 **Qualifications of Training Personnel:** Personnel designated to conduct training shall be fully qualified and shall have a minimum of three years experience with the systems/subsystem as installed, or comparable successful experience as a trainee.
- 1.8.11 **Training Aids:** Training aids shall include approved operation and maintenance (O and M) manual(s) prepared by Contractor as part of this Contract; training manuals, including course outline, basic test of instructions modules and trainee workbook; films; slides; video tape(s); charts; models; hand-outs; catalogues' samples; and other visual and written aids to complement instruction. In addition spare parts and other special hardware shall be provided to support "hand-on" familiarization with the equipment or systems.
- 1.8.12 **Training Manuals:** Training manuals in English and Arabic shall be provided for each training course covering both the classroom and on-the-job phases. The organization of the manuals shall follow the same sequence as the course's schedule presentation of material, providing such additional background and supplementary information as a trainee may need to understand the O and M manuals. The training manuals shall contain course agenda, schedule of hours devoted to each topic or subject and objectives for each lesson.

- 1.8.13 Laboratory Equipment spare parts and mock-up models may be used for theoretical orientation. However, practical “hands-on” familiarization shall be provided on equipment, which is either installed and operable or ready to be installed and capable of being operated. System spares of special hardware items may be used to support “hands-on” familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved procedures.
- 1.8.14 **Proficiency:** At designated intervals, each trainee’s proficiency level shall be determined by written, oral and practical performance tests.
- 1.8.15 **Completion:** Upon satisfactory completion of the training, it shall be certified, in writing, that each trainee, by name, is qualified to operate or maintain the system, supervise or instruct, as applicable.
- 1.8.16 **Disposition:** Upon completion of the training program, all training aids, test equipment and similar items provided by Contractor for this training program shall become the property of the Employer.
- 1.8.17 Schedule of all Plant Requiring Lubrication should be provided together with manufacturer’s recommendations on the type of lubricant and the method and frequency of application where the type of lubricant is identified by product name, a generic reference (e.g. B.S.) should also be given. Special requirements for the handling and storage of lubricants should be provided where applicable for recommended lubricants.
- 1.8.18 **Make-Up Instruction:** Make-up instruction shall be scheduled to accommodate shift work and authorized absences.
- 1.8.19 **Training Categories:** Training shall be provided using approved programs in the following categories:
- Operations
  - Maintenance
  - Computer Software
  - Operations – Supervisor
  - Operations – Instructor
  - Maintenance – Supervisor
  - Maintenance – Instructor
  - Other categories as may be required by Contractor’s system design.
- 1.8.20 **Operations Training:** Operators shall be provided with a thorough training in all aspects of system/subsystem operation under both normal and abnormal conditions. This training shall include, but not be limited to:
- Orientation to provide overview of system/subsystem purpose, configuration and operations;

Terminology;  
Operations theory and interface;  
Equipment appearance, functions, concepts and operation;  
Operating modes, practices and procedures under normal and emergency conditions;  
Safety precautions;  
On-the-job operating experience covering all system/subsystem operating functions, activities and tasks including those associated with degraded operating modes, failure recognition and recovery processes;  
Familiarity with the content and use of O and M manuals and related reference publications.

- 1.8.21 **Maintenance Training:** Maintenance training shall cover all on-site routine, preventive and remedial maintenance of the system/subsystem. This training shall include, but not be limited to:

Orientation to provide overview of system/subsystem purpose, configuration and operations;  
Terminology;  
Operations theory and interfaces;  
Equipment modes, practices and procedures under normal and emergency conditions;  
Safety precautions;  
Use of tools and test equipment;  
Preventive maintenance;  
Troubleshooting, diagnostics and testing;  
Assembly and disassembly;  
Repair and parts replacement;  
Parts ordering practices and storage;  
Failure and recovery procedures;  
System/subsystem cabling;  
Familiarity with and use of O and M manuals and other reference materials.

- 1.8.22 **Computer Software Training:** Computer software training shall cover the use, management, development and maintenance of system/subsystem software. This training shall include but not be limited to:

Orientation to provide overview of system/subsystem concepts, configuration and operations;  
Basis programming and software architecture;  
System executive and utility program;  
Application program;  
Modification program;  
Modification of command lines codes;  
Interrupt logic;  
Intra- and inter-system interfaces;  
Processor system operating procedures;

Diagnostics;  
Communications software;  
File management;  
Hand-on training;  
Safety precautions;  
Familiarization with and use of O and M manuals and other reference materials.

- 1.8.23 **Operations – Supervisor Training:** Supplemental and specialized training shall be provided for supervisor level trainees. This training shall impart the knowledge and skills necessary to schedule, supervise and improve the proficiency of operating and computer software personnel.
- 1.8.24 **Operations – Instructor Training:** Supplemental and specialized training shall be provided to prepare graduate trainees or nominated instructors successfully to instruct future trainees in system/subsystem operations and computer software.
- 1.8.25 **Maintenance – Supervisor Training:** Supplemental and specialized training shall be provided for supervisory level trainees. This training shall impart the knowledge and skills necessary to schedule, supervise and improve the proficiency of maintenance personnel.
- 1.8.26 **Maintenance – Instructor Training:** Supplemented and specialized training shall be provided to prepare graduate trainees of nominated instructions successfully to instruct future trainees in all phases of system/subsystem maintenance.

## **1.9 INITIAL OPERATION OF SYSTEMS**

- 1.9.1 After installation is complete, operate system for time required to complete tests specified under TESTING, BALANCING AND ADJUSTING, to demonstrate performance in accordance with design requirements and to provide instruction and training to the Employer's designated personnel.
- 1.9.2 Commencement Date: obtain approval of commencement date.

## **1.10 NOISE AND VIBRATION**

- 1.10.1 Equipment is to operate under all conditions of load without objectionable noise or vibration.
- 1.10.2 Noise and vibration noticeable outside a room in which moving equipment is installed, or annoyingly noticeable inside the room, will be considered objectionable.

- 1.10.3 Noise Level resulting from equipment and heard in the same building or nearby buildings is not to exceed specified noise levels as measured with a standard sound level meter on the 'A' scale.
- 1.10.4 **Correction:** Conditions considered objectionable are to be corrected by approved means and as directed.
- 1.10.5 Method of Correction: noise is to be corrected by addition of sound absorbers in ducts, by internal duct lining, by installation of sound barriers or dampeners on walls and/or ceilings of equipment rooms or by other method to produce satisfactory noise levels.
- 1.10.6 Vibration Control is to be by approved vibration isolators applied and installed in accordance with manufacturer's instructions.
- 1.11 GUARANTEE**
- 1.11.1 Guarantee is to cover perfect mechanical operation of systems, perfect attainment of temperatures and humidity within specified design conditions, acceptable noise and vibration levels and reasonable consumption of power, fuel and water.
- 1.11.2 **Defects During Guarantee Period:** If during guarantee period any equipment or material proves defective or any part of system fails to function properly, equipment is to be replaced and defects and malfunctions corrected as directed by the Engineer.
- 1.11.3 **Extension of Guarantee:** If during guarantee period any piece of major equipment is replaced or rebuilt, the guarantee period is to be extended to cover a full season of proper operation of that equipment.
- 1.11.4 **Maintenance and Operation:** Provide necessary skills and labor to assure proper operation and to provide regular and preventive maintenance required for equipment and controls during guarantee period on a continuous 24 hour basis.
- 1.11.5 **Maintenance and Operation:** Act promptly to correct problems arising in operation of equipment or system.
- 1.11.6 **Maintenance and Operation:** Provide the Employer with monthly inspection certificates of equipment, record findings on a check list, and certify that each piece of equipment has been examined, is operating as intended and has been properly maintained as recommended by the manufacturer.
- 1.11.7 **Maintenance and Operation:** Check all controls monthly to ascertain that they function as designed.



1.11.8 Spare Parts for normal wear and tear are to be provided by the Employer.

**1.12 QUALITY ASSURANCE**

1.12.1 Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.12.2 **Equipment Selection:** Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished at no additional cost to the Contract, provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, equipment spaces, and the like are increased accordingly. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.12.3 **Equipment Vibration Tolerance:**

After air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance as requested by manufacturers.

1.12.4 **Products Criteria:**

- A) **Equipment Service:** Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.
- B) **Multiple Units:** When 2 or more units of materials or equipment of the same type or class are required; these units shall be products of one manufacturer.
- C) **Assembled Units:** Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- D) **Nameplates:** Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- E) Asbestos products or equipment or materials containing asbestos shall not be used.

1.12.5 **Manufacturer's Recommendations:** Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to

installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

- 1.12.6 Provide copies of approved equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

**1.13 WELDING**

**1.13.1 The Contractor is entirely responsible for the quality of the welding and shall:**

- A) Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
- B) Comply with ASME B31.1 and AWS B2.1.
- C) Perform all welding operations required for construction and installation of the piping systems.

- 1.13.2 **Qualification of Welders:** Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1, Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications, and AWS B2.1, and / or, as approved by the Qualifications."

- 1.13.3 **Examining Welder:** Examine each welder at job site, in the presence of the Resident Engineer, to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number assigned.

- 1.13.4 **Examination Results:** Provide the Resident Engineer with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.

- 1.13.5 **Beveling:** Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.



- 1.13.6 **Alignment:** Utilize split welding rings or approved alternate method for joints on all pipes above 50 mm to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.
- 1.13.7 **Erection:** Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation.
- 1.13.8 **Defective Welds:** Replace and re-inspect defective welds. Repairing defective welds by adding weld material over the defect or by pinning will not be permitted. Welders responsible for defective welds must be re-qualified.
- 1.13.9 **Electrodes:** Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

#### **1.14 DELIVERY, STORAGE, AND HANDLING**

- 1.14.1 The equipment supplied shall be packed for protection against damage during handling, transport, warehousing and installation. The efficiency of the packing shall be the responsibility of the Contractor. The Contractor shall repair or replace any damaged items, at no additional cost, as instructed by the Engineer even after delivery of the equipment, if it is proven that the damage was caused by packing, storage, or handling deficiencies.
- 1.14.2 Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- 1.14.3 Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- 1.14.4 Protect flanges, fittings, and piping specialties from moisture and dirt.
- 1.14.5 Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### **1.15 SEQUENCING AND SCHEDULING**

- 1.15.1 Coordinate mechanical equipment installation with other trades and building components.
- 1.15.2 Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- 1.15.3 Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

- 1.15.4 Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- 1.15.5 Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- 1.15.6 Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."
- 1.15.7 Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

**1.16 GENERAL**

- 1.16.1 All facilities provided for the Engineer's and/or Employer's staff shall remain available until the end of the Maintenance Period or until such earlier time as the Engineer may instruct.
- 1.16.2 All Site Office Facilities and associated facilities shall remain the property of the Contractor and shall be maintained and insured by him until Taking – Over, at which time the facilities shall become the property of the Employer as they are or ordered to be removed.

## **PART 2   PRODUCTS**

### **2.1   PIPE AND PIPE FITTINGS**

- 2.1.1 Refer to individual Division-22 piping Sections for pipe and fitting materials and joining methods.
- 2.1.2 **Pipe Threads:** ASME B1.20.1 or British Standard Taper Pipe Thread for factory-threaded pipe and pipe fittings.

### **2.2   JOINING MATERIALS**

- 2.2.1 Refer to individual Division-22 piping Sections for special joining materials not listed below.
- 2.2.2 Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
- A) ASME B16.21, nonmetallic, flat, asbestos-free, 3.2 mm maximum thickness, unless thickness or specific material is indicated.
- Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
  - Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B) AWWA C110, rubber, flat face, 3.2 mm thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- 2.2.3 Flange: ASME B18.2.1, carbon steel, unless otherwise indicated; Bolts, Nuts and washers, stainless steel for potable/domestic water piping, galvanized for other piping systems.
- 2.2.4 Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- 2.2.5 Solder Filler Metals: ASTM B32.
- A) Alloy Sn95: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
- B) Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
- C) Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.

- D) Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
  - E) Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- 2.2.6      **Brazing Filler Metals:** AWS A5.8.
- A) BcuP Series: Copper-phosphorus alloys.
  - B) BAg1: Silver alloy.
- 2.2.7      **Welding Filler Metals**: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- 2.2.8      **Solvent Cements**: Manufacturer's standard solvent cements for the following:
- A) ABS Piping: ASTM D2235.
  - B) CPVC Piping: ASTM F493.
  - C) PVC Piping: ASTM D2564. Include primer according to ASTM F656.
  - D) PVC to ABS Piping Transition: ASTM D3138.
- 2.2.9      **Plastic Pipe Seals**: ASTM F477, elastomeric gasket.
- 2.2.10      **Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts**: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- 2.2.11      **Couplings**: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
- A) Sleeve: ASTM A126, Class B, gray iron.
  - B) Followers: ASTM A47 malleable iron or ASTM A536 ductile iron.
  - C) Gaskets: Rubber.
  - D) Bolts and Nuts: AWWA C111.
  - E) Finish: Enamel paint.
- 2.2.12      Couplings for RTRP and Fittings: Piping manufacturer's standard.

## **2.3      DIELECTRIC FITTINGS**

- 2.3.1 **General:** Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- 2.3.2 **Description:** Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- 2.3.3 **Insulating Material:** Suitable for system fluid, pressure, and temperature.
- 2.3.4 **Dielectric Unions:** Factory-fabricated, union assembly, for 1725 kPa minimum working pressure at 82 deg. C.
- 2.3.5 **Dielectric Flanges:** Factory-fabricated, companion-flange assembly, for 1035 or 2070 kPa minimum working pressure as required to suit system pressures.
- 2.3.6 **Dielectric-Flange Insulation Kits:** Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic resin gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
- A) Provide separate companion flanges and steel bolts and nuts for 1035 or 2070 kPa minimum working pressure as required to suit system pressures.
- 2.3.7 **Dielectric Couplings:** Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 2070 kPa minimum working pressure at 107 deg. C.
- 2.3.8 **Dielectric Nipples:** Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 2070 kPa minimum working pressure at 107 deg. C.
- 2.4 FLEXIBLE CONNECTORS**
- 2.4.1 **General:** Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 860 kPa minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
- A) **DN50 and Smaller:** Threaded.
- B) **DN65 and Larger:** Flanged.
- C) **Option for DN65 and Larger:** Grooved for use with keyed couplings.

- 2.4.2 **Bronze-Hose, Flexible Connectors:** Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
- 2.4.3 **Stainless-Steel-Hose/Steel Pipe, Flexible Connectors:** Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
- 2.4.4 **Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors:** Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
- 2.4.5 **Rubber, Flexible Connectors:** CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 860 kPa minimum working-pressure rating at 104 deg. C Units may be straight or elbow type, unless otherwise indicated.

## 2.5 **MECHANICAL SLEEVE SEALS**

**Description:** Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

## 2.6 **PIPING SPECIALTIES**

- 2.6.1 **Sleeves:** The following materials are for wall, floor, slab, and roof penetrations:
- A) **Steel Sheet Metal:** 0.6 mm minimum thickness, galvanized, round tube closed with welded longitudinal joint.
  - B) **Steel Pipe:** ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.
  - C) **Stack Sleeve Fittings:** Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    - Under deck Clamp: Clamping ring with set screws.
    - Screws used for outdoor and wet application shall be of stainless steel.
- 2.6.2 **Escutcheons:** Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
- A) **ID:** Closely fit around pipe, tube, and insulation of insulated piping.
  - B) **OD:** Completely cover opening.

- C) Cast Brass: One piece, with set screw and polished chrome-plated finish.
- D) Cast Brass: Split casting, with concealed hinge, set screw and polished chrome-plated finish.
- E) Stamped Steel: One piece, with set screw and chrome-plated finish.
- F) Stamped Steel: One piece, with spring clips and chrome-plated finish.
- G) Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
- H) Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
- I) Cast-Iron Floor Plate: One-piece casting.

2.6.3 **Screws**: Provide Stainless Steel screws for outdoor and wet applications.

## 2.7 GROUT

**Non-shrink, Nonmetallic Grout:** ASTM C1107, Grade B.

- Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
- Design Mix: 34.5 MPa, 28-day compressive strength.
- Packaging: Premixed and factory packaged.

## **PART 3** EXECUTION

### **3.1** PIPING SYSTEMS - COMMON REQUIREMENTS

- 3.1.1 **General:** Install piping as described below, unless piping Sections specify otherwise. Individual Division-22 piping Sections specify unique piping installation requirements.
- 3.1.2 **General Locations and Arrangements:** Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- 3.1.3 Install piping at indicated slope.
- 3.1.4 Install components with pressure rating equal to or greater than system operating pressure.
- 3.1.5 Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- 3.1.6 Install piping free of sags and bends.
- 3.1.7 Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- 3.1.8 Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- 3.1.9 Install piping to allow application of insulation plus 25 mm clearance around insulation.



- 3.1.10 Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- 3.1.11 Install fittings for changes in direction and branch connections.
- 3.1.12 Install couplings according to manufacturer's written instructions.
- 3.1.13 Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
- A) Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
  - B) Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
  - C) Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
  - D) Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
  - E) Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- 3.1.14 Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- 3.1.15 Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- A) Cut sleeves to length for mounting flush with both surfaces.
    - Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 50 mm above finished floor level. Extend sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - B) Build sleeves into new walls and slabs as work progresses.
  - C) Install sleeves large enough to provide 6 mm annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - Steel Pipe Sleeves: For pipes smaller than DN150.
    - Steel, Sheet-Metal Sleeves: For pipes DN150 and larger, penetrating gypsum-board partitions.
    - Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of soil pipe to extend sleeve to 50 mm above finished floor

level. Refer to Division-7 Section "Sheet Metal Flashing and Trim" for flashing.

- \* Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

- D) Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division-7 Section "Joint Sealants" for materials.
- E) Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

3.1.16 **Aboveground, Exterior-Wall, Pipe Penetrations:** Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 25 mm annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- A) Install steel pipe for sleeves smaller than 150 mm in diameter.
- B) Install steel sheet for sleeves 150 mm in diameter and larger.
- C) Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

3.1.17 **Underground, Exterior-Wall, Pipe Penetrations:** Install steel pipe for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 25 mm annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- A) Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

3.1.18 **Fire-Barrier Penetrations:** Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stopping materials.

3.1.19 Verify final equipment locations for roughing-in.

3.1.20 Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.1.21 **Piping Joint Construction:** Join pipe and fittings as follows and as specifically required in individual piping Specifications Group:

- A) Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- B) Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C) Soldered Joints: Construct joints according to AWS' "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
- D) Brazed Joints: Construct joints according to AWS' "Brazing Handbook," Chapter "Pipe and Tube."
- E) Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
  - Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
  - Align threads at point of assembly.
  - Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
  - Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F) Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
- G) Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- H) Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
  - Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
  - ABS Piping: ASTM D2235 and ASTM D2661.
  - CPVC Piping: ASTM D2846 and ASTM F493.
  - PVC Pressure Piping: ASTM D2672.

- PVC Non-pressure Piping: ASTM D2855.
- PVC to ABS Non-pressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.

- I) Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657 procedures and manufacturer's written instructions.
- Plain-End Pipe and Fittings: Use butt fusion.
  - Plain-End Pipe and Socket Fittings: Use socket fusion.

3.1.22 **Piping Connections**: Make connections according to the following, unless otherwise indicated:

- A) Install unions, in piping DN50 and smaller, adjacent to each valve and at final connection to each piece of equipment with DN50 or smaller threaded pipe connection.
- B) Install flanges, in piping DN65 and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
- C) Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
- D) Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.1.23 Protect underground pipes installed less than 1500 mm from FGL and passing under roads or landscaped areas by 50 mm thick precast concrete slabs. Slabs to extend 200 mm from both sides of protected pipe and be located 600 mm. above pipe.

## **3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- 3.2.1 Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- 3.2.2 Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Engineer.
- 3.2.3 Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- 3.2.4 Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting,

with minimum interference to other installations. Extend grease fittings to accessible locations.

- 3.2.5 Install equipment giving right of way to piping installed at required slope.
- 3.2.6 Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

### **3.3      PAINTING AND FINISHING**

- 3.3.1      Refer to Division-9 Section "Painting" for paint materials, surface preparation, and application of paint.
- 3.3.2      Apply paint to exposed piping according to the following, unless otherwise indicated:
- A)    Interior, Ferrous Piping: Use semi-gloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
  - B)    Interior, Galvanized-Steel Piping: Use semi-gloss, acrylic-enamel finish. Include 2 finish coats over galvanized metal primer.
  - C)    Interior, Ferrous Supports: Use semi-gloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
  - D)    Exterior, Ferrous Piping: Use semi-gloss, acrylic-enamel finish. Include 2 finish coats over rust-inhibitive metal primer.
  - E)    Exterior, Galvanized-Steel Piping: Use semi-gloss, acrylic-enamel finish. Include 2 finish coats over galvanized metal primer.
  - F)    Exterior, Ferrous Supports: Use semi-gloss, acrylic-enamel finish. Include 2 finish coats over rust-inhibitive metal primer.
- 3.3.3      Do not paint piping specialties with factory-applied finish.
- 3.3.4      **Damage and Touchup:** Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### **3.4      CONCRETE BASES**

Construct concrete bases of dimensions indicated or otherwise required, but not less than 150 mm larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 21 MPa, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

### **3.5      ERECTION OF METAL SUPPORTS AND ANCHORAGE**

- 3.5.1      Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment. Floor mounted metallic supports shall have base and concrete plinths beneath.
- 3.5.2      **Field Welding:** Comply with AWS D1.1, "Structural Welding Code--Steel."
- 3.5.3      **Floor Mounted Support:** Provide base plate and concrete plinths beneath each floor mounted support.

### **3.6      DEMOLITION**

- 3.6.1      Disconnect, demolish, and remove Work specified in Division-22 Sections.
- 3.6.2      If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- 3.6.3      **Accessible Work:** Remove indicated exposed pipe and ductwork in its entirety.
- 3.6.4      **Work Abandoned in Place:** Cut and remove underground pipe a minimum of 50 mm beyond face of adjacent construction. Cap and patch surface to match existing finish.
- 3.6.5      **Removal:** Remove indicated equipment from Project site.
- 3.6.6      **Temporary Disconnection:** Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

### **3.7      CUTTING AND PATCHING**

- 3.7.1      Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- 3.7.2      Repair cut surfaces to match adjacent surfaces.

### **3.8      GROUTING**

- 3.8.1      Install nonmetallic, no shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

- 3.8.2 Clean surfaces that will come into contact with grout.
- 3.8.3 Provide forms as required for placement of grout.
- 3.8.4 Avoid air entrapment during placing of grout.
- 3.8.5 Place grout, completely filling equipment bases.
- 3.8.6 Place grout on concrete bases to provide smooth bearing surface for equipment.
- 3.8.7 Place grout around anchors.
- 3.8.7 Cure placed grout according to manufacturer's written instructions.

**END OF SECTION 22 00 10**



## CONTENTS

### SECTION 21 10 00

#### WATER - BASED FIRE SUPPRESSION SYSTEMS

##### **PART 1    GENERAL**

- 1.1    Related Documents
- 1.2    Scope of Work
- 1.3    Codes and Standards
- 1.4    Design Criteria for Hydraulic Calculation
- 1.5    Submittals

##### **PART 2    PRODUCTS**

- 2.1    Manufacturers
- 2.2    Material and Products - General
- 2.3    Basic Identification
- 2.4    Basic Pipes and Pipe Fittings
- 2.5    Basic Piping Specialties
- 2.6    Basic Support and Anchors
- 2.7    Sprinkler

##### **PART 3    EXECUTION**

- 3.1    Inspection
- 3.2    Installation of Basic Identification
- 3.3    Installation of Fire Protection Piping
- 3.4    Installation of Piping Specialties
- 3.5    Installation of Supports and Anchors
- 3.6    Flushing
- 3.7    Testing
- 3.8    Cleaning and Inspecting

## SECTION 21 10 00

### WATER - BASED FIRE SUPPRESSION SYSTEMS

#### **PART 1 GENERAL**

##### **1.1 RELATED DOCUMENTS**

Drawings and General Provisions of the Contract, including General Conditions, Particular Conditions and Division-1 Specifications Group, apply to work of this Section.

- Division-1 Specifications Group apply to work of this section.
- Division-22 Basic Mechanical Materials and Methods sections apply to work of this section.

##### **1.2 SCOPE OF WORK**

- 1.2.1 Extent of fire protection work is indicated on Drawings and schedules, and by requirements of this section.
- 1.2.2 Installation of a hydraulically calculated combined standpipe system and automatic fire sprinkler system complete and ready for operation, as indicated. Contractor to submit full hydraulic calculation for the entire system as per the Drawings and the following specification.
- 1.2.3 Installation of all necessary accessories for the proper operation of the system as per NFPA 13 and NFPA 14.
- 1.2.4 Painting of exposed piping and supports to match surrounding background in stairways and other finished areas and red in unfinished areas.

##### **1.3 CODES AND STANDARDS**

- 1.3.1 **NFPA Compliance:** Install fire protection systems in accordance with the following NFPA Standards:
- A) Standards for the Installation, Maintenance and Use of Portable Fire Extinguisher - NFPA 10.
  - B) Standards for the Installation of Standpipe and Hose Systems NFPA 14.
  - C) Standard for the Installation of Sprinkler Systems NFPA 13.
  - D) Standard for the Installation of Private Fire Service Mains and their

Appurtenances - NFPA 24.

E) National Electrical Code - NFPA 70.

F) CO2 fire Extinguishing systems NFPA-12.

1.3.2 **UL Compliance:** Provide fire protection products in accordance with UL standards; provide UL label on each product.

1.3.3 **FM (Factory Mutual) Compliance:** Provide fire protection products and installations in accordance with FM standards and approved for 207 kPa working pressure; provide FM label on each product.

1.3.4 **Fire Department Compliance:** All material and equipment necessary to meet the requirements of codes and the requirements of the local fire authorities are to be provided regardless of failure to specifically mention same in this Section or to show on Drawings.

1.3.5 **Screw Thread Connections:** Comply with local Fire Department regulations for sizes, threading and arrangement of connections for fire department equipment to fire protection systems.

#### **1.4 DESIGN CRITERIA FOR HYDRAULIC CALCULATION**

1.4.1 When not shown on Drawings, base the system hydraulic calculations using the area/density method in accordance with NFPA13.

1.4.2 Provide sprinklers in accessible shafts per NFPA13.

1.4.3 Provide sprinklers in gravity type metal chutes per NFPA82.

A) Add water allowance of 15 L/s for inside and outside hose streams to the sprinkler requirements at the connection to the distribution main.

B) **Hydraulic Calculations:** The calculated demand including hose stream requirements shall fall no less than 10 percent below the available supply curve.

1.4.3 **Seismic Protection:** Seismically brace all piping systems in accordance with Zone 2A of NFPA13 and uniform building code (UBC).

#### **1.5 SUBMITTALS**

1.5.1 **Hydraulic Calculations:** Submit hydraulic calculations to the Engineer for approval.

- 1.5.2 **Product Data:** Submit manufacturer's technical product data and installation instructions for fire protection materials and products. Manufacturer's literature and data sheets are to be submitted indicating the necessary installation dimensions, weights, materials and performance information. The performance is to include capacities, pressure drop, design and operating pressure, temperatures, and similar data. Complete electrical data, including power conditions, and identifying types and numbers, to be included. Where pertinent, electrical diagrams are to be provided. Literature and data sheets may be provided by standard sales sheets marked to indicate the specific equipment provided.
- 1.5.3 **Certificate of Installation:** Submit certificate upon completion of fire protection piping work which indicates that work has been tested in accordance with NFPA 13 and NFPA 14, and also that system is operational, complete, and has no defects.
- 1.5.4 **Record Drawings:** At project closeout, submit record Drawings of installed fire protection piping and products; in accordance with requirements of Division-1.
- 1.5.5 **Maintenance Data:** Submit operation and maintenance data and parts lists for fire protection materials and products. Include this data, product data, Shop Drawings, approval Drawings, approval calculations, certificate of installation, and record Drawings in maintenance manual; in accordance with requirements of Division-1. Contractor is to furnish data covering model, type and serial numbers, capacities, maintenance and operation of each item of equipment or apparatus. Operating instructions are to cover all phases of control.
- 1.5.6 **Valve Schedule:** Furnish a printed schedule, in duplicate, describing each valve by number, giving locations and service for which used. System identification to be as stipulated in the other sections of these specifications. One copy of this schedule is to be mounted under glass in a simple black enamel steel frame and hung in the mechanical equipment room where directed. The other copy is to be submitted to the Engineer before completion of the work.
- 1.5.7 **Shop Drawings and Manufacturer's Literature:** Submit Shop Drawings and manufacturers literature on fire protection system components, according to the following listing:
- A) **Hangers and Supports:**
- Hanger Supports
  - Brackets
  - Hangers
  - Clamps
  - Fire Protection Water Pipe, Fittings and Valves
  - List of Manufacturers

- Piping Layout and Details
- Valves
- Pipe
- Fittings

B) Sprinkler Systems:

- List of Manufacturers
- Sprinkler Piping and Head Layout and Details
- Sprinkler Heads
- Water Flow Indicators
- Electric Alarm Switches
- Valve Supervisory Switches
- Valve and Hydraulically Calculated ID signs
- Manufacturers Installation Instructions for all equipment in brochure

C) Other:

- Leak Test Certificates
- Operation and Maintenance Instructions

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURERS**

Subject to compliance with the specification requirements of this section, provide products by one of the attached list of manufacturers or approved equal shown in Section 01 62 00.

### **2.2 MATERIALS AND PRODUCTS - GENERAL**

2.2.1 Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection to comply with installation requirements.

2.2.2 Provide materials and products of sizes and types matching piping and equipment connections.

2.2.3 Provide fittings of materials which match pipe materials used in fire protection systems.

### **2.3 BASIC IDENTIFICATION**

2.3.1 Provide identification complying with Division-22 Basic Mechanical Materials and Methods section.

2.3.2 **Fire Protection Signs:** Provide the following signs:

- A) At each sprinkler valve, sign indicating what portion of system valve controls.
- B) At each outside alarm device, sign indicating what authority to call if device is activated.

### **2.4 BASIC PIPES AND PIPE FITTINGS**

2.4.1 Provide pipes and pipe fittings complying with Division-22 section "Plumbing Piping", in accordance with the following listing:

#### **2.4.2 Fire Water Piping**

- A) Pipe Sizes 50 mm and Smaller: Black seamless steel pipe schedule 40; threaded black malleable iron fittings.
- B) Wrapping: Machine wrap all underground black steel pipe with polyvinyl chloride tape, using 50% overlap. Hand wrap fittings using 100% overlap

wrap extending 150 mm beyond fitting onto wrapped pipe. Comply with tape manufacturer's installation instructions.

- C) Pipe sizes 65 mm and Larger: Black seamless steel pipes schedule 40 with mechanical grooved fittings
- D) Fire Water Piping Inside Buildings: shall be mechanical coupling type with grooved piping.
- E) Cut Grooved and Threaded pipes: shall be schedule 40 equivalent according to ASTM A-135 Grade A. Pipes serving high pressure zones to be schedule 80. All pipes shall have a Corrosion Resistance Ratio, (CRR) of 1.00 or greater, per UL listings.
- F) Roll grooved pipes shall be schedule 40 according to ASTM A-795 Type E, Grade A.
- G) Pipes shall be black carbon steel, except in FM approved dry systems where pipe is to be "hot-dip" galvanized in accordance with ASTM A-123 zinc coating specifications.

- 2.4.3 **Pipe Jointing Method:** Pipes shall be joined via grooved Rigid Firelock Coupling with Angle Pad Design for pressures up to 2070 kPa. Zero Flex Design shall be used for pressure ratings up to 4140 kPa. All couplings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12 or malleable iron conforming to ASTM A-47 Grade 32510/ Housings shall be red or orange enamel coated or hot dip galvanized.
- 2.4.4 **Gaskets:** shall be Grade "E" EPDM compound (green color coded) conforming to ASTM D-2000, UL listed classified to ANSI/NSF 61 for water supply systems and flush seal gaskets for dry service. All gaskets shall be selected as per manufacturer's recommendation according to service application. Gaskets must be manufactured by the same source for couplings and fittings to secure compability.
- 2.4.5 **Grooved Fittings and Coating:** Shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12 with grooved or shouldered ends for direct connection into the grooved piping system. Fittings shall be orange or red enamel coated or hot dip galvanized.
- 2.4.6 **Fittings for Plain End Steel Pipe:** Shall be Victaulic FIT fittings DN 25 mm, DN 32 mm, DN 40 mm and DN 50 mm with self-contained Grade "E" standard gaskets, internal pipes stop for uniform takeoff dimensions, plated 1/4 - turn positive locking lugs of heat treated carbon steel with externally visible locked position indicator for easy inspection of plain end steel with externally visible locked position indicator for easy inspection of plain end steel with externally visible locked position indicator for easy inspection of plain end steel pipe

connections prepared. FIT products to be used in dry systems. "L" silicone gaskets.

- 2.4.7 **Branch Outlets - Hole Cut Pipe:** Hole cut branch outlets shall be mechanical T branch connections with locating collar emerging into the hole. Gaskets shall be Grade E standard pressure responsive gasket. Branch shall have a machine cut hole at a predetermined position, on the centerline of the pipe, of a size to receive the housing collar, in accordance with manufacturers' specifications.

## 2.5 **BASIC PIPING SPECIALTIES**

Provide piping specialties complying with Division-22 Section Basic Mechanical Materials and Methods, in accordance with the following listing:

- Pipe escutcheons.
- Dielectric unions.
- Drip pans.
- Pipe sleeves.
- Sleeve seals.
- Fire Barrier Penetration Seals.

## 2.6 **BASIC SUPPORTS AND ANCHORS**

Provide supports and anchors complying with Division-22 Section Basic Mechanical Materials and Methods, in accordance with the following listing:

- Adjustable steel clevis hangers, adjustable steel band hangers, or adjustable band hangers, for horizontal-piping hangers and supports.
- Two-bolt riser clamps for vertical piping supports.
- Steel turnbuckles and malleable iron sockets for hanger-rod attachments.
- Concrete inserts, top-beam C-clamps, side beam or channel clamps or center beam clamps for building attachments.

## 2.7 **BASIC VALVES**

- 2.7.1 Provide valves complying with Division-22 Section "General – Duty Valves for Plumbing", in accordance with the following listing:

- 2.7.2 **Shut Off and Butterfly Valve:** Shall be UL listed and FM approved for 2065 kPa service supplied with a ductile iron body conforming to ASTM A-536 coated with a polyphenylene sulfide blend, a disc of ductile iron conforming to ASTM A-536 with EPDM coating providing bubble tight shut off. Sizes 65-150 mm shall have an approved weatherproof manual actuator suitable for indoor or outdoor use with two single pole, double throw supervisory switches either pre-wired (WRD) or unwired (UWD) monitoring the open position as specified on the Drawings. The 200 mm size will be either unsupervised or feature



factory installed DPDT switches monitoring the open position as specified on the Drawings. Valves shall be installed in accordance with the latest published manufacturer's specification. Valves shall be provided with tamper switch and connected to fire alarm panel.

- 2.7.3 **Check and Non Return Valve:** Shall be single disc, spring loaded, check valves 65-300 mm as UL listed and FM approved for a single check and anti-water hammer service and for horizontal or vertical installation, supplied drilled, tapped and plugged downstream for drainage outlet with Grade "E" EPDM seal, housing cast of ductile iron conforming to ASTM A-536 Grade 65-45-12 with grooved ends for installation with grooved end couplings rated for service up to 1725 kPa working pressure.
- 2.7.4 **Ball Valves:** 50-80 mm, UL listed and FM approved, supplied with a ductile iron body to ASTM A-536 and a ball to Type 316 stainless steel. Valve will be either un-supervised or have factory installed double pole, double throw switches monitoring the open position. Valve shall be supplied with grooved ends to connect with grooved end couplings and rated service up to 2065 kPa/3200 kPa working pressure depends on system pressure. Valves shall be installed in accordance with the latest published manufacturer's specification.
- 2.7.5 **Alarm Check Valve:** Shall be 40-150 mm spring assisted, UL listed and FM approved for vertical installation supplied with Grade "E" EPDM clapper seal, housing cast of Ductile Iron to ASTM A-536 Grade 65-45-12, serviceable without removal from the line. Valve to be connected with couplings as applicable rated for service up to 2065 kPa/3200 kPa working pressure depends on system pressure.
- 2.7.6 **Dry Pipe Valves:** Shall be 40 -150 mm, low differential, latched closed, spring assisted, self resetting clapper, UL listed and FM approved for vertical installation supplied with Grade "E" EPDM seal, housing cast of ductile iron conforming to ASTM A-536 Grade 65-45-12 serviceable without removal from the line. Valve to be connected with couplings as applicable rated for service up to 2065 kPa/3200 kPa working pressure depends on system pressure.
- 2.7.7 **Actuated Check Valve with Deluge Trim:** Shall be 40-150 mm low differential, latched closed spring assisted, self resetting clapper, pneumatic, hydraulic or electric release, UL listed and FM approved for vertical installation supplied with Grade "E" EPDM clapper seal, housing cast of ductile iron to ASTM A-536 Grade 65-45-12 serviceable without removal from the line to be connected with couplings as applicable rated for service up to 2065 kPa/3200 kPa working pressure depends on system pressure.
- 2.7.8 **Actuated Check Valve with Pre-Action Trim:** Shall be 40-150 mm low differential latched closed spring assisted, self resetting clapper, pneumatic, hydraulic or electric release, non single, or double interlock, UL listed and FM approved for vertical installation supplied with Grade "E" EPDM clapper seal,

housing cast of ductile iron to ASTM A-536 Grade 65-45-12 serviceable without removal from the line to be connected with couplings as applicable rated for service up to 2065 kPa/3200 kPa working pressure depends on system pressure.

- 2.7.9 **Self-contained Test and Drain Valve:** Bronze body, with chrome plated bronze ball, brass stem, steel handle, teflon seat and sight glasses. Provide valve with three position indicator plate (off, test, and drain), 6 mm tapping for pressure gage and various other orifice inserts to simulate flow through 10 mm, 12 mm, 13 mm and 14 mm diameter sprinklers.
- 2.7.10 **Alarm Test Module:** Shall be FIT locking lugs 30 mm NPT threaded a combination sight glass/orifice, bronze top works and 6 mm NPT plug for attachment of a gauge water hose for pressure testing.
- 2.7.11 **Landing Valves (LV):** 65 mm screwed, brass hose angle valve, 2050 kPa/3200 kPa WWP, male hose threads same as local fire department service, permanently attached to polished brass cap and chain, 65 mm x 40 mm reducer.

## 2.8 **SPRINKLERS**

- 2.8.1 Suspended Ceiling:
1. Manufacturers:
    - a. [Viking- U.S.A]
    - b. [Grinell – U.S.A ]
    - c. [Reliable –U.S.A]
  2. Type: [Concealed] pendant type with matching [screw on] escutcheon plate.
  3. Finish [Chrome plated.]
  4. Escutcheon Plate Finish: color as selected.
  5. Fusible Link: [Fusible solder link type] temperature rated for specific area hazard.
- 2.8.2. Exposed Area Type:
1. Manufacturers:
    - a. [Viking- U.S.A]
    - b. [Grinell – U.S.A ]
    - c. [Reliable –U.S.A]
  2. Type: Standard upright type.
  3. Finish: [Chrome plated.]
  4. Fusible Link: [Fusible solder link type] temperature rated for specific area hazard.
- 2.8.3. Sidewall Type:
1. Manufacturers:

- a. [Viking- U.S.A]
    - b. [Grinell – U.S.A ]
    - c. [Reliable –U.S.A]
  2. Type: [Standard] horizontal sidewall type with matching [screw on] escutcheon plate.
  3. Finish: [Chrome plated.]
  4. Escutcheon Plate Finish: [Chrome plated.]
  5. Fusible Link: [Fusible solder link type] temperature rated for specific area hazard.
- 2.8.4 Piping Specialties
- a. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm , with pressure retard chamber and variable pressure trim with test and drain valve.

## **PART 3   EXECUTION**

### **3.1   INSPECTION**

Examine areas and conditions under which fire protection materials and products are to be installed.

### **3.2   INSTALLATION OF BASIC IDENTIFICATION**

3.2.1   Install mechanical identification in accordance with Division-22 Section "Basic Mechanical Materials and Methods".

3.2.2   Install fire protection signs on piping in accordance with NFPA 13 and NFPA 14 requirements.

### **3.3   INSTALLATION OF FIRE PROTECTION PIPING**

3.3.1   Install pipes and pipe fittings in accordance with Division-22 Section "Plumbing Piping".

3.3.2   Comply with requirements of NFPA 13 and NFPA 14 for installation of fire protection piping materials.

3.3.3   Install piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that piping systems comply with requirements and serve intended purposes.

3.3.4   Coordinate with other work, including plumbing piping, as necessary to interface components of fire protection piping properly with other work.

3.3.5   Install drain piping at low points of piping systems. Provide dry drum drips where required.

3.3.6   Install sectional valves in inlet piping, at bottom of each riser, and in loops as indicated.

3.3.7   Install water flow indicators where indicated. Mount supervisory switches on each sectional valve.

3.3.8   Install pressure gages at top of each standpipe.

3.3.9   Install manual shutoff at each audible alarm station.

3.3.10   Install Inspector's test connection where indicated, or at most remote point from riser.

- 3.3.11 Do not use fire fighting water pipes to supply water for other purposes.
- 3.3.12 Sprinkler piping to be not less than 25 mm even if serving only one sprinkler.
- 3.3.13 Make sprinkler piping connections to the top of cross mains and feed mains.
- 3.3.14 Provide flush and test connections at ends of cross and feed mains. Minimum size to be 25 mm.
- 3.3.15 Locate branch lines at not more than half branch line spacing from wall.

### **3.4 INSTALLATION OF PIPING SPECIALTIES**

Install piping specialties in accordance with Division-22 Section "Plumbing Piping".

### **3.5 INSTALLATION OF SUPPORTS AND ANCHORS**

- 3.5.1 Install supports and anchors, in accordance with Division-22 Section "Basic Mechanical Materials and Methods".
- 3.5.2 Support horizontal pipes at intervals not exceeding 3 m.
- 3.5.3 Support vertical pipes at every floor.
- 3.5.4 Support cross mains of sprinkler piping independently of branch line hangers. Provide one hanger on each length between branch lines.
- 3.5.5 Install hangers without regard to location of pipe sleeves through walls. Centre pipes in sleeves and do not use sleeves for pipe support.

### **3.6 FLUSHING**

- 3.6.1 Prior to connecting fire risers for flushing, flush water feed mains, lead-in connections and control portions of fire piping. After fire piping installation has been completed and before piping is placed in service, flush entire system, as required to remove foreign substances, under pressure as specified in NFPA 13. Continue flushing until water is clear, and check to ensure that debris has not clogged sprinklers.

### **3.7 TESTING**

- 3.7.1 **Hydrostatic Testing:** After flushing system, test fire piping hydrostatically, for period of 2 hours, at not less than 1380 kPa or at 345 kPa in excess of maximum static pressure when maximum static pressure is in excess of 1030

kPa. Check system for leakage of joints. Measure hydrostatic pressure at low point of each system or zone being tested.

- 3.7.2 Repair or replace piping system as required to eliminate leakage in accordance with NFPA standards for "little or no leakage" and retest as specified to demonstrate compliance.

**3.8 CLEANING AND INSPECTING**

Clean and inspect fire protection systems in accordance with requirements of Division-22 Basic Mechanical Materials and Methods.

**END OF SECTION 21 10 00**