SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

A. The purpose of this specification is to set out the technical requirements for the piping systems to be used for the Project.

1.2 SUMMARY

A. This Section includes the following:
1. Nomenclature
2. Metallic Piping Requirement
3. Non-Metallic Piping Requirement
4. Piping Specialty Items
5. Painting and Coating
6. Piping Fabrication

1.3 DEFINITIONS

1.	ANSI	American National Standard Institute
2.	ASME	American Society of Mechanical Engineers
3.	ASTM	American Society for Testing and Materials
4.	AWWA	American Water Works Association (AWWA)
5.	BE	Beveled End
6.	BS	British Standard
7.	CA	Corrosion Allowance
8.	CL	Class (Pound Rating)
9.	DN	Nominal Diameter
10	EN	European Norm
11.	FF	Flat Face
12.	FLG	Flange
13.	GALV	Galvanized
14.	HB	Brinell Hardness
15.	HEX.NUT	Hexagonal Nut
16.	MSS SP	Manufacturers Standardization Society, Standard Practice
17.	NPS	Nominal Pipe Size
18.	NPTM	National Standard Pipe Taper Thread (Male)

19.	NPTF	National Standard Pipe Taper Thread (Female)
20.	OD	Outside Diameter
21.	PTFE	Poly-Tetrafluoro-Ethylene
22.	PVC	PolyVinyl Chloride
23.	PWHT	Post Weld Heat Treatment
24.	PMS	Piping Material Specification
25.	RF	Raised Face
26.	RTFE	Reinforced PTFE
27.	SCRD	Screwed
28.	SS	Stainless Steel
29.	SW	Socket Weld
30.	WN	Welding Neck

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
1. Pipe
2. Fittings
3. Flanges
4. Spectacle plates, Blinds and Blanks
5. Stud Bolts & Nuts
6. Gaskets
7. Valves
8. GRE/GRP Piping
9. HDPE Piping
10. uPVC Piping

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS

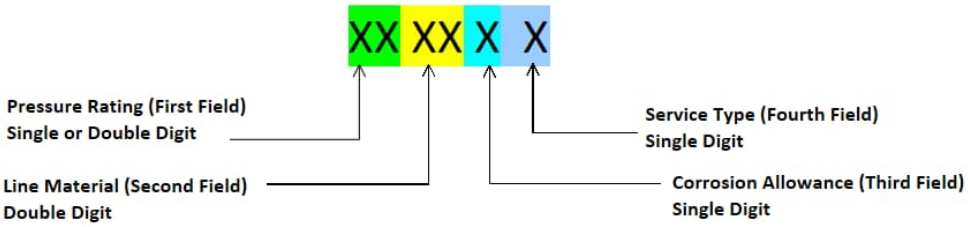
2.1 NOMENCLATURE

2.1.1

2.1.1 Line Class Designation System

A. The following system establishes procedures used for identifying new line classes. The base piping line class designator system consists of four alpha-numeric fields containing one or two characters each.

B. Each field describes various features of the piping line class.



Pressure Rating (First Field)- Single or Double Digit	
Symbol	Nominal Pressure Rating or Class
1	150
3	300
6	600
06	PN 06 (6 barg)
10	PN 10 (10 barg)
16	PN 16 (16 barg)
20	PN 20 (20 barg)

Line Material (Second Field)- Double Digit

Symbol	Material
CS	Carbon Steel
CG	Galvanized Carbon Steel
SD	Type 316/316L Stainless Steel
SP	Duplex Stainless Steel (UNS S32205/ S31803)
SY	Super Duplex Stainless Steel (UNS S32750)
FE	Glass Fiber Reinforced Epoxy (GRE)
FE	Glass reinforced Vinylester
FP	Glass Fiber Reinforced Plastics (GRP)
PE	Polyethylene - HDPE
PV	PolyVinyl Chloride- PVC/ CPVC/ uPVC

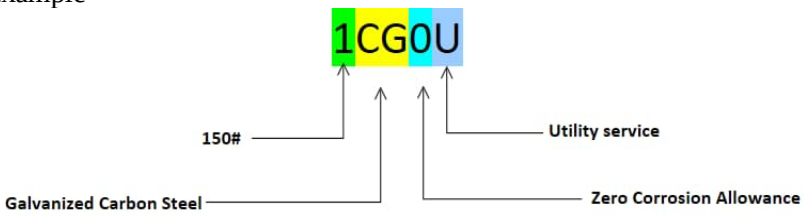
Corrosion Allowance (Third Field)- Single Digit

Symbol	Corrosion Allowance
0	Zero corrosion allowance
1	1.6 mm (1/16”)
2	3.2 mm (1/8”)
9	As noted in individual piping class

Service Type (Fourth Field)- Single Digit

Symbol	Service
P	Process (General Hydrocarbon)
U	Utility

Example



2.1.2 Valve Datasheet Tagging Philosophy

A. Manual valve datasheet tagging consists of 4 parts each with 2 characters (total 8 characters) written together in series as shown below;

“AABBCCDD”

B. First 2 characters “AA” represents valve type.

Symbol	Description
GA	Gate Valve
GL	Globe Valve
BA	Ball Valve
BU	Butterfly Valve
CH	Check Valve

C. Second 2 characters “BB” represents valve rating.

Symbol	Description
01	150#
03	300#
06	600#

D. Third 2 characters “CC” represents MOC of valve-Body.

Symbol	Description
CS	Carbon Steel
SS	Stainless Steel
NB	Nickel Al-Bronze
DI	Ductile Iron

DS	Duplex Stainless Steel
SD	Super Duplex Stainless Steel
PV	Non-Metallic Valves (PP/ CPVC)
BR	Bronze

E. And last 2 characters "DD" represents generic sequence number to differentiate based on different valve requirements.

Symbol	Description
01- 99	Generic sequence number to differentiate based on different valve requirements, such as valve sub type, operation, services, etc.

Example: BA01CS01 - Represents Ball valve with 150#, Carbon Steel Body.

F. For Piping Class Summary refer Appendix A

G. For Piping Class Details Refer Appendix B

H. For Branch Table Details Refer Appendix C

2.2 METALLIC PIPING REQUIREMENT

2.2.1 General

A. Piping general Project requirements shall be as per the requirements stated in Basis of Design, doc. No. 40101-2-JCB-000000-1N0-DI-000002.

B. Minimum pipe size shall be 1/2". Piping sizes shall be in accordance with ASME B36.10M, however sizes 1 ¼", 2 ½", 3 ½", 5" shall not be used unless and until approved by COMPANY.

C. Steel pipes of welded construction shall be 100% radiographed. The weld seam shall be single longitudinal. ERW pipe shall not be used in On-plot piping in accordance with ASME B31.3 except for fire water systems.

D. Pre-welding heating requirement are as per section 330 of ASME B31.3 and Post-welding heating requirement are as per section 331 of ASME B31.3. Unless specified otherwise, minimum preheat temperatures for materials of various P-Numbers are to be in accordance with Table 331.1.1 except as provided in Table 331.1.2 and Table 331.1.3. of ASME B31.3. Where minimum distance between joints and/or joint and branch tap off could not be maintained PWHT is required, irrespective of pipe wall thickness.

E. All welders, welding operators shall be qualified in accordance with the ASME SEC IX for all welding, including tack, temporary, and repair welds.

F. The test records of all welders and welding operators shall be available at the work location for review by COMPANY. Performance qualification tests shall not be performed on production joints.

G. When Charpy V-notch impact testing is a requirement, it shall be conducted in accordance with ASTM A370.

H. Positive material identification (PMI) is required for all SS piping bulk materials.

I. When a line connects to systems with different pressure classifications, the valves installed in lines shall be of higher-pressure classification. The specification break will take place on the downstream side of the pressure reducing device.

J. Welding of dissimilar material shall be avoided. Flanged connection is to be introduced at junction point of specification break due to dissimilar material.

K. Steel flanges pressure-temperature rating as per ASME B16.5.

L. Standard branch connections shall be made in accordance with the branch connection tables refer Appendix-C Branch Table. Additional branch fittings may be used for design flexibility and stress consideration subjected to approval from COMPANY.

M. For all vent, drain (except hydrotest vent/ drain) and Instrument connection details refer Project P&ID's. Vent and drain size shall be of minimum 1" for pipe sizes 3" and above, ¾" for pipe sizes 2" and below. Vents and drains without downstream connections (e.g. hydrotest drain/ vent) shall be blinded after hydrotest.

N. Blinds, spacers and spectacle blinds shall conform to ASME B16.48 and as dictated by the individual piping line classes.

O. Spectacle blinds shall have the same contact surface finish as flanges.

P. Pressure testing shall be in accordance with ASME B31.3 except for the fire water system, which shall be to NFPA 24.

Q. All non-metallic piping with metallic valves shall have independent supports and shall not be supported using pipes.

R. Piping in oxygen services shall follow design standard CGA G-4.4. Underground piping for oxygen/ propane services shall be fully butt welded.

S. For all flange bolting the Contractor shall ensure that the bolts are tightened in the correct alternating sequence using the correct torque wrenches/ hydraulic tensioning equipment. The method of tightening shall be submitted as a written procedure for approval.

2.2.2 Pipes

A. The pipe dimensions shall be in accordance with ASME B36.10M for carbon steel and ASME B36.19M for stainless steel materials.

B. Steel pipes (2” and above) except galvanized shall be supplied with beveled ends. Pipes below 2” diameter shall be supplied with plain ends (except galvanized pipe). Big bore pipes (3" and above) in galvanized piping class should be procured ungalvanized and HDG to be carried out after spool fabrication. Length for CS Galvanized pipe shall in Single Random Length.

C. Beveled ends shall be in accordance with ASME B16.25. Flame cut weld bevel ends are not permitted. Plain end pipes, if mentioned, shall have ends square cut with burrs removed.

D. Carbon steel pipes shall be fully killed and fine grained and supplied in normalized condition. Hot finished pipe need not be heat treated.

E. For gas services using CS material, Process verification required for any potential low temperature (below -29 Deg C) during upset/ uncontrolled depressurization. Provided the scenario is credible, LTCS piping shall be considered. However, this requirement is not envisaged in this project.

F. All Stainless-Steel pipes shall be supplied in solution annealed condition and dual certified as SS316/316L.

G. Steel pipes with sizes 3” and above shall be supplied in double random lengths and for sizes 2” and below shall be supplied in single random lengths.

H. For pipes specified as “galvanized”, galvanizing shall be in accordance with ASTM A123.

2.2.3 Fittings

A. Piping fittings shall have dimensions as per ASME B16.9 or MSS SP-75 as applicable.

B. Integrally reinforced forged branch fittings such as Sockolet, Weldolet etc. shall be as per MSS-SP 97. Fittings not covered in ASME B16.9 and MSS-SP-97 shall conform to manufacturer’s standard.

C. Butt welding end details shall be as per ASME B16.25.

D. For fittings specified as “galvanized”, galvanizing shall be in accordance with ASTM A123.

E. Stainless steel SS316 material when used shall be dual grade i.e, SS316/316L.

F. Carbon steel fittings shall be ASTM A234 WPB and for Stainless steel ASTM A403 WP316/316L.

G. Elbows shall be long radius type (radius equal to 1.5 times NPS).

H. For steel piping, all forged fittings shall be normalized. Caps shall be seamless. Tees shall be forged or extruded. Fabricated Tees (made by joining two pipes) are not acceptable. All threaded plugs shall be solid steel plugs.

I. Swage nipples (concentric/ eccentric) if specified as pipe materials are acceptable in forging materials (up to 1½") and wrought fitting materials (above 1½") also in the corresponding material grades.

J. Branch connections shall be as defined in branch connection table refer Appendix-C.

2.2.4 Flange

A. Carbon steel flanges and other forged items shall be ASTM A105N and stainless steel shall be ASTM A182 F316/316L.

B. Raised face flanges shall have smooth finish giving roughness of Ra 3.2 to 6.3µm. Flat face flanges shall have a stock finish giving roughness of Ra 6.3 to 12.5µm.

C. Metallic flat face flanges shall be used at interface between metallic and nonmetallic piping and equipment with flat face nozzles, wherever specified.

D. Flanges for oxygen/ oxidizing gas service shall be fully cleaned, degreased and packed ready for immediate use.

E. Slip-on flanges shall not be fabricated from blind flanges.

F. Dimensions of 24" flanges and smaller shall comply where applicable with ASME B16.5. Dimensions of 26" flanges and larger shall comply where applicable with ASME B16.47 series A. Dimensionally, ASME B16.47 Series A flanges are identical to MSS SP-44 flanges.

G. During the interface of raised face flange with flat face flange, a full-face gasket along with a metallic backing ring to raised face flange shall be used.

2.2.5 Spectacle Plates Blinds and Blanks

A. The piping design shall include provision for spectacle plates or blanks and spacers at flanged joints as required for pressure testing, for blinding off during repairs or inspection for positive product segregation or for other operating reasons.

B. The surface finish for the gasket seat area shall meet flange dimensional standards (ASME B16.5, ASME 16.47)

C. The design wall thickness of all spectacle blinds and blanks shall be determined in accordance with ASME B31.3. Spectacle plates and blinds shall be in accordance with ASME B16.48 shall be used.

D. Jackscrews shall be used in orifice flanges or joints/ flanged connections with spectacle blinds for pipe sizes above 4 inch. It shall be continuously threaded in accordance with ANSI B1.1, UNC series class 2A fit, may be fabricated by welding nut to stud bolt.

2.2.6 Stud Bolts and Nuts

A. Bolting for flanged joints shall be selected in accordance with ASME B16.5 with bolts in A193 Grade B7 and nuts in A194 Grade 2H.

B. In severe environmental conditions, all bolting shall be supplied with the ceramic fluoropolymer coating.

C. In galvanized piping, bolting used shall be hot dip galvanized in accordance to ASTM A153.

D. Each stud-bolt shall be supplied with minimum two heavy hexagonal nuts unless otherwise specified.

2.2.7 Gaskets

A. All Gaskets shall be in accordance with the pipeline class as well as ASME B16.20 and ASME B16.21. They shall be suitable for the intended service and compatible with the flange facing, rating and bolting.

B. Asbestos shall not be used for non-metallic gaskets or part of metallic gaskets. Use of asbestos in any form is strictly prohibited

C. Dissimilar metals shall be electrically insulated from each other. Insulating Gasket Kit shall be provided for dissimilar material flange connection

D. Flat face flanges shall be provided with full-face gaskets.

E. All Gaskets shall be suitable for the intended service and compatible with the flange facing, rating and bolting. The gasket contact area of the flange shall not be coated.

2.2.8 Valves

A. Valves shall be selected in accordance with the Project P&ID’s and piping classes listed in the Appendix-B.

B. Valves used in firewater services shall be full port design.

C. All valves shall comply with technical requirements and shall be manufactured and supplied in line with and respective valve datasheets.

2.3 NON-METALLIC PIPING REQUIREMENT

A. Non-metallic piping shall be compatible with the fluid service and shall not be subjected to excessive temperature, shock, vibration and pulsation in all fluid service.

B. For non-metallic piping, minimum pipe size shall be 1” and shall follow supplier/manufacturer's recommendation for length of pipes

C. Additional protection shall be provided to ensure the integrity of the system against physical damage. Markers indicating the location of the buried pipe shall be installed at intervals not exceeding 30 m. Piping joints shall be clear of concrete anchor blocks.

D. Non-metallic piping shall have built-in protection from Ultraviolet (UV) light if it is exposed to sunlight.

E. Non-Metallic piping shall not exceed the recommended temperature limits addressed in Table A323.4.2c of ASME B31.3.

F. Materials used in Potable water service shall be in accordance with NSF 61 and for firewater shall be UL/ FM approved.

G. Non-metallic gaskets shall be in accordance with ASME B16.21.

H. Flanges shall have pressure rating equal to or greater than the non-metallic piping pressure rating. Threaded flanges shall not be used on non-metallic piping systems, washers shall be used for bolting non-metallic flanges. Flat washers shall be used under nuts and bolt heads.

I. Material for bolts shall be ASTM A307 Grade A or B and for nuts ASTM A563 Grade A shall be used. Diameters and lengths of stud bolts shall be in accordance with material requisition and shall comply with standards ASME B16.5 (for flanges 24" and smaller), ASME B16.47 Series A (for flanges 26" to 60”), Manufacturer standards with design calculation verified by 3rd party (for flanges 64" to 80”).

J. Transition from non-metallic to metallic piping shall be done in a manner that the weight of metallic piping shall not be transferred to non-metallic piping.

2.3.1 GRE/GRP Piping Requirement

A. Dimensions and surface finishes of pipes shall be measured in accordance with ASTM D3567.

B. All pipe, fittings and flanges shall be manufactured and supplied by the same manufacturer to avoid incompatibility due to intermixing of products from different manufacturers.

C. The Supplier will provide full time representative(s)/inspector(s) for inspecting the installation including lamination works on site and pressure testing of piping to ensure full compliance with the installation procedures recommended by the Manufacturer/ Supplier.

D. GRE/GRP in sewer flow shall be 45 deg turning wherever possible. Fittings such as flanges, bends, tees, junctions and reducers shall be equal or superior in performance to the pipe of the same diameter and pressure. All fittings shall have a smooth internal surface with similar wall construction.

E. All flanges, bends, reducers, tees, wyes and other fittings may be compression-moulded, manufactured from mitered section of pipe, or manufactured by the filament wound process, using epoxy resin and fiberglass reinforcement such that the resistance to chemical attack, the pressure rating, and the temperature rating, are equal to or better than that of the pipe.

F. Flange bolt hole sizes and the number of bolt holes and bolt hole circles for up to 24” pipe size shall comply with ASME B16.5. For flanges above 24" it shall match with ASME B16.47 Series A and for flanges above 64" shall as per manufacturing standards with design calculation and shall submit the 3rd party verification of design calculation.

G. For flanges larger than 1000 mm in diameter for each size a design calculation, be submitted as a substitute to the Short-Term Rupture Strength test, described in ASTM D4024.

H. All fittings shall be fabricated in the factory to ensure quality control. Complex fittings arrangements may be pre-assembled by the pipe Manufacturer in the factory such that field joints are kept to a minimum.

I. Joints between pipes and pipe fittings shall bell and spigot joint for sizes up to 30” and butt-wrap type joint above 30” sizes and shall assure quality jointing even in difficult site condition. However, manufacturer's recommendation shall be considered for selecting the suitable joints for the applicable sizes and rating.

J. Piping systems, including pipe, fittings, jointing systems and adhesives, specified for dedicated fire water systems, shall be UL listed or FM approved. A test certificate shall be submitted. The seal or mark of the certifying organization shall be indicated on the pipe. Fire water piping system design and construction should comply with the SAF requirements for HCIS.

K. Pressure testing for the fire water system shall be in accordance with NFPA 24. In firewater application, GRE material shall be designed considering velocity limitation of 2.5 m/s under normal flow conditions and maximum velocity of 5.0 m/s when a pump is operating at 150% of rated capacity.

L. Materials shall have stable mechanical properties up to 65 Deg C/ 150 Deg F. Pipes for above ground application shall be tested in accordance with ASTM D2925.

2.3.2 HDPE Piping Requirement

A. HDPE piping material design, dimensions, manufacturing, installation shall be in accordance with ISO 4427 part 1 to 5- Plastics Piping Systems - Polyethylene (PE) pipes and fittings for water supply.

B. HDPE adaptor flanges shall be fabricated to match end flange dimensions ASME B16.5.

C. Joints between pipes and pipe fittings shall electro fusion/ Butt fusion type and shall assure quality jointing even in difficult site condition. However, manufacturer's recommendation shall be considered for selecting the suitable joints for the applicable sizes and rating. After joining is made, the pipe shall not be disturbed in any manner.

D. Segmented HDPE fittings shall not be used unless prior approval from Company is obtained. HDPE flanges specifications shall be identical with valves flanges.

E. HDPE pipes and fittings shall be covered and protected against weather during storage and handling.

F. Each length of pipe shall be inspected for crack and other defects before installation.

G. All pipe, fittings and flanges shall be manufactured and supplied by the same manufacturer to avoid incompatibility due to intermixing of products from different manufacturers.

H. All flanges and bolts inside valve boxes shall be wrapped with pipe wrap roll. HDPE pipes and fittings with gases, nicks, abrasion or any such physical damage which may have occurred during storage and handling which are wider or deeper than 10% of the wall thickness shall not be used and must be removed from the construction site.

2.3.3 uPVC Piping Requirement

A. uPVC pipes and fittings shall be manufactured in accordance to DIN 8061/62 or SSA 14/15 by an approved pipe Manufacturer in a purpose-built facility to produce such materials. The Manufacturer/ Supplier shall have experience in the production of similar pipe and pipe fittings of sizes and lengths. Evidence of previous experience shall be presented to the Contractor during the bidding stage.

B. The uPVC pipe materials manufacturer shall be responsible for the following:

i. Manufacture and supply of the uPVC pipes, fittings and accessories. The Manufacturer shall provide general recommendations on installation requirements.

ii. To give technical assistance to the Contractor if necessary on the method of installation of pipes and fittings as per the manufacturer's recommendation.

iii. Inspection and testing.

iv. Marking of pipe for identification.

v. Provision of a Site Supervisor(s) to assist the Contractor during erection as applicable.

C. Joints between pipes and pipe fittings shall Solvent weld joint and shall assure quality jointing even in difficult site condition. However, manufacturer's recommendation shall be considered for selecting the suitable joints for the applicable sizes.

D. Non-pressure pipe systems installed are tested to low pressures for a specific period (leakage tests) as per manufacture/ supplier recommendations.

E. Inspection and testing requirements shall be in accordance with BS EN 1401 standards.

2.4 PIPING SPECIALTY ITEMS

A. Piping specialty items are engineered items not found in the piping material line classes. Data sheet for individual piping specialty item will be used for enquiry and purchase. The data sheet

shall include information on the design/ operating conditions, flow rates, material requirements, connection methods and other relevant data.

2.5 PAINTING AND COATING

A. All material shall be painted and coated for corrosion as per ISO 12944 Class C4. For all corrosion protection coatings, the Supplier's instructions shall be followed. Any damage to a surface coating that occurs during installation or commissioning shall be repaired following the Supplier's recommended procedure.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. 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 the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 50 mm above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. PVC or Steel Pipe Sleeves: For pipes smaller than DN 150.
b. Steel Sheet Sleeves: For pipes DN 150 and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Plastic Piping Solvent Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

H. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to manufacturer’s recommendation.

1. Plain-End PE Pipe and Fittings: Use butt fusion.
2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install flanges, in piping DN 50 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.4 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

   1. Stenciled Markers: According to ASME A13.1.
   2. Plastic markers, with application systems. Install on insulation segment if required for hot no insulated piping.
   3. Locate pipe markers on exposed piping according to the following:

      a. Near each valve and control device.
      b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
      c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
      d. At manholes and similar access points that permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.

APPENDICES

Appendix A: PIPING CLASS SUMMARY

Fluid	Fluid Code	Pipe Material	Pipe Spec	Operating Pressure	Operating Temp	Design Pressure (Note 2)	Design Temp
Fire Water	FW	CS	1CS1U	10	Ambient	16	85
		HDPE	16PE0U	10	Ambient	Note 1	Note 1
Potable Water	PW	SS	1SD0U	5	Ambient	16	85
		HDPE	16PE0U	5	Ambient	16	Note 1
Sanitary Sewerage	SS	GRE	10FE0U	0.5	Ambient	10	65
		HDPE	10PE0U	0.5	Ambient	10	Note 1
Compressed Air	CA	CS	1CG0U	10	40	15	65
Chilled Water Supply (network)	CHS	CS	1CS1Z	6	7	16	85
Chilled Water Return (network)	CHR	CS	1CS1Z	4	12	16	85
Chilled Water Supply (Inside plant)	CHS	CS	1CS1U	6	7	16	85
Chilled Water Return (Inside plant)	CHR	CS	1CS1U	4	12	16	85
Process Waste Water	PWW	HDPE	10PE0U	0.5	Ambient	10	Note 1
Cooling Water Supply	CWS	GRE	16FE0U	6	30	16	65
Cooling Water Return	CWR	GRE	16FE0U	4	40	16	65
Treated Process Water	TPW	GRE	16FE0U	10	Ambient	16	85
		HDPE	16PE0U	10	Ambient	Note 1	Note 1
Irrigation Water	IW	GRE	16FE0U	4	Ambient	16	65
		HDPE	16PE0U	4	Ambient	16	Note 1
Drain	DR	CS	1CS1U	1	Ambient	3.5	85
Vent	VT	CS	1CS1U	1	Ambient	3.5	85

Appendix B: PIPING CLASS DETAILS

PIPE CLASS : 1CG0U

Line Class: 1CG0U Service: Refer Appendix-A (Pipe Class Summary) Rating Class: 150# FF, ASME B16.5 Temperature Limit: 0 to 85°C Corrosion Allowance: 0 mm			Basic Material: Galvanized/ Carbon Steel Design Code: ASME B31.3 Stress Relief: Not Required Examination: As per applicable Code Buttweld Construction: ASME B16.25		
Item	**NPS**	**Rating/ Schedule**	**Type**	**Specification**	**Notes**
PIPE	2" and below	Sch 40	Smls, threaded	ASTM A53 Gr. B/ ASTM A106 Gr. B Galvanized	
	3" - 6"	Sch 40	Smls	ASTM A53 Gr. B/ ASTM A106 Gr. B	3
	8" - 12"	Sch 20	Smls	ASTM A53 Gr. B/ ASTM A106 Gr. B	3
	14" - 24"	Sch 10	Smls	ASTM A53 Gr. B/ ASTM A106 Gr. B	3
NIPPLES	2" and below	Sch 40	Seamless	ASTM A53 Gr. B/ ASTM A106 Gr. B Galvanized	
THREADED FITTINGS Caps, Elbows, Tees, Couplings, Plugs	2" and below	Class 3000		ASTM A105N Galvanized, Threaded, ASME B16.11	
UNIONS	2" and below	Class 3000		ASTM A105N Galvanized, Threaded, ASME B16.11	
SWAGED NIPPLES	2" and below	Sch. 80	Seamless	ASTM A53 Gr. B/ ASTM A106 Gr. B Galvanized	
BOSSES/ THREADOLET	2" and below	Class 3000		ASTM A105N Galvanized, Threaded female outlet	
BUTT WELD FITTINGS Elbows, Tees, Caps, Reducers	3" - 24"	Match pipe		ASTM A234 Gr.WPB, ASME B16.9	3
FLANGE BLIND FLANGE Slip on	2" and below	Class 150	FF	ASTM A105N Galvanized, Threaded, ASME B16.5	
	3" - 24"	Class 150	FF	ASTM A105N, ASME B16.5	3
	2" and below	Class 300	FF	ASTM A105N Galvanized, Threaded, ASME B16.5	4
	3" - 24"	Class 300	FF	ASTM A105N, ASME B16.5	3, 4
SPEC. BLINDS	3" - 24"	Class 150	FF	ASTM A516 Gr. 60, ASME B16.48	3
GASKETS	All sizes	Class 150	1.6 mm Compressed Synthetic fiber		1
		Class 300	1.6 mm Compressed Synthetic fiber		1, 4
BOLTING	Below 1½"	Class 150	Mild steel machine bolts/ square heads and hex nuts to ASTM A307 Gr. B coated with Hot dip galvanised as per ASTM A153.		
	1½" and above		ASTM A193 B7 stud bolts, semi-finished, heavy pattern ASTM A194 2H hex nuts coated with Hot dip galvanised as per ASTM A153.		
	Below 1½"	Class 300	Mild steel machine bolts/ square heads and hex nuts to ASTM A307 Gr. B coated with Hot dip galvanised as per ASTM A153.		4
	1½" and above		ASTM A193 B7 stud bolts, semi-finished, heavy pattern ASTM A194 2H hex nuts coated with Hot dip galvanised as per ASTM A153.		4
GLOBE VALVE	2" and below	Class 800	Threaded	BB, OS&Y, Swivel Plug Disc Type, Valve MOC as per datasheet	
	3" and above	Class 150	FF Flanged	BB, OS&Y, Swivel Plug Disc Type, Valve MOC as per datasheet	
CHECK VALVE	2" and below	Class 800	Threaded	Horizontal Piston Type, Valve MOC as per datasheet	

PIPE CLASS : 1CG0U

Line Class: 1CG0U	Basic Material: Galvanized/ Carbon Steel
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 150# FF, ASME B16.5	Stress Relief: Not Required
Temperature Limit: 0 to 85°C	Examination: As per applicable Code
Corrosion Allowance: 0 mm	Buttweld Construction: ASME B16.25

Item	NPS	Rating/ Schedule	Type	Specification	Notes
	3" and above	Class 150	FF Flanged	Dual Plate, Wafer Lug Thru. Bolt, Valve MOC as per datasheet	
BALL VALVE	2" and below	Class 800	Threaded	Floating Ball Type, Valve MOC as per datasheet	
	2"	Class 300	FF Flanged	Floating Ball Type, Valve MOC as per datasheet	4
	3" - 4"	Class 150	FF Flanged	Floating Ball Type, Valve MOC as per datasheet	
	6" and above	Class 150	FF Flanged	Trunnion Mounted type, Valve MOC as per datasheet	
BUTTERFLY VALVE	4" and above	Class 150	FF Flanged	Concentric disc type, Double Flanged, Valve MOC as per datasheet	

Notes

1 For flat face flanges, use full face gaskets.
2 Refer Appendix-C for Branch Table - Metallic Piping.
3 Pipes, flanges and fittings of sizes 3" and above shall be Hot dip galvanised after spool fabrication. For distribution network pipe to pipe connection galvanised pipe will be used with field weld joints and local galvanising of the weld joint subject to company approval.
4 To be used to match with the Instrumentation/ Equipment Connections of Class 300# rating.

PIPE CLASS : 1CS1U

Line Class: 1CS1U	Basic Material: Carbon Steel
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 150# RF, ASME B16.5	Stress Relief: As per design Code
Temperature Limit: 0 to 85°C	Examination: As per design Code
Corrosion Allowance: 1.6 mm	Buttweld Construction: ASME B16.25

Item	NPS	Rating/ Schedule	Type	Specification	Notes
PIPE	3/4" - 1½"	Sch STD	Smls/ERW	ASTM A106 Gr. B / A53 Type E Gr.B suitable for Grooved coupling	
	2"	Sch STD	Smls/ERW	ASTM A106 Gr. B / A53 Type E Gr.B suitable for Grooved coupling	
	3" - 24"	Sch STD	Smls/ERW	ASTM A106 Gr. B / A53 Type E Gr.B suitable for Grooved coupling	
NIPPLES	3/4" - 1½"	Sch XS	Socketweld	ASTM A106 Gr. B /A53 Type E Gr.B /A197 B16.3	
SWAGES	3/4" - 1½"	Sch XS	Socketweld	ASTM A234 Gr.WPB, MSS SP-95 / A53 Type E Gr.B /A197	
FITTINGS Elbows, Tees, Caps, Couplings, etc.	3/4" - 1½"	Class 3000	Socketweld / Grooved	ASTM A105N, B16.11 / ASTM A536, 65-45-12 ANSI/ UL 213C / A197 B16.3	
	2" - 24"	Match pipe	Buttweld	ASTM A234 Gr.WPB, ASME B16.9 / ASTM A536, 65-45-12 ANSI/ UL 213C/ A197 B16.3	1
FLANGE BLIND FLANGE	3/4" - 1½"	Class 150	Socketweld/ Grooved RF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	
	2" - 24"	Class 150	Weldneck/ Grooved RF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	1
	3/4" - 1½"	Class 150	Socketweld/ Grooved FF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	3
	2" - 24"	Class 150	Weldneck/ Grooved FF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	3
	3/4" - 1½"	Class 300	Socketweld/ Grooved FF/RF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	4
	2" - 24"	Class 300	Weldneck/ Grooved RF/FF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	4
SPEC. BLINDS	2" - 12"	Class 150	FF	ASTM A516 Gr. 60, ASME B16.48 / ASTM A536, 65-45-12	
SPACER & BLANK	14" - 24"	Class 150	FF	ASTM A516 Gr. 60, ASME B16.48 / ASTM A536, 65-45-12	
SOCKOLETS	3/4" - 1½"	Class 3000	Socketweld	ASTM A105N, MSS SP-97	
WELDOLETS	2" and Above	Match pipe	Buttweld	ASTM A105N, MSS SP-97	
COUPLING	3/4" - 24"	Match pipe	Bolted	ASTM A 536 65-45-12, UL213C	
BOLTING	All sizes	Class 150	ASTM A193 B7 stud bolts with ASTM A194 2H heavy hex nuts with Ceramic Fluoropolymer Coating		
		Class 300	ASTM A193 B7 stud bolts with ASTM A194 2H heavy hex nuts with Ceramic Fluoropolymer Coating		4
GASKETS	All sizes	Class 150	Spiral-wound, 316 SS windings, flexible graphite filled, with CS outer ring, 4.5mm Thk, B16.20		
		Class 300	Spiral-wound, 316 SS windings, flexible graphite filled, with CS outer ring, 4.5mm Thk, B16.20		4
BALL VALVE	3/4" - 1½"	Class 800	Socketweld	Floating Ball Type, Full Bore, Valve MOC as per datasheet	
	2" - 4"	Class 150	RF Flanged	Floating Ball Type, Full Bore, Valve MOC as per datasheet	
GATE VALVE	2" and above	Class 150	RF Flanged	BB, OS&Y, Solid/ Flexible Wedge, Graphite packing, Full Port, Valve MOC as per datasheet	
CHECK VALVE	2" and above	Class 150	RF Flanged	Dual Plate, Wafer Lug Thru. Bolt, Full Port, Valve MOC as per datasheet	

Notes

1 Schedule of fittings and flanges shall be same as to match pipe.

2 Piping systems, including pipe, fittings, jointing systems and adhesives, specified for dedicated fire water systems, shall be UL listed or FM approved. A test certificate shall be submitted. The seal or mark of the certifying organization shall be indicated on the pipe. Fire water piping system design and construction should comply with the SAF requirements for HCIS.

3 To be used if metal to non-metallic flange interface is required and shall be provide with Full face gasket.

PIPE CLASS : 1CS1U

Line Class: 1CS1U			Basic Material: Carbon Steel			
Service: Refer Appendix-A (Pipe Class Summary)			Design Code: ASME B31.3			
Rating Class: 150# RF, ASME B16.5			Stress Relief: As per design Code			
Temperature Limit: 0 to 85°C			Examination: As per design Code			
Corrosion Allowance: 1.6 mm			Buttweld Construction: ASME B16.25			
Item	**NPS**	**Rating/ Schedule**	**Type**	**Specification**		**Notes**
4 To be used to match with the Instrumentation/ Equipment Connections of Class 300# rating.						

PIPE CLASS : 1CS1Z

Line Class: 1CS1Z	Basic Material: Carbon Steel (pre insulated)
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 150# RF, ASME B16.5	Stress Relief: As per design Code
Temperature Limit: 0 to 85°C	Examination: As per design Code
Corrosion Allowance: 1.6 mm	Buttweld Construction: ASME B16.25

Item	NPS	Rating/ Schedule	Type	Specification	Notes
PIPE	3/4" - 1½"	Sch STD	Smls/ERW	ASTM A106 Gr. B / A53 Type E Gr.B suitable for Grooved coupling	
	2" - 4"	Sch STD	Smls/ERW	ASTM A106 Gr. B / A53 Type E Gr.B suitable for Grooved coupling	
	6" - 24"	Sch STD	Smls/ERW	ASTM A106 Gr. B / A53 Type E Gr.B suitable for Grooved coupling, pre insulated pipe	
NIPPLES	3/4" - 1½"	Sch XS	Socketweld	ASTM A106 Gr. B /A53 Type E Gr.B /A197 B16.3	
SWAGES	3/4" - 1½"	Sch XS	Socketweld	ASTM A234 Gr.WPB, MSS SP-95 / A53 Type E Gr.B /A197	
FITTINGS Elbows, Tees, Caps, Couplings, etc.	3/4" - 1½"	Class 3000	Socketweld / Grooved	ASTM A105N, B16.11 / ASTM A536, 65-45-12 ANSI/ UL 213C/ A197 B16.3	
	2" - 24"	Match pipe	Buttweld	ASTM A234 Gr.WPB, ASME B16.9 / ASTM A536, 65-45-12 ANSI/ UL 213C/ A197 B16.3, preinsulated fittings (6" & above)	1
FLANGE BLIND FLANGE	3/4" - 1½"	Class 150	Socketweld/ Grooved RF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	
	2" - 24"	Class 150	Weldneck/ Grooved RF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	1
	3/4" - 1½"	Class 150	Socketweld/ Grooved FF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	3
	2" - 24"	Class 150	Weldneck/ Grooved FF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	3
	3/4" - 1½"	Class 300	Socketweld/ Grooved FF/RF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	4
	2" - 24"	Class 300	Weldneck/ Grooved RF/FF	ASTM A105N, ASME B16.5 / ASTM A536, 65-45-12 ANSI/ UL 213C/A197	4
SPEC. BLINDS	2" - 12"	Class 150	FF	ASTM A516 Gr. 60, ASME B16.48 / ASTM A536, 65-45-12	
SPACER & BLANK	14" - 24"	Class 150	FF	ASTM A516 Gr. 60, ASME B16.48 / ASTM A536, 65-45-12	
SOCKOLETS	3/4" - 1½"	Class 3000	Socketweld	ASTM A105N, MSS SP-97	
WELDOLETS	2" and Above	Match pipe	Buttweld	ASTM A105N, MSS SP-97	
COUPLING	3/4" - 24"	Match pipe	Bolted	ASTM A 536 65-45-12, UL213C	
BOLTING	All sizes	Class 150	ASTM A193 B7 stud bolts with ASTM A194 2H heavy hex nuts with Ceramic Fluoropolymer Coating		
		Class 300	ASTM A193 B7 stud bolts with ASTM A194 2H heavy hex nuts with Ceramic Fluoropolymer Coating		4
GASKETS	All sizes	Class 150	Spiral-wound, 316 SS windings, flexible graphite filled, with CS outer ring, 4.5mm Thk, B16.20		
		Class 300	Spiral-wound, 316 SS windings, flexible graphite filled, with CS outer ring, 4.5mm Thk, B16.20		4
BALL VALVE	3/4" - 1½"	Class 800	Socketweld	Floating Ball Type, Full Bore, Valve MOC as per datasheet	
	2" - 4"	Class 150	RF Flanged	Floating Ball Type, Full Bore, Valve MOC as per datasheet	
GATE VALVE	2" and above	Class 150	RF Flanged	BB, OS&Y, Solid/ Flexible Wedge, Graphite packing, Full Port, Valve MOC as per datasheet	
CHECK VALVE	2" and above	Class 150	RF Flanged	Dual Plate, Wafer Lug Thru. Bolt, Full Port, Valve MOC as per datasheet	

Notes

1 Schedule of fittings and flanges shall be same as to match pipe.

2 Piping systems, including pipe, fittings, jointing systems and adhesives, specified for dedicated fire water systems, shall be UL listed or FM approved. A test certificate shall be submitted. The seal or mark of the certifying organization shall be indicated on the pipe. Fire water piping system design and construction should comply with the SAF requirements for HCIS.

3 To be used if metal to non-metallic flange interface is required and shall be provide with Full face gasket.

PIPE CLASS : 1CS1Z

Line Class: 1CS1Z	Basic Material: Carbon Steel (pre insulated)
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 150# RF, ASME B16.5	Stress Relief: As per design Code
Temperature Limit: 0 to 85°C	Examination: As per design Code
Corrosion Allowance: 1.6 mm	Buttweld Construction: ASME B16.25

Item	NPS	Rating/ Schedule	Type	Specification	Notes
4 To be used to match with the Instrumentation / Equipment Connections of Class 300# rating.					
5 Insulation thickness to be confirmed later.					

PIPE CLASS : 1SD0U

Line Class: 1SD0U	Basic Material: 316/ 316L Stainless Steel (Dual Grade)
Service: Refer Appendix-A (Pipe Class Summary)	Code: ASME B31.3
Rating Class: 150# RF	Stress Relief: As per design Code
Temperature Limit: 0 to 65°C	Examination: As per design Code
Corrosion Allowance: 0 mm	Buttweld Construction: ASME B16.25

Item	NPS	Rating/ Schedule	Type	Specification	Notes
PIPE	2" and below	SCH 40S	Seamless	ASTM A312 TP 316/316L	3
	3" to 24"	SCH 10S	Seamless/ Welded	ASTM A312 TP 316/316L or ASTM A358 Gr 316/316L	3
FITTINGS El's, Tees, Reducers, Caps, Couplings, etc.	1½" and below	Class 3000	Socketweld	ASTM A182 F316/316L, ASME B16.11	4
	2" to 24"	Match pipe	Buttweld	ASTM A403 WP316/316L, Seamless, ASME B16.9	1
SWAGES	1½" and below	Sch 40S	Threaded	ASTM A403 WP316/316L, Seamless, MSS SP-95	
NIPPLES	1½" and below	Sch 40S	Threaded	ASTM A312 TP 316/316L, Seamless	
THREADOLETS	1½" and below	Class 3000	Threaded	ASTM A182 F316/316L, MSS SP-97	
FLANGE BLIND FLANGE	1½" and below	Class 150	Threaded RF	ASTM A182 F316/316L, ASME B16.5	
	2"	Class 150	Weldneck RF	ASTM A182 F316/316L, ASME B16.5	
BOLTING	All sizes	Class 150	ASTM A193 B7 stud bolts with ASTM A194 2H heavy hex nuts with Ceramic Fluoropolymer Coating		
GASKETS	All sizes	Class 150	Spiral-wound, 316 SS windings, flexible graphite filled with 316 SS steel outer ring, 4.5mm Thk, as per ASME B16.20		
BALL VALVE	1½" and below	Class 800	Threaded	Floating Ball Type, Valve MOC as per datasheet	

Notes

1 Schedule of fittings and flanges to be same as pipe.
2 Refer Appendix-C for Branch Table - Metallic Piping.
3 For buried piping protective-visco-wrap coating shall be applied as per Painting and Coating Specification.
4 Coupling end connection type can be selected to meet the matching end type requirement eg, one end socketweld and other end

PIPE CLASS : 10FE0U

Line Class: 10FE0U Service: Refer Appendix-A (Pipe Class Summary) Rating Class: 10 barg/ 150# FF Temperature Limit: 0 to 65°C Corrosion Allowance: 0 mm	Basic Material: Glass Reinforced Epoxy (GRE) Design Code: ASME B31.3 Stress Relief: Not Applicable Examination: As per Supplier Joint Constuction: Below 30" use Bell and Spigot For 30" & above use Butt & Wrap

Item	NPS	Rating/ Schedule	Type	Specification	Notes
PIPE	1" - 48"	10 barg		GRE, ASTM D2996	1 - 18
	50" - 80"	10 barg		GRP/GRV, AWWA C950	1 - 18
FITTINGS	1" - 80"	10 barg		ASTM D5685, ASTM D3567	1 - 18
FLANGE BLIND FLANGE	1" - 24"	Class 150	FF	GRE Flange, dimension to match ASME B16.5	1 - 19
	26" - 48"	Class 150	FF	GRE Flange, dimension to match ASME B16.47 Series A	1 - 19
	50" - 60"	Class 150	FF	GRP Flange, dimension to match ASME B16.47 Series A	1 - 19
	64" - 80"	Class 150	FF	GRP/GRV Flange, dimension to match MFG Standard.	1 - 19
	1" - 24"	Class 300	FF	GRE Flange, dimension to match ASME B16.5	1 - 19, 20
GASKETS (Note-11)	1" - 24"	Class 150	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match ASME B16.5		1 - 18
	26" - 60"	Class 150	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match ASME B16.47 Series A		1 - 18
	64" - 80"	Class 150	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match MFG Standard.		1 - 18
	1" - 24"	Class 300	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match ASME B16.5		1 - 18, 20
BOLTING	All sizes	Class 150	ASTM A307 Grade A or B bolts with ASTM A563 Grade A heavy hex nuts with Ceramic Fluoropolymer Coating		1 - 18
		Class 300	ASTM A307 Grade A or B bolts with ASTM A563 Grade A heavy hex nuts with Ceramic Fluoropolymer Coating		1 - 18, 20
GATE VALVE	1" and above	Class 150	FF, Flanged	BB, OS&Y, Solid/ Flexible Wedge, Graphite packing, Valve MOC as per datasheet	1 - 18
CHECK VALVE	1" - 1 1/2"	Class 150	FF, Flanged	Horizontal Piston Type, Valve MOC as per datasheet	1 - 18
	2" and above	Class 150	FF, Flanged	Dual Plate, Wafer Lug Thru. Bolt, Valve MOC as per datasheet	1 - 18
BALL VALVE	1" to 4"	Class 150	FF, Flanged	Floating Ball Type, Valve MOC as per datasheet	1 - 18
	6" and above	Class 150	FF, Flanged	Trunnion Mounted type, Valve MOC as per datasheet	1 - 18
BUTTERFLY VALVE	4" and above	Class 150	FF, Flanged	Concentric disc type, Double Flanged, Valve MOC as per datasheet	1 - 18

Notes

1. Pipe and couplings shall be filament-wound using epoxy resin and fiberglass reinforcement.
2. Resin shall be suitable for the services specified and shall be noted by the supplier in their proposal. The resin system used for the interior liner, the structural wall, fittings, and adhesives shall be epoxy, with suitable curing agents so that it meets the performance requirements and temperature limits.
3. The structural wall reinforcement shall be of commercial-grade glass fiber, suitable for the services specified, treated with a compatible binder and coupling agent.
4. Resin additives such as pigments, dyes or coloring agents may be used provided they do not adversely affect the performance of the pipe. The pipe must contain a UV inhibitor.
5. Adhesive for bonded joints shall be of a material suitable for the services and design conditions specified. It shall be mutually compatible with the resin used to manufacture the pipe.
6. The chemical composition of the flexible elastomeric seals shall be compatible with the type of service and environment to which it will be subjected.
7. Flanges, bends, reducers, tees, wyes and other fittings may be compression-molded, manufactured from mitered section of pipe, or manufactured by the filament wound process, using thermosetting epoxy resin and fiberglass reinforcement such that the resistance to chemical attack, the pressure rating, and the temperature rating, are equal to or better than that of the pipe.
8. All pipe, fitting, and flange surfaces that are exposed to the fluid shall have a smooth, uniform, resin-rich liner with a minimum thickness of 0.5 mm. The interior liner shall be reinforced with either non-woven polyester fibers or glass veil surfacing mat. Polyester or glass veil liner reinforcement is not required on 100 mm and smaller fittings at the mitered joints, provided all gaps at the joints are filled with resin to act as an effective corrosion barrier and to prevent the presence of any exposed glass fibers.

PIPE CLASS : 10FE0U

Line Class: 10FE0U	Basic Material: Glass Reinforced Epoxy (GRE)
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 10 barg/ 150# FF	Stress Relief: Not Applicable
Temperature Limit: 0 to 65°C	Examination: As per Supplier
Corrosion Allowance: 0 mm	Joint Constuction: Below 30" use Bell and Spigot For 30" & above use Butt & Wrap

9	All machined or cut surfaces shall be post-coated with catalyzed resin, except for bonding surfaces for field points and mechanical RTR (fiberglass) threads. Post-coating shall be performed within four hours of machining or other surface preparation.
10	Adhesive-bonded joints shall be bell-and-spigot type and shall not require a field-applied overwrap to develop the required strength.
11	Compatibility of the elastomeric material with the service shall be confirmed by supplier.
12	All pipe, fittings and flanges for an installation shall be manufactured or supplied by the same manufacturer to avoid incompatibility due to intermixing of products from different manufacturers.
13	Threads shall be per ASME B1.20.1 and shall conform to the requirements of ASME B31.3, paragraph A 314.2.2.
14	Dimensions and surface finishes shall be measured in accordance with ASTM D3567. The average wall thickness of the pipe shall not be less than the nominal wall thickness published in the manufacturer literature, current at the time of purchase. The minimum wall thickness at any point shall not be less than 87.5% of the nominal wall thickness, when measured in accordance with ASTM D3567.
15	Flange bolt hole sizes and the number of bolt holes and bolt hole circles for up to 24" pipe size shall comply with ASME B16.5. For flanges above 24" it shall match with ASME B16.47 Series A and for flanges above 64" shall match with manufacturer standards.
16	Unless otherwise defined, specified face-to-face, centerline-to-face, and centerline-to-centerline dimensions of special fabrications (spools) shall have a tolerance of +6 mm. The lateral offset of flanges from the pipe centerline and rotation of flanges shall be limited to 3 mm. The flange face alignment shall be within 1.5 mm of the required position when measured across the flange face.
17	Refer Appendix-C for Branch Table- Non-Metallic Piping. This is preliminary data, branch connection details and type shall be confirmed based on Supplier recommended branching connection table.
18	All piping that handles potable water shall be disinfected in accordance with governing codes/ standards and local regulations. Materials for drinking water applications shall be in accordance with National Sanitation Foundation (NSF 61)
19	During the interface of flat face flange with raised face flange, a full face gasket along with a metallic backing ring to raised face flange shall be used.
20	To be used to match with the Instrumentation/ Equipment Connections of Class 300# rating.

PIPE CLASS : 16FE0U

Line Class: 16FE0U Service: Refer Appendix-A (Pipe Class Summary) Rating Class: 16 barg/ 150# FF Temperature Limit: 0 to 65°C Corrosion Allowance: 0 mm	Basic Material: Glass Reinforced Epoxy (GRE) Design Code: ASME B31.3 Stress Relief: Not Applicable Examination: As per Supplier Joint Constuction: Below 30" use Bell and Spigot For 30" & above use Butt & Wrap

Item	NPS	Rating/ Schedule	Type	Specification	Notes
PIPE	1" - 48"	16 barg		ASTM D2996	1 - 17
FITTINGS	1" - 48"	16 barg		ASTM D5685, ASTM D3567	1 - 17
FLANGE BLIND FLANGE	1" - 24"	Class 150	FF	GRE Flange, dimension to match ASME B16.5	1 - 18
	26" - 48"	Class 150	FF	GRE Flange, dimension to match ASME B16.47 Series A	1 - 18
	1" - 24"	Class 300	FF	GRE Flange, dimension to match ASME B16.5	1 - 18, 19
GASKETS (Note-11)	1" - 24"	Class 150	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match ASME B16.5		1 - 18
	26" - 48"	Class 150	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match ASME B16.47 Series A		1 - 18
	1" - 24"	Class 300	3.2mm thick Elastomer, full face, 50-60 Durometer, Shore "A", ASME B16.21, To match ASME B16.5		1 - 17, 19
BOLTING	All sizes	Class 150	ASTM A307 Grade A or B bolts with ASTM A563 Grade A heavy hex nuts with Ceramic Fluoropolymer Coating		1 - 17
		Class 300	ASTM A307 Grade A or B bolts with ASTM A563 Grade A heavy hex nuts with Ceramic Fluoropolymer Coating		1 - 17, 19
GATE VALVE	1" and above	Class 150	FF, Flanged	BB, OS&Y, Solid/ Flexible Wedge, Graphite packing, Valve MOC as per datasheet	1 - 17
CHECK VALVE	1" - 1 1/2"	Class 150	FF, Flanged	Horizontal Piston Type, Valve MOC as per datasheet	1 - 17
	2" and above	Class 150	FF, Flanged	Dual Plate, Wafer Lug Thru. Bolt, Valve MOC as per datasheet	1 - 17
BALL VALVE	1" to 4"	Class 150	FF, Flanged	Floating Ball Type, Valve MOC as per datasheet	1 - 17
	6" and above	Class 150	FF, Flanged	Trunnion Mounted type, Valve MOC as per datasheet	1 - 17
BUTTERFLY VALVE	4" and above	Class 150	FF, Flanged	Concentric disc type, Double Flanged, Valve MOC as per datasheet	1 - 17

Notes

1. Pipe and couplings shall be filament-wound using epoxy resin and fiberglass reinforcement.
2. Resin shall be suitable for the services specified and shall be noted by the supplier in their proposal. The resin system used for the interior liner, the structural wall, fittings, and adhesives shall be epoxy, with suitable curing agents so that it meets the performance requirements and temperature limits.
3. The structural wall reinforcement shall be of commercial-grade glass fiber, suitable for the services specified, treated with a compatible binder and coupling agent.
4. Resin additives such as pigments, dyes or coloring agents may be used provided they do not adversely affect the performance of the pipe. The pipe must contain a UV inhibitor.
5. Adhesive for bonded joints shall be of a material suitable for the services and design conditions specified. It shall be mutually compatible with the resin used to manufacture the pipe.
6. The chemical composition of the flexible elastomeric seals shall be compatible with the type of service and environment to which it will be subjected.
7. Flanges, bends, reducers, tees, wyes and other fittings may be compression-molded, manufactured from mitered section of pipe, or manufactured by the filament wound process, using thermosetting epoxy resin and fiberglass reinforcement such that the resistance to chemical attack, the pressure rating, and the temperature rating, are equal to or better than that of the pipe.
8. All pipe, fitting, and flange surfaces that are exposed to the fluid shall have a smooth, uniform, resin-rich liner with a minimum thickness of 0.5 mm. The interior liner shall be reinforced with either non-woven polyester fibers or glass veil surfacing mat. Polyester or glass veil liner reinforcement is not required on 100 mm and smaller fittings at the mitered joints, provided all gaps at the joints are filled with resin to act as an effective corrosion barrier and to prevent the presence of any exposed glass fibers.
9. All machined or cut surfaces shall be post-coated with catalyzed resin, except for bonding surfaces for field points and mechanical RTR (fiberglass) threads. Post-coating shall be performed within four hours of machining or other surface preparation.
10. Adhesive-bonded joints shall be bell-and-spigot type and shall not require a field-applied overwrap to develop the required strength.

PIPE CLASS : 16FE0U

Line Class: 16FE0U	Basic Material: Glass Reinforced Epoxy (GRE)
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 16 barg/ 150# FF	Stress Relief: Not Applicable
Temperature Limit: 0 to 65°C	Examination: As per Supplier
Corrosion Allowance: 0 mm	Joint Constuction: Below 30" use Bell and Spigot For 30" & above use Butt & Wrap

11	Compatibility of the elastomeric material with the service shall be confirmed by supplier.
12	All pipe, fittings and flanges for an installation shall be manufactured or supplied by the same manufacturer to avoid incompatibility due to intermixing of products from different manufacturers.
13	Threads shall be per ASME B1.20.1 and shall conform to the requirements of ASME B31.3, paragraph A 314.2.2.
14	Dimensions and surface finishes shall be measured in accordance with ASTM D3567. The average wall thickness of the pipe shall not be less than the nominal wall thickness published in the manufacturer literature, current at the time of purchase. The minimum wall thickness at any point shall not be less than 87.5% of the nominal wall thickness, when measured in accordance with ASTM D3567.
15	Flange bolt hole sizes and the number of bolt holes and bolt hole circles for up to 24" pipe size shall comply with ASME B16.5. For flanges above 24" it shall match with ASME B16.47 Series A Flanges.
16	Unless otherwise defined, specified face-to-face, centerline-to-face, and centerline-to-centerline dimensions of special fabrications (spools) shall have a tolerance of +6 mm. The lateral offset of flanges from the pipe centerline and rotation of flanges shall be limited to 3 mm. The flange face alignment shall be within 1.5 mm of the required position when measured across the flange face.
17	Refer Appendix-C for Branch Table- Non-Metallic Piping. This is preliminary data, branch connection details and type shall be confirmed based on Supplier recommended branching connection table.
18	During the interface of flat face flange with raised face flange, a full face gasket along with a metallic backing ring to raised face flange shall be used.
19	To be used to match with the Instrumentation/ Equipment Connections of Class 300# rating.

PIPE CLASS : 10PE0U

Line Class: 10PE0U	Basic Material: HDPE
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3
Rating Class: 10barg/ PE-100, SDR-17	Stress Relief: Not Applicable
Temperature Limit: 0 to 40°C	Examination: In accordance with ASME B31.3
Corrosion Allowance: 0 mm	Joint Construction: Electro-Fusion/ Butt Fusion Type

Item		NPS	Rating/ Schedule	Type	Specification	Notes
PIPE		25mm - 450mm	10barg/ PE-100, SDR-11	PE	HDPE, ISO 4427-2	1
FITTINGS		25mm - 450mm	10barg/ PE-100, SDR-11	PE	HDPE, ISO 4427-3	2
LAP JOINT FLANGE BLIND FLANGE		1" – 18"	Class 150	RF	A182 F316/316L, ASME B16.5	3,4
FLANGE ADAPTER		1" – 18"	Class 150	PE	HDPE, PE-100, SDR-11, ISO 4427-2	5
GASKETS	For Chemical Dosing	1" – 18"	Class 150	RF	3.2mm thick PTFE, raised face, ASME B16.21	7,10,13
	For Contaminated Waste water-(U/G)	1" – 18"	Class 150	RF	3.2mm thick Elastomer, raised face, 50-60 Durometer, Shore "A", ASME B16.21	7,10,13
BOLTING		ASTM A307 Grade A or B bolts with ASTM A563 Grade A heavy hex nuts & washers with Ceramic Fluoropolymer Coating				8,9,10
GATE VALVE		1" and above	Class 150	RF, Flanged	BB, OS&Y, Valve MOC as per datasheet	
CHECK VALVE		1" - 1 1/2"	Class 150	RF, Flanged	Horizontal Piston Type, Valve MOC as per datasheet	
		2" and above	Class 150	RF, Flanged	Dual Plate, Wafer Lug Thru. Bolt, Valve MOC as per datasheet	
		1" to 4"	Class 150	RF, Flanged	Ball Check Type, Valve MOC as per datasheet	
BALL VALVE		1" to 4"	Class 150	RF, Flanged	Floating Ball Type, Valve MOC as per datasheet	
		6" and above	Class 150	RF, Flanged	Trunnion Mounted type, Valve MOC as per datasheet	

Notes

1. Joints between pipes and pipe fittings shall electro fusion /Butt fusion type and shall assure quality jointing even in difficult site condition. However, manufacturer's recommendation shall be considered for selecting the suitable joints for the applicable sizes and rating. After joining is made, the pipe shall not be disturbed in any manner.
2. Fiberglass reinforcement (covered) of HDPE fittings in not acceptable.
3. Buried metallic components, if used, shall be protected from corrosion by coating, cathodic protection, or other acceptable methods.
4. One edge of backup ring shall be radiused or chamfered. This edge fits against the back of the flange adapter.
5. Flange adapters shall be provided with a serrated sealing surface.
6. Integral wire electrofusion couplings shall be installed in accordance with the manufacturer's recommendation.
7. Use washers on both ends of the bolts. Corrosion protection is required for below ground,
8. Consideration shall be given to fluoropolymer coated bolts for buried service. Coated bolts are not stocked.
9. Bolting torque requirements shall be in accordance with gasket manufacturer's recommendation.
10. SS flat washers shall be used between the nut and back-up ring in accordance with the manufacturer's recommendation.
11. HDPE materials shall not be used in hydrocarbon (2% concentration or greater) contaminated soil conditions.
12. HDPE shall be provided with long term UV protection (2% to 3% carbon black).
13. Compatibility of the elastomeric material with the service shall be confirmed by supplier.

PIPE CLASS : 16PE0U

Line Class: 16PE0U	Basic Material: HDPE
Service: Refer Appendix-A (Pipe Class Summary)	Design Code: ASME B31.3/ ISO 4427
Rating Class: 16barg/ PE-100, SDR-11	Stress Relief: Not Applicable
Temperature Limit: 0 to 40°C	Examination: In accordance with ASME B31.3
Corrosion Allowance: 0 mm	Joint Construction: Electro-Fusion/ Butt Fusion Type

Item		NPS	Rating Schedule	Type	Specification	Notes
PIPE		25mm - 450mm	16 barg/ PE-100, SDR-11	PE	HDPE, ISO 4427-2	1
FITTINGS		25mm - 450mm	16 barg/ PE-100, SDR-11	PE	HDPE, ISO 4427-3	2
LAP JOINT FLANGE BLIND FLANGE	For SWS- Rising Mains	1" – 18"	Class 150	RF	DI, ASTM A536, ASME B16.42	3,4
	For (IWW)- Rising Mains	1" – 18"	Class 150	RF	ASTM A182 UNS S31803 (PREN>37), ASME B16.5	3,4
FLANGE ADAPTER		1" – 18"	Class 150	PE	HDPE, PE-100, SDR-11, ISO 4427-2	5
GASKETS		1" – 18"	Class 150	RF	3.2mm thick Elastomer, raised face, 50-60 Durometer, Shore "A", ASME B16.21	7,10,13
BOLTING		ASTM A307 Grade A or B bolts with ASTM A563 Grade A heavy hex nuts & washers with Ceramic Fluoropolymer Coating				8,9,10
GATE VALVE		1" and above	Class 150	RF, Flanged	BB, OS&Y, Valve MOC as per Appendix-E	

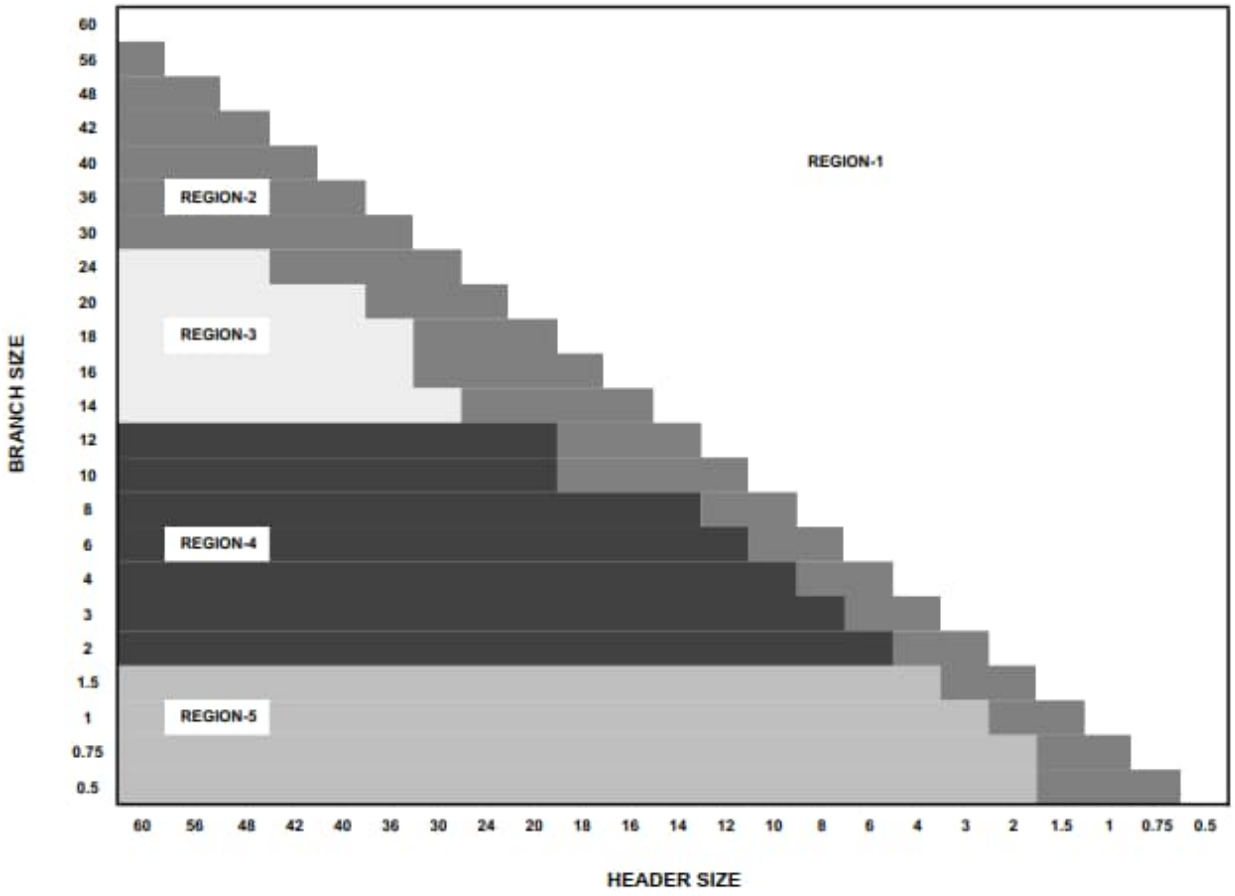
Notes

1. Joints between pipes and pipe fittings shall electro fusion /Butt fusion type and shall assure quality jointing even in difficult site condition. However, manufacturer's recommendation shall be considered for selecting the suitable joints for the applicable sizes and rating. After joining is made, the pipe shall not be disturbed in any manner.
2. Fiberglass reinforcement (covered) of HDPE fittings in not acceptable.
3. Buried metallic components, if used, shall be protected from corrosion by coating, cathodic protection, or other acceptable methods.
4. One edge of backup ring shall be radiused or chamfered. This edge fits against the back of the flange adapter.
5. Flange adapters shall be provided with a serrated sealing surface.
6. Integral wire electrofusion couplings shall be installed in accordance with the manufacturer's recommendation.
7. Use washers on both ends of the bolts. Corrosion protection is required for below ground,
8. Consideration shall be given to fluoropolymer coated bolts for buried service. Coated bolts are not stocked.
9. Bolting torque requirements shall be in accordance with gasket manufacturer's recommendation.
10. SS flat washers shall be used between the nut and back-up ring in accordance with the manufacturer's recommendation.
11. HDPE materials shall not be used in hydrocarbon (2% concentration or greater) contaminated soil conditions.
12. HDPE shall be provided with long term UV protection (2% to 3% carbon black).
13. RCompatibility of the elastomeric material with the service shall be confirmed by supplier.

Appendix C: BRANCH TABLE

APPENDIX-C BRANCH TABLE

METALLIC PIPING



LEGEND

1 EQUAL TEE

2 REDUCING TEE

3 REDUCING TEE OR BRANCH WELD WITH REINFORCING PAD

4 WELDOLET OR BRANCH WELD WITH REINFORCING PAD

5 WELDOLET, SOCKOLET, THREADOLET OR WELDING BOSSES

APPENDIX-C BRANCH TABLE

NON-METALLIC PIPING*

*This is preliminary data, branch connection details and type shall be confirmed based on Manufacturer/ Supplier recommended branching connection table.

BRANCH PIPE SIZE	HEADER PIPE SIZE											
	24	20	18	16	14	12	10	8	6	4	3	2
24	ET											
20	RT	ET										
18	RT	RT	ET									
16	RT	RT	RT	ET								
14	RT	RT	RT	RT	ET							
12	RT	RT	RT	RT	RT	ET						
10	RT	RT	RT	RT	RT	RT	ET					
8	S	RT	RT	RT	RT	RT	RT	ET				
6	S	S	S	RT	RT	RT	RT	RT	ET			
4	S	S	S	S	S	S	RT	RT	RT	ET		
3	S	S	S	S	S	S	S	S	RT	ET	ET	
2	S	S	S	S	S	S	S	S	S	ET	ET	ET

LEGEND

ET	Equal Tee
RT	Reducing Tee
S	Reducing Saddle