ADNOC GROUP PROJECTS & ENGINEERING

PIPING MATERIAL SPECIFICATION INDEX

Specification

AGES-SP-09-002

ص ب 898، أبوظبي، الإمارات العربية المتحدة
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GROUP PROJECTS & ENGINEERING FUNCTION/ PT&CS DIRECTORATE

CUSTODIAN	Group Projects & Engineering / PT&CS
DISTRIBUTION	Specification applicable to ADNOC & ADNOC Group Companies

The Group Projects & Engineering Function is the owner of this Specification and responsible for its custody, maintenance and periodic update.

In addition, Group Projects & Engineering Function is responsible for communication and distribution of any changes to this specification and its version control.

This document will be reviewed and updated in case of any changes affecting the activities described in this document.

INTER-RELATIONSHIPS AND STAKEHOLDERS

1.1 The following are inter-relationships for implementation of this Specification:

(a) ADNOC Upstream and ADNOC Downstream Directorates; and

(b) ADNOC Onshore, ADNOC Offshore, ADNOC Sour Gas, ADNOG Gas Processing. ADNOC LNG, ADNOC Refining, ADNOC Fertilisers, Borouge, Al Dhafra Petroleum, Al Yasat

1.2 The following are stakeholders for the purpose of this Specification:

(a) ADNOC PT&CS Directorate

1.3 This Specification has been approved by the ADNOC PT&CS is to be implemented by each ADNOC Group company included above subject to and in accordance with their Delegation of Authority and other governance-related processes in order to ensure compliance.

1.4 Each ADNOC Group company must establish/nominate a Technical Authority responsible for compliance with this Specification.

DEFINED TERMS / ABBREVIATIONS / REFERENCES

'ADNOC' means Abu Dhabi National Oil Company.

'ADNOC Group' means ADNOC together with each company in which ADNOC, directly or indirectly, controls fifty percent (50%) or more of the share capital.

'Approving Authority' means the decision-making body or employee with the required authority to approve Policies and Procedures or any changes to it.

'Business Line Directorates' or **'BLD'** means a directorate of ADNOC which is responsible for one or more Group Companies reporting to, or operating within the same line of business as, such directorate.

'Business Support Directorates and Functions' or **'Non- BLD'** means all the ADNOC functions and the remaining directorates, which are not ADNOC Business Line Directorates.

'CEO' means chief executive officer.

'Group Company' means any company within the ADNOC Group other than ADNOC.

'Standard' means normative references listed in this specification.

'COMPANY' means 'Abu Dhabi National Oil Company or any of its group companies. It may also include an agent or consultant authorized to act for, and on behalf of the COMPANY'.

'CONTRACTOR' means the party which carries out the project management, design, engineering, procurement, construction, commissioning for ADNOC projects.

'SHALL' Indicates mandatory requirements "**Group Company**" means any company within the ADNOC Group other than ADNOC.

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GENERAL

1 PURPOSE

The ADNOC Standard Engineering Specification (AS) defines the ADNOC mandatory requirement based on the experience acquired through the involvement with the design, construction, operation and maintenance across all assets. The Engineering Specification – Standards are based on, or reference international, regional and industry standards.

Where the ADNOC Standard Engineering Specification (AS) may not cover certain requirement or diversity of condition at each locality, then it may be amended to suit the project specific requirement whenever deemed necessary. These amendments will achieve at least the same level of integrity as reflected in the Standard Engineering Specification.

This Specification, Piping Material Specification is the basis of Pipe Classes required for use with all Process and Utility services. It allows selection of Pipe Classes for the Offshore, Onshore, Gas Processing, Refining and other installations depending upon the type of project.

The index of piping material classes attached in Appendix E1 shall be used as the standard piping classes. Additional piping material classes may be further developed/amended to suit specific project requirements and Process conditions and Material selection report. Any additional PMC's developed for specific conditions shall be developed based on the associated Material Selection Diagram (MSD) and the most severe conditions and in compliance with the ASME/API rated Design Pressure and Design Temperature Diagrams (DPDT)

The purpose of this Specification is as follows: -

- Group-wide standardisation of piping material and piping systems design;
- Variety control, leading to reduced costs of stocking material;
- Integrity control in relation to applied standards;
- Increased leverage for centralised purchasing;
- Reduced risk of wrong material selection.

2 SCOPE

This Specification generally covers the selection of piping classes based on the rated design conditions, type of fluid conveyed, Corrosiveness, Sourness and Toxicity. Amendment of applicable Piping Class for localised thickness increase for cases such as AIV, FIV, etc shall be carried out during projects stage.

The following pipework is outside the scope of this specification, unless otherwise noted:

a) Heating, plumbing, ventilation and similar piping inside buildings.

b) Instrumentation tubing. (Downstream of Piping Block Valve)

c) Instrument Control valves / Safety & Relief valves.

d) Pipeline designed as per ASME B31.4 and ASME B31.8

e) Proprietary packages, examples Gas turbines, Boiler packages, Seal packages etc

f) Package Unit piping designed to codes other than ASME B31.3 & ASME B31.1

g) Underground Drainage systems, other than Process drain

h) Subsea Pipework & Pipelines

3 DEFINED TERMS / ABBREVIATIONS / REFERENCES

Consultant: Is the party that performs specific services, which may include but are not limited to, Engineering, Technical support, preparation of Technical reports and other advisory related services specified by the party that engages them

Sub-Contractor: Is the party engaged by a Contractor to do part of the work awarded to the Contractor by the COMPANY. The work of the Subcontractor is carried out under the direction and control of the Contractor. The Company maintains the right to review all proposed Subcontractors and Subcontracts. However, the right to review does not relieve CONTRACTOR of their obligations under the Contract nor does it create any contractual relationship whatsoever between the Subcontractor and COMPANY

- Manufacturer/Vendor/Supplier - is the party that manufactures or supplies equipment and provides the support services at Site to install and commission the supplied equipment.
- NOTE: Vendor is the supplier of the equipment and not necessarily the Manufacturer.
- Sub-Vendor - Supplier of equipment and support services for an equipment/package or part thereof supplied by a VENDOR.

FEED: Is the Front End Engineering Design.

EPC: Is the Engineering, Procurement, Construction, Commissioning and Start-up.

Concession/Deviation Request: A Concession/Deviation requested by the CONTRACTOR either on their behalf or on behalf of their SUBCONTRACTOR(s), VENDOR(s) and/or SUB-VENDOR(s), after receiving the award of the Contract or Purchase Order.

It usually refers to an authorization to use, repair, recondition, reclaim, or release materials, components or equipment already in progress or completely manufactured but which does not meet or comply with COMPANY requirements.

CONCESSION/DEVIATION REQUEST: Is subject to COMPANY approval solely at their discretion.

Document: Any form, letter, facsimile, contract, specification, requisition, drawing, or record of any kind required to transmit information from one party to another. It also includes computer generated drawings, lists, charts, for example and other data used to denote a permanent record of the Project progress.

Should: Denotes an action or requirement which is not mandatory, but which is strongly recommended to comply with the requirements of this document.

ITP: Inspection and test plan prepared by the Manufacturer reviewed and approved by ADNOC highlighting the principal hold and witnessing points during the production of piping components.

Quality Assurance: All those planned and systematic actions (QA) necessary to ensure quality i.e. to provide adequate confidence that a product or service will be fit for its intended purpose.

Quality Manual: A document setting out the general quality policies, procedures and practices manufacturing organization.

Quality Plan: A document prepared by the Manufacturer setting out the specific quality practices, resources and activities relevant to a particular project.

Quality System: The structure organization, responsibilities, activities, resources and events that together provide organized procedures and method of implementation to ensure the capability of the organization to meet quality requirements.

Representative Third Party Inspection organization appointed by ADNOC.

Corrosion Allowance: The additional wall thickness added to the calculated minimum wall thickness (required to contain the pressure), to compensate for wall thinning due to corrosion.

Note:

The corrosion allowance given in the listed line classes in this standard is based on typical values from previous projects. However, it is the responsibility of the material/corrosion engineer to specify the appropriate corrosion allowance for the service conditions and intended service life. If the required corrosion allowance is not covered in the listed line classes in this standard, a line class with the required corrosion allowance shall be developed for the specific project's "Piping Line Classes". The wall thickness and schedules of the pipe and fitting shall be calculated to meet the Code requirements including the required corrosion allowance.

Item Description: Abbreviated Item Descriptions shown in the individual Line Class/Piping Class.

Line Class/Piping Class: Collection of piping components, Valves, suitable for a defined service and design limits, in a piping system.

Pipe Wall Thickness: Unless otherwise specified, piping component wall thicknesses, specified in the individual LINE CLASSES are based only on design considerations of pressure, temperature, and allowances for corrosion, MANUFACTURER'S minus tolerance and any allowance for the depth of threads or grooves. Piping component wall thicknesses do not include additional thickness that may be required to compensate for design considerations such as thermal loads due to restraints, live loads, hydraulic shock, or loads and sources from other causes such as AIV, all of which must be considered in the design of piping systems.

Pressure Temperature Ratings: Pressure-temperature ratings for NPS 24 and smaller carbon steel, ferritic alloy steel, and austenitic stainless steel piping, flanges, and valves are based on the latest edition of ASME B16.5 and ASME B16.34 and API 6A.

- For flanges NPS 26 and larger, ASME B16.47, Series A flanges shall be used for design and Pressure Temperature Ratings
- Where specified by ASME B31.3, bolting calculations shall be performed to verify the ability to seat the selected gasket and to maintain a sealed joint under the given pressure/temperature (P/T) rating.

Purchase Description: PROJECT Piping Material Commodities Catalogue (to be developed during detailed design) shall be referenced for the Purchase Descriptions of each item.

Abbreviations	
13CR	13% Chrome Steel
ACC	According to
ADNOC	Abu Dhabi National Oil Company
API	American Petroleum Institute
ASCC	Alkaline Stress Corrosion Cracking
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AG	Above Ground
BB	Bolted Bonnet
BC	Bolted Cap
BE	Bevelled End
BLE	Bevel Large Ends
BS	British Standard
BW	Butt Weld
CA	Corrosion Allowance
CALC	Calculate
CE	Carbon Equivalent
CL	Class
CLA	Clamp Connector
CNAF	Compressed Non-Asbestos Fibre
CONC	Concentric
CR	Chromium
CRA	Corrosion Resistant Alloys
CS	Carbon Steel
Cu	Copper
DEG	Degree
DEP	Design Engineering Practice (Shell)
DNV	Det Norske Veritas
EB	Extended Bonnet
ECC	Eccentric
EFW	Electric Fusion Welding

Abbreviations	
ENP	Electroless Nickel Plating
EPDM	Ethylene-Propylene Dimethylene
ERW	Electric Resistance Welding
ES	Extended Stem
EXT	Extended
FB	Full Bore
FBE	Fusion Bonded Epoxy
FBW	Furnace Butt Weld
Fe	Iron
FF	Flat Face
FFG	Female Ring Joint Groove
FLEX	Flexible
FLG	Flange
FLGD	Flanged
FRP	Fibre Reinforced Plastic
FS	Fire Safe
FV	Full Vacuum
GALV	Galvanised
GEAR	Gear Operated
GKSW	Gasket Spiral Wound
GO	Gear Operated
GRE	Glass Reinforced Epoxy
GRP	Glass Reinforced Polyester
GRV	Glass Reinforced Vinylester
GTAW	Gas Tungsten Arc Welding
H_2S	Hydrogen Sulphide
HAZ	Heat Affected Zone
HB	Brinell Hardness Number Symbol per ASTM E10 (formerly HN)
HC	Hydrocarbon
HDPE	High Density Polyethylene
HEX	Hexagonal

Abbreviations	
HF	Hard Facing (API STD 600 Table 3 Trim No. 5)
HIC	Hydrogen Induced Cracking
HORIZ	Horizontal
HW	Hand Wheel
IAA	Integrity Assurance Authority
ID	Inside Diameter
IDBB	Integral Double Block and Bleed
IN	Inches
INC	Inconel/Incoloy
INST	Installation
IR	Inner Ring
ISNS	Inside Screw and Non-Rising Stem
ISO	International Organisation for Standardisation
ISRS	Inside Screw and Rising Stem
ITCS	Impact Tested Carbon Steel
L	Length
LB	Pound
LBB	Long Bolted Bonnet
LJ	Lap (Loose) Joint
LO	Lever Operated
LONGIT	Longitudinal
LR	Long Radius
LTCS	Low-temperature Carbon Steels
MANUF	Manufacturer
MAX	Maximum
MESC	Material & Equipment Standards & Codes (Shell)
MDMT	Minimum Design Metal Temperature
MECH	Mechanical
METAL	Metallic
MIN	Minimum
MM	Millimetre

Abbreviations	
Mo	Molybdenum
MOC	Material of Construction
MPS	Manufacturing Procedure Specification
MSS SP	Manufacturers Standardization Society - Standard Practice
MT	Magnetic Particle Testing
NACE	National Association of Corrosion Engineers
NB	Nominal Bore
ND	Nominal Diameter
NDE	Non-Destructive Examination
Ni	Nickel
NPS	Nominal Pipe Size
NPT	National Pipe Thread
OD	Outside Diameter
OR	Outer Ring
OS&Y	Outside Screw and Yoke Type
OXYG	Oxygen
PBE	Plain Both Ends
PE	Plain End
P&ID's	Piping and Instrumentation Drawings
PLE	Plain Large End
PMC	Project Management Consultant
PQR	Procedure Qualification Report
PRES	Pressure
PSE	Plain Small End
PSL	Product Specification Level
PT	Dye Penetrant Testing
PTFE	Poly-Tetrafluoro-Ethylene
PVC	Poly Vinyl Chloride
PWHT	Post Weld Heat Treatment
Q & T	Quenched & Tempered
QA	Quality Assurance

Abbreviations	
QAS	Quality Assurance System
QC	Quality Control
QMS	Quality Management Systems
QP	Quality Plan
Ra	Roughness Average
RB	Reduced Bore
RF	Raised Face
RT	Radiographic Testing
RTJ	Ring Type Joint
S	Service
SAW	Submerged Arc Welding
SB	Screwed Bonnet
SBE	Socket Both Ends
SCC	Stress Corrosion Cracking
SCH	Schedule
SCRD	Screwed
SDSS	Super Duplex Stainless Steel
SI	The International System of Units
SMLS	Seamless
SMYS	Specified Minimum Yield Stress
SO	Slip On
SOHIC	Stress Oriented Hydrogen Induced Cracking
SOL	Solid
SOUR	Sour Service
SPI	Spiral
SS	Stainless Steel
SSC	Sulphide Stress Cracking
STC	Standard of Construction
STD	Standard
STL	Stellite

Abbreviations	
STR	Strainer
SW	Socket Weld
TBE	Thread Both Ends
TE	Threaded End
TEMP	Temporary
TLE	Thread Large End
TOE	Threaded One End
TPA	Third Party Agency
TR	Trim
TSE	Thread Small End
UB	Union Bonnet
UG	Underground
UNS	Unified Numbering System
UPVC	Unplasticised Poly Vinyl Chloride
VCFS	Very Critical Flange Fire Safe Service
VDRS	Vendor Document Requirement Schedule
VERT	Vertical
WB	Welded Bonnet
WN	Welding Neck
WND	Wound
WPS	Welding Procedure Specification
WRAS	Water Regulations Advisory Scheme

4 NORMATIVE REFERENCES

International Code(s) and Standards are listed in Section D.

5 REFERENCE DOCUMENTS

Reference documents are listed in Section D.

6 ORDER OF PRECEDENCE

The specifications and codes referred to in this specification shall, unless stated otherwise, be the latest approved issue at the time of Purchase Order placement.

It shall be the CONTRACTOR 'S responsibility to be, or to become, knowledgeable of the requirements of the referenced Codes and Standards.

The CONTRACTOR shall notify the COMPANY of any apparent conflict between this specification, the related data sheets, the Codes and Standards and any other specifications noted herein.

Resolution and/or interpretation precedence shall be obtained from the COMPANY in writing before proceeding with the design/manufacture.

In case of conflict, the order of document precedence shall be:

1. UAE Statutory requirements
2. ADNOC Codes of Practice
3. Equipment datasheets and drawings
4. Project Specifications and standard drawings
5. Company Specifications
6. National/International Standards

In the event of any conflict of data or requirements in any of the project applicable specified documents and standards in which some of the requirement could be more stringent, then the Contractor/Supplier shall carefully scrutiny on the most stringent requirements with regards to the safety, environmental, economic and legal aspects in all cases, the Contractor/Supplier shall provide the results of the analysis in writing for the COMPANY approval. In all such cases of conflict the COMPANY decision shall be final.

7 SPECIFICATION DEVIATION/CONCESSION CONTROL

This document sets the mandatory standard requirement to supplement the requirements of the certifying authority, legislative requirement guidance note issued by any authority and documents referenced herein.

Compliance with this Specification & Standards and documents referenced therein does not relieve the Contractor/Supplier of his responsibility to furnish units of proper design, quality of works workmanship and the attainment of the design to meet the specified conditions & duties.

Where other Specifications and Standards referred in this Specification. It is the Contractor/Supplier responsibility to obtain such documents and familiarise with the requirements thereof.

In the event of any conflict of data or requirements in any of the project applicable specified documents and standards in which some of the requirement could be of more stringent, then the Contractor/ Supplier shall carefully scrutiny on the most stringent requirements with regards, to the safety, environmental, economic and legal aspects. In all cases, the Contractor/ Supplier shall provide the results of the analysis; in writing; for the COMPANY approval. In all such cases of conflict, the COMPANY decision shall be final.

The facilities/equipment design manufacturing and installation shall deem to be in full compliance with all specifications applicable in this document. Any exception or deviation that is not possible to meet due to technical unavoidable constraints shall be highlighted and submitted with justification to the COMPANY. Such exceptions/deviations shall only be implemented upon attaining formal written approval of COMPANY through ‘The Management of Change’ (MOC) process.

8 QUALITY CONTROL AND ASSURANCE

Equipment shall only be purchased from Vendors approved by ADNOC Category Management. This approval indicates that the VENDOR has an approved Quality management system and a proven track record in supply of this equipment type.

8.1 SUBCONTRACTORS/SUBVENDORS

The VENDOR shall assume unit responsibility and overall guarantee for the equipment package and associated equipment.

The VENDOR shall transmit all relevant purchase order documents including specifications to his SUBVENDORS and SUBCONTRACTORS.

It is the VENDOR'S responsibility to enforce all Purchase Order and Specification requirements on his SUBVENDORS and SUBCONTRACTORS.

The VENDOR shall submit all relevant SUBVENDOR and SUBCONTRACTOR drawings and engineering data to the CONTRACTOR.

The VENDOR shall obtain and transmit all SUBVENDOR and SUBCONTRACTORS warranties to the CONTRACTOR/COMPANY, in addition to the system warranty.

Standard QA / QC Input

9 CRITICALITY RATING

Criticality Rating shall be defined in accordance COMPANY Quality System and Criticality Rating Specification.

SECTION A

10 PIPING CLASS NUMBERING

The Piping Class Number shall be comprised of 7 symbols consisting of 8 characters (with a hyphen/dash following symbol 5) as follows: -

Symbol	Description	Type of Characters	Number of Characters	A C1 S 3 J - F A
1st	Pressure Rating	Numeric	1	
2nd	Material Identifier	Alpha-Numeric	2	
3rd	Service Identifier	Alphabetic	1	
4th	Corrosion Allowance	Numeric	1	
5th	Valve Trim	Alphabetic	1	
6th	Flange Face	Alphabetic	1	
7th	Unique Service Description	Alphabetic	1	

10.1 First Symbol - Class Pressure Rating Identifier

Pressure rating	CODE
ASME Rating Class 150	A
ASME Rating Class 300	B
ASME Rating Class 600	C
ASME Rating Class 900	D
ASME Rating Class 1500	E
ASME Rating Class 2500	F
API Class 5000	G
API Class 10000	H

10.2 Second Symbol (2 characters) - Material Identifier

	Material	Code
Carbon Steel	ASTM A 106 Gr. B/ASTM A672-C65 CL22	C1
	API 5L X60	C2
	API 5L X-65	C3
	API 5L Gr. B-Galvanised	C4
LTCS	ASTM A 333 Gr. 6	L1
	API 5L X-60 (Impact Tested)	L2
SS	ASTM A312-TP316/316L	S1
	ASTM A312-TP321	S2
	6Mo	S3
	SDSS (ASTM A790 UNS S32760)	S4
Clad	CS + Incoloy 825 (UNS N08825)	E1
	CS+ Inconel 625 (UNS N06625)	E2
	LTCS + Incoloy 825 (UNS N0 8825)	E3
	LTCS + Inconel 625 (UNS N0 6625)	E4
	CS+SS316 Cladded	E5
	LTCS+SS316 Cladded	E6
	CS-X60-IMPACT TESTED + Alloy 825	E7
Non-Metallic Lined	CS + FBE Lined	F1
	CS + Cement Lined	F2
	CS + PTFE Lined	F3
	CS + PVDF lined	F4
	CS + Refractory Lined	F5
	CS + Glass Flake Lining	F6
Alloy Steel	1 1/4CR - 1/2MO (P11)	G1
	5CR - 1/2MO (P5)	G2

	Material	Code
	9CR - 1MO	G3
Non-Ferrous Metal	UNS N0 8825	N1
	UNS N0 6625	N2
	Hastalloy 276	N3
	Copper Nickel 90/10	N4
	Titanium	N5
	Monel	N6
Non Metallic	CPVC	P1
	HDPE	P2
	GRE	P3
	GRVE	P4
	GRE/GRV	P5
	GRV/GRP	P6

10.3 Third Symbol - Service Identifier

Service Identifier	Code
Non Sour	A
Mandatory PWHT-Sour (also Sour with Chloride)	H
Lethal	L
Mandatory PWHT-Non Sour	P
Sour	S
Mandatory PWHT-Lethal	T

10.4 Fourth Symbol - Corrosion Allowance Identifier

Corrosion Allowance	Code
0 mm	0
1.5 mm	1
3 mm	3
4.5 mm	4
6 mm	6
9 mm	9

10.5 Fifth Symbol - Valve Trim Identification

Valve Trim	Code
Stainless Steel Type 316	A
AISI 410	B
Alloy 825	C
Alloy 625	D
Super Duplex Stainless Steel	E
Aluminium Bronze	F
Monel 400	G
Alloy 20	H
Hastalloy 276	I
Plastic CPVC	J
Titanium	K

10.6 Sixth Symbol - Flange Face

This character is preceded by a hyphen/dash '-'

Flange Face	Code
Raised Face/Flat Face	F
Ring Type Joint	J

10.7 Seventh Symbol - Unique Service Description

The seventh symbol indicates the Unique Service Description.

Unique Service Description	Code
Normal	A
High Temperature and Cryogenic	B
Cryogenic (< -50°C)	C
High Temperature (>200°C)	H
Jacketed – High Temperature	J
Pipeline	P
Project Specific Identifier (if applicable)	X, Y & Z

11 DESIGN CONSIDERATIONS /MINIMUM DESIGN REQUIREMENTS

11.1 General

Unless otherwise specified in this Specification, pipe and piping components shall be designed in accordance with ASME B31.3. Pipe work needing repair or modification in future shall also follow this Specification.

The pressure and temperature limits in each piping class are the design limits of the relevant piping class for the specified service design conditions.

11.2 Threaded Piping

a) Threaded joints shall not be used in Sour piping services, including VENDOR package piping or piping likely to be subject to vibration or transporting highly corrosive fluids and Hazardous fluids.
b) Threaded piping is allowed for galvanised piping (up to NPS 3) and hydro test vent and drain in utility services of Category D fluids and for downstream of primary block valve for instrument in process services.
c) Threaded piping shall be assembled with sufficient unions to allow disassembly for maintenance; however, unions shall be kept to a minimum. Galvanized piping, NPS 3 and above shall be assembled with flanged joints. Flanges shall be welded to pipes before Galvanizing.
d) Pipe threads shall be NPT and in accordance with ASME B1.20.1.

11.3 Socket Weld Piping

a) Socket weld joints shall not be used in Sour piping services including VENDOR package piping or in piping likely to be subject to vibration (AIV, FIV), severe cyclic conditions and any service where crevice corrosion or severe erosion may occur.
b) Socket welding is construction method (if specified in the PIPING CLASSES) for NPS 1½ and smaller in classes 150#, 300# and 600# in Non-sour utility service (including Plant air, Steam etc.) provided it is not subject to vibration.

11.4 Wet H_2S/Sour Services (H_2S>50ppm)

For the purposes of this specification, “Wet H_2S/Sour Service” refers to the process streams containing free water in liquid phase, and H_2S > 50 ppm (any pH).

Following additional requirements shall apply.

a) All piping shall be in accordance with material requirements of NACE MR0103 / ISO 17945, for Refinery Service and NACE MR0175/ISO 15156 (including its supplements, modified narrative) for Upstream Services. Piping specified to NACE MR0103 / ISO17945 shall have Stainless steel trim SS 316 as minimum (complying with NACE MR0103 / ISO 17945 hardness).

b) Austenitic Stainless Steel 300-series can be used in sour service with chlorides up to 30ppm for pressure piping, clad piping and/or valve trim. However, in case the chlorides are in excess of 30ppm Austenitic Stainless Steel 300-series should not be used.

c) For requirements such as CE, Sulphur content, HIC requirements, hardness for example refer to the document “Materials Selection Guidelines” Doc. No. AGES-GL-07-001.

d) The Piping Code recommends longitudinal welds of fabricated piping be 100% Radiographed. All piping butt welds under the service shall be 100% radiographed. All weld joints shall be full penetration

e) Each piping system shall be 100% visually inspected and hydrostatic leak tested prior to initial operation.

f) Valves in sour service shall be required to meet fugitive emission class A/B as per ISO 15848 Parts 1 & 2 as indicated in Piping & Pipeline Valve specification AGES-SP-09-003.

11.5 Lethal Services (H_2S>500ppm or Hydrofluoric Acid service))

Piping systems which contains very large amounts of H_2S (H2S> 500ppm) in liquid or vapour phase and containing Hydrofluoric Acid Service are identified as “Lethal service”. This is based on Facility Layout & Separation Distances Guidelines AGES-GL-03-001 & Management of Hydrogen Sulphide (H2S) HSE-OS-ST21.

In addition to the requirements specified in section 11.4, following shall also apply.

a) All such piping systems categorised as 'Toxic /Lethal' the following requirements shall apply to piping or piping components.

b) Piping design and fabrication shall comply with Chapter VIII (Piping for Cat. M Fluid Service) and Appendix F of the Piping Code ASME B 31.3.

c) All piping shall be in accordance with material requirements of NACE MR0103 / ISO 17945, for Refinery Service and NACE MR0175/ISO 15156 (including its supplements, modified narrative) for Upstream Services. Piping specified to NACE MR0103 / ISO17945 shall have Stainless steel trim SS 316 as minimum (complying with NACE MR0103 / ISO 17945 hardness).

d) Flanged joints shall be minimised. Piping design shall ensure any flanges are located in positions with inherently low bending moments.

e) Increasing the rating of flanges shall be considered if the risk of flange leakage is high and unavoidable in design.

f) Welded valves may be considered instead of Flanged valves if specified in the project documentation based on HSE requirements.

11.6 Non-Metallic Piping

For piping subject to a water service (for example., Demineralized Water, Softened Water, Distilled Water, Drinking Water, Utility Water, Sea water, Fire water etc.), non-metallic piping (for example., Glass- Reinforced Epoxy / HDPE) may be used as specified in material selection report.

- For Plant drain service (Sour /non-sour), GRE can also be used if it meets the Pressure & Temperature limits and as per material section reports recommendations
- In offshore applications GRE can be used for above deck services where it meets the Pressure & Temperature limits and material selection requirements.

11.6.1 UPVC Piping

UPVC Piping shall be in accordance with ASTM D1784. Socket type pipe fitting shall be as per ASTM D2466 or ASTM D2467.

11.6.2 CPVC Piping

CPVC Piping shall be in accordance with ASTM D1784. For socket type pipe shall be as per ASTM F441 and pipe fitting shall be as per ASTM F438 or ASTM F439.

11.6.3 HDPE Piping

a) Pipes and fittings shall comply with the requirements of ISO 4427 PE 100. The pressure rating of the fittings shall be the same as or higher than that of the pipes. The SDR (Standard Dimension Ratio) and pressure rating of the pipes and fittings shall be based on the Maximum Allowable Operating Pressure and Temperature limited to 60° C.

- Polyethylene pipes and fittings shall be high density polyethylene pipes (HDPE), and shall comply with the requirements of ISO 4427 type PE 100, PN16 SDR11 and higher grades as applicable.
- The material used for the manufacturer of pipes and fittings shall have physical characteristics of the PE100 material and shall be in accordance with Table 1 and Table 2 of clause 4.4 of ISO 4427-1. Further physical characteristics of the PE100 material in the form of pipe shall comply with the requirements of Table 5 of ISO 4427-2 and with Table 4 of ISO 4427-3 when in the form of fittings
- HDPE Potable Water piping Materials in contact with drinking water shall fully comply with Regulation and Supervision Bureau (RSB) standards Abu Dhabi, certified by an internationally recognised authority, such as the "WRAS Certification Scheme" conforming its suitability to

permanent contact with potable water, as being non-tainting and suitable for permanent contact with potable water at temperatures of up to 60° C.

b) When the annual average operational temperature exceeds 20° C a pressure reduction factor shall be applied to determine the allowable long term operating pressure. To evaluate this figure consult Table A1 in Annex A of ISO 4427-1which gives conservative pressure reduction coefficients for elevated operational temperatures based on ISO 13761.

c) Transition fittings to join HDPE with other materials shall be provided by factory made propriety items and not made by in-field construction, wherever possible fittings shall be formed using the injection moulding process.

d) Branch connections in buried HDPE piping shall be protected from soil shear forces by low density packing and or protection shields.

11.6.4 Fibre Reinforced Plastic Piping (FRP)

a) GRE pipe systems shall be in accordance with BS EN ISO 14692, Parts 1 to 4 'Requirements for Fibre Reinforced Plastic (FRP) Pipes and Fittings'. Manufacturer's recommendations and limitations shall comply with the requirements of ISO 14692 that shall cover requirements such as jointing, Temperature limitations, UV protection liner, 1000 hr regression test, Fire safe requirement for installation in process area etc.

b) GRE for use in potable water service, pipe system shall be certified to WRAS standards

c) . For use in Fire Water services, Fire endurance properties shall be assessed, and product be certified by a certifying authority such as Factory Mutual (FM) or other approved authority.

d) For Fire Water piping in above ground applications shall be supplied with a Fire Retardant coating.

e) For GRE pipes up to NPS 24, a minimum design pressure of 20 Barg shall be considered irrespective of actual operating pressure for process drain and pressurised fire water system.

If the pressure is more than 20 barg then GRVE (Glass-fibre/vinyl ester) and GRUP (Glass-fibre/ Isopthalic polyester) pipes should NOT be used

f) Following maximum temperature shall be followed for selection of GRE, GRV and GRP pipes based on experience and resin type.

- Max Design Temperature - GRE - 100°C
- Max Design Temperature - GRVE - 100°C
- Max Design Temperature - GRUP - 60°C

g) GRE/ GRP vendor where he shall be responsible for qualification & QA/ QC, manufacturing, system design, inspection & testing in accordance with referenced ISO, ASTM & API standards.

h) Vendor shall also be responsible for system design with full supervision and attendance during site installation & testing to ensure full compliance with the approved procedures and site quality plans& ITP; all the way to commissioning.

i) For all projects, it shall be mandatory for the Manufacturer to provide sufficient training to the installation/erection team personnel in the area of general laying and particularly joints integrity. Training records shall be maintained by Manufacturer and shall be signed, stamped and submitted to the Company.

j) UV protection for GRE/GRP piping shall be provided to cater to storage, handling and installation.

11.7 Steam Services

a) All valves NPS 2 and larger in Steam Service shall be flanged, including those installed in headers, for maintenance purposes. If socket weld is permitted Valves NPS 1 1/2 and smaller may be used

b) The preferred block valve for steam service shall be a gate valve with split wedge. For steam services, trim shall be stellited.

c) Valves in all pressure ratings used for superheated steam service shall have butt-welded ends.

11.8 Glycol Services

a) All Glycol injection valves shall be socket welded up to NPS 1.5 and flanged for higher sizes.

b) Lubricated valves shall not be used in this service.

c) Valves in glycol service shall be supplied with a back seat feature to enable valves to be repacked under pressure.

11.9 Caustic Soda Services

a) Sodium hydroxide embrittlement is a type of stress corrosion which is strongly influenced by temperature. The temperature the pipe might reach in service shall be established in order to determine the required preventive measures. The piping material should be in line with material selection report.

b) Carbon steel welds in Caustic Service shall be stress relieved including attachment welds irrespective of thickness. (Refer section 12.1.1)

c) Piping for Caustic Soda Service shall comply with the following requirements:

- The application of cold-formed parts or cold forming shall be restricted as far as possible.
- Hot spots due to direct wall-to-wall contact with steam (or electrical) tracing shall be avoided by applying spacers (ceramic, glass fibre or filled phenolic resin).
- All drawings for the fabrication of carbon steel piping intended for Caustic Soda Service shall be clearly marked “CAUSTIC SODA SERVICE”.
- When PWHT is required, Carbon steel piping shall be clearly identified, either by painting or fixing an adhesive tape around the parts, to show that it is in CAUSTIC SODA SERVICE with PWHT.
- 100% NDE shall be applied.
- Spray guards or flange shields (e.g. Technoshield or equivalent) shall be installed around flange joints and flanged valve bonnets to protect personnel from leaks or accidental spray outs.

11.10 Sulphuric Acid Services

a) Concentrated Sulphuric Acid (90% and above) service shall use Carbon steel piping in accordance with NACE RP0391.

b) Dilute Sulphuric Acid service shall use PVDF / PTFE lined carbon steel piping.

c) The use of pipe bends and elbows shall be restricted as far as possible. For the fabrication of sweep-in connections, standard long-radius elbows (DN 80/NPS 3) or larger) shall be used.

d) In carbon steel systems where turbulence or unacceptably high velocities cannot be avoided, spool pieces of carbon steel lined with fully-resistant material (PTFE/ PVDF) shall be used. The length of such spool pieces shall be at least 20 D.

e) Carbon steel piping for Sulfuric Acid Service shall comply with the following requirements:

- The number of pipe bends and elbows shall be restricted to the absolute minimum.
- Pipe bends shall have a radius of at least 5D (where D is the nominal pipe diameter).

- Standard elbows, which shall be used for sweep-in connections, shall be of the long-radius type with a radius of 1.5D.
- Pipe reducers shall be avoided as far as possible. Where a reduction is necessary, the reducer shall be concentric, except in the case of a horizontal line where the reducer could inhibit drainage (for example., where the reduced diameter is in the direction of drainage), in which case an eccentric reducer (bottom flat) may be considered. The reduced bore SHALL match with the connecting piping bore.
- Flat ring gaskets, with ID dimensions matching the bore of the pipes and a thickness of 1.5 mm, shall be used.
- For junctions, pipe work shall be designed to avoid 90º tees. Instead, 45º laterals, Y-type, or sweep-in junctions shall be used.
- All open butt welds shall be made with Gas Tungsten Arc Weld (GTAW) root pass.
- All drawings for the fabrication of carbon steel piping intended for this service shall be clearly marked “SULFURIC ACID SERVICE."
- Carbon steel piping shall be clearly identified, either by painting or fixing an adhesive tape around the parts, to show that it is in SULFURIC ACID SERVICE.

11.11 Chlorine Services

For the purposes of this specification, “Chlorine Services” are defined as piping systems with concentrations greater than or equal to 3500 ppm, which shall use filament-wound fiberglass reinforced vinyl ester (GRVE) pipe or as specified in the material selection report. Fiberglass piping materials and installation shall be in accordance with ISO 14692 Part 1 and 2 ‘Requirements for Fibre Reinforced Plastic (FRP) Pipes and Fittings.

Note. There are few traditional piping materials suitable for Sodium Hypochlorite service. The fluid is inherently unstable and reverts to saltwater over time. The presence of metallic ions accelerates and complicates this process. The only metallic material suitable for this service is Titanium. Systems using this material can be fully welded to avoid potential flange leakage. This material should be considered where plastic and composite piping is compromised due to operational conditions, site location or wider considerations such as personnel safety.

Chlorinated gas service generally uses CPVC materials, however, materials selection report shall be followed.

11.12 Low Temperature & Refrigeration Services

For the purposes of this specification, “Low Temperature Services” are defined as piping which operates at, or may be exposed to, temperatures below -29°C.

Additional requirements to prevent brittle fracture of piping in Low Temperature Service (for example., impact testing of materials, limits on material selection and added welding, NDE, and PWHT requirements) shall be in accordance with ASME B31.3 and ASME Boiler and Pressure Vessel Code Section V.

- Valves in services with operating temperature below -50°C shall be provided with an extended bonnet for cryogenic service along with requirements of MESC SPE 77/200. Bonnet extension shall be determined by insulation thickness.
- A stress ratio of less than 1 shall not be used to justify use of materials temperatures below the material minimum temperature shown in Table A-1 or Fig. 323.2.2A (including Notes). The use of the stress ratio approach (Fig 323.2.2B) shall not be used for design purposes.
  (The above stress ratio approach only to be used for in-service fitness-for-service assessments if approved by COMPANY.)

11.13 Brine Service

Glass Reinforced Epoxy pipe (GRE) shall be used for brine services. Materials and installation shall be in accordance with ISO 14692 Part 1 and 2 ‘Requirements for Fibre Reinforced Plastic (FRP) Pipes and Fittings’

11.14 Waste and Open Drain Piping

Waste and Drain system piping for unpolluted Rainwater, Oily Water, and Sanitary Waste Water shall be in accordance with ASTM F3371 – 19.

Sewer system piping shall be as per following:

- Oily Sewer - GRE / HDPE
- Accidently Oil Sewer / Accidentally Oil Contaminated - GRE / HDPE
- Sanitary Sewer - uPVC
- Storm water Sewer - GRE / HDPE

11.15 Auxiliary Systems Piping

Auxiliary piping within the propriety Rotating equipment/packages, the SUPPLIER may propose their own piping classes in accordance with ASME B31.1/B31.3 code (as applicable). (Lube oil, seal system, etc)

For engineered packages like Fuel gas skids, Gas conditioning skids, etc all the requirement of these specification shall be applicable

However, compliance to the requirements of this specification for pipework systems supplied within the package shall be required. The vendor detailed piping specifications shall be submitted by the SUPPLIER for COMPANY approval. Any non-compliance/deviation to this shall be highlighted to COMPANY in proposal stage.

This applicable for engineered packages like Fuel gas skids, Gas conditioning skids etc.

11.16 Fire Water Piping

The materials for Firewater piping shall be selected in accordance with the Materials Selection report.

The below are recommended materials for fire water system based on the type of water sources:

- **Seawater- Fire water network** - 90/10 CuNi for small bore lines below NPS 2 and GRE for NPS 3 and above.
- **Freshwater-Fire water network** - For Onshore only - GRE (Underground) and Carbon Steel FBE Lined (Above ground)
- **Dry Fire Systems** – Galvanised CS / 90/10 CuNi / Super Duplex Stainless Steel (SDSS)
- **Foam System (concentrated)** - Stainless Steel Type 316/316L
- **Foam Solution (with Fresh water)** - Carbon Steel FBE Lined

For Fire water service, Above Ground (A/G) and Under Ground (U/G), Carbon Steel Pipe work shall be used.

The use of FRP piping is normally avoided for Onshore, above ground applications. This is because these are prone to mechanical damage.

Where FRP pipe is used above ground for offshore applications, it shall be mandatory to be specified and supplied with a UV protective coating and shall be fire retardant.

FRP piping should not be used in services where significant vibration will occur. Direct hook up with rotating equipment should therefore avoided. Use of this material type in areas subject to blast shall be avoided. For Offshore applications where GRE is used for Fire water system, blast loads shall be considered in GRE calculations if applicable.

Firewater headers shall be subject to surge analysis study. Surge pressure at any location in network shall not exceed design pressure of piping components. This shall accurately represent the as built geometry of the system, the firewater pump characteristics including the impellor inertia and pressure / relief system. The piping wall thickness shall be adequate for the maximum surge pressure with a Dynamic Load Factor x 2 plus

a minimum of +10% margin**.** The header restraint system shall be sized to accommodate the preceding factors.

11.17 Vacuum Service

All metallic piping class sizes up to and including DN 600 (NPS 24) shall meet the design condition of full vacuum at ambient temperature.

- Allowable external pressures shall be verified in accordance with ASME B31.3 Paragraph 304.1.3 using the calculation from ASME BPVC VIII, Division 1, Parts UG-28 through UG-30.
- Pipe and fittings larger than DN 600 (NPS 24) need should not be designed for full vacuum. However, all piping components in steam services and services as identified in the line list shall be designed for full vacuum irrespective of size.
- Vacuum rings shall only be used with COMPANY approval (specify the minimum spacing between the rings)
- Special requirements for valves in (High) Vacuum Service shall be in accordance with (applicable MESC SPE specs)

11.18 Amine Service

The materials for amine service shall be carbon steel with a suitable corrosion allowance CRA clad carbon steel or 316 stainless steel in line with Material selection Guideline AGES-GL-07-001 and material selection report.

API RP 945 recommendations shall be applied for amine service piping including closure welds.

For amine service, carbon steel piping and piping component welds including attachments irrespective of wall thickness, diameter, geometry and kind, the weld shall be post weld heat treated, and no exceptions shall be granted by Company in this regard. (Refer section 12.1.1)

11.19 Acoustically Induced Vibration & Flow Induced Vibration Study

The release of high-pressure energy into piping systems (typically flare) can result in Acoustic Induced Vibration (AIV). The effect is directly related to the sound power level and the pipe diameter/ thickness ratio. This phenomenon may result in rapid fatigue failure of the pipe wall. The effect is most severe at positions of local stiffness discontinuities.

The extent of piping considered to be affected is determined by process engineering with an initial assessment during FEED execution to ensure purchasing accuracy. Initially, the extent of AIV piping shall be considered as 100 pipe diameters upstream and 200 pipe diameters downstream. The actual extent of the affected piping and the sound power level / piping class is provided by Process Engineering.

The primary prevention measure to avoid pipe failure requires the pipe wall thickness (in sections determined to be affected) to be thickened. To ensure minimum design and construction risk piping classes are required. These classes shall include the requirement for thickened pipe wall and other support locations. These classes created from standard classes but when modified, are identified by the suffix to the parent class of ‘AIV’.

Flow Induced Vibration (FIV) is the result of turbulence in the process fluid, which occurs due to major flow discontinuities such as bends, tees, partially closed valves, and small-bore connections. The high levels of broadband kinetic energy created downstream of these sources is concentrated at low frequencies and can lead to excitation of vibration modes of the piping and connected equipment. In order to determine the extent of FIV affected piping, Process engineer needs to review piping system configuration with respect to matured data of flow characteristic of Process fluid which can be available during detail engineering phase of project.

Energy Institute guidelines for ‘Avoidance of Vibration Induced Fatigue Failure in Process Pipework’ shall be followed to mitigate impact of AIV/FIV.

11.20 Seawater Service

For Underground (U/G) piping NPS 2 and larger sizes, the recommended piping material is Glass Reinforced Epoxy (GRE) / High Density polyethylene (HDPE).

For Aboveground (A/G) piping the recommended piping materials are:

- NPS < 2: SDSS S32760 (PREN ≥40) / 90/10 CuNi
- NPS ≥ 2: GRE with UV protection / CS +lined

However, the above shall be further evaluated Material selection Guideline AGES-GL-07-001 and material selection report.

SECTION B

TECHNICAL SPECIFICATION

12 PIPING MATERIALS AND DESIGN SPECIFICATIONS

12.1 General

In general, all the material requirements shall comply with the requirements of the applicable ASTM standards with additional requirements of applicable MESC SPE, Material selection Guideline AGES-GL-07-001,Pipe class and incorporating the changes specified within this specification.

All material in carbon and low alloy steel, excluding screwed, galvanized and castings shall have a maximum carbon content of 0.23%. For castings, a carbon content of 0.25% maximum may be permitted in line with Material selection Guideline AGES-GL-07-001.

The following defines the minimum requirements for materials:

- The carbon steel and carbon manganese steel piping shall be fully killed and manufactured by the electric furnace or the basic oxygen process as and to fine grain low hydrogen practice.
- “Silicon Killed” carbon steel has been specified for all Piping Classes where the materials of construction are specified as carbon steel.
- CS / LTCS forgings shall be supplied in the normalized or normalized & tempered condition and in compliance to the additional requirement of applicable MESC SPE.
- Stainless steel, duplex stainless steel and Nickel alloys shall be in Annealed/Solution Annealed condition when specified in the relevant material standard, MESC SPE and Material selection guidelines (AGES-GL-07-001)
- Cast iron shall not be used in Hydrocarbon services.

For “Sour Service” application, all material shall comply with NACE MR0175/ISO 15156 for upstream processes and NACE MR0103/ISO 17945 for downstream processes.

For Sweet and Sour service, Carbon Equivalent (CE) based on the Ladle Analysis shall not exceed 0.43, calculated by the following formula

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

Impact testing on steels shall be in accordance with ASME B31.3 based on minimum design metal temperature (MDMT) and pipe wall thickness. Method of testing to be in accordance with ASTM A370.

- Impact test is required for carbon steel material ASTM A106 and API 5L (PSL2) when the design temperature is below the minimum temperature of ASME B31.3 Figure 323.2.2
- Impact testing is required for ASTM A694 material at applicable piping class minimum design temperature

Carbon Steel material for sour service seamless piping shall be HIC resistant and have a sulphur content <0.01% and be secondary treated with calcium for inclusion shape control. Carbon Steel material for longitudinally welded pipe shall have a sulphur content <0.003% and be secondary treated with calcium for inclusion shape control

Materials for all pipe, fittings, flanges, bolting, gaskets and valves shall comply with the applicable codes, industry specifications and MESC SPE specifications referenced in Section D of this specification.

Carbon steel Castings shall be in ‘Normalized’ or ‘Quenched and Tempered’ condition. Welds or weld repairs, if any, shall be subject to stress-relieving

Carbon steel forgings shall be in ‘Normalized’ condition.

SDSS material shall have minimum 25% Cr and PREN>40.

Zinc content in Al-Br material shall be less than 16.

SS316/SS316L shall be supplied in Dual Certification

Positive Material Identification (PMI) test shall be carried out for all Stainless steel, CRA, Cu-Ni alloy materials prior to packing. This shall apply to all items such as but not limited to pipe, fittings, flanges, bolts, valves including trim components, spectacle blind, spacer & blank etc. for procurement, fabrication and welds.

For API 10000 and above pipe classes, material shall comply with PSL-3 requirements of API 6A

Non-Destructive Examination (NDE) at the manufacturing stage of the materials shall be in accordance with the requirements of the applicable ASTM material specifications, MESC specifications and the approved Inspection & Test Plan (ITP).

12.1.1 Post Weld Heat Treatment (PWHT)

a) General

Post weld Heat Treatment shall be in accordance with the requirements of code of practices, including the latest edition/version at the time of construction for the following international specifications, standards and codes:

- ASME B31.3 – Process Piping
- API RP 582 - Recommended Practice Welding Guidelines for the Chemical, Oil, and Gas Industries
- NACE MR0175/ ISO 15156 - Material for Sour Environment' for Upstream applications
- NACE MR0103/ISO 17945 - Metallic materials resistant to sulphide stress cracking in corrosive petroleum refining environments'
- NACE SP0472 - Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments

Piping and pressure retaining items shall be post weld heat treated (PWHT) in accordance with applicable specifications, standards, and codes; or as per project applicable documents/ specifications, material specifications or as specified by the ADNOC based on service conditions.

For sour service, all requirements of ISO 15156 / NACE MR0175 (all parts) or ISO 17945 / NACE MR0103 shall be satisfied.

When PWHT is required, it shall be performed after completion of all welding including any weld repairs, weld overlay, cladding restoration, and non-destructive examination (NDE), but before any hydrostatic testing or other load testing.

Note: Exemption of PWHT (Code exemption or any other) is not permitted unless specifically mentioned in this document or allowed in project documentation

b) Mandatory PWHT

PWHT is mandatory for the following services as minimum and wherever specially indicated in the project documentation

i. All caustic soda (NaOH) service pipe work, including conditions where caustic carryover may occur (e.g., downstream of caustic injection points).

ii. All Amine service piping work

iii. Hydrogen service pipe work for P-No. 1, 3, 4, and 5A/B/C base materials above 200°C

iv. Boiler deaerator service pipe work

v. All Hydro Fluoric acid service pipe work

vi. Carbonate piping (particularly in FCC unit)

vii. As per ASME B31.3 code requirements with additional requirement of PWHT for wall thicknesses above 20 mm for carbon steel (P–No. 1, all Group Nos.) irrespective of service. (i.e. no exemptions as per Table 331.1.3 is allowed for thickness > 20mm)

viii. In Sour oil and gas production and in natural-gas sweetening plants in H_2S-containing environments (i.e. following NACE MR0175/ ISO 15156), PWHT is required for all thickness. However, Code exemptions for PWHT is permitted only for <20 mm thickness provided if hardness requirement of NACE MR0175/ ISO 15156 & all requirement of Table 331.1.3 of ASME B 31.3 including multilayer welding for thickness >5mm are met

ix. In Sour petroleum refining and related processing environments (i.e. following NACE MR0103/ISO 17945), PWHT is required for all thickness to meet the hardness requirements as defined in NACE MR0103/ISO 17945 & NACE SP0472

12.2 Pipe

Pipes shall be specified by reference to the Nominal Pipe Size (NPS) and Schedule No (Sch.) as per B36.10 and B36.19.

Where available, nominal wall thicknesses of pipe specified in the piping classes, shall be in accordance with ASME B36.10M and ASME B36.19M.

Pipe NPS 1¼, 2½, 3½, 5, 7 inches shall not be used except at equipment having such connection sizes. Equipment supplied with connections of these sizes shall be adjusted to a standard size immediately adjacent to the equipment by means of suitable reduced fittings. Bushing shall not be used.

The use of non-standard pipe diameters like NPS 22, 26, 28, 32, 34, 38, 44 and 46 shall be avoided though it is permitted to use in un-avoidable circumstances. The use of these sizes requires prior approval from ADNOC.

The minimum pipe sizes (including Branches) for various services shall comply with Process Design Criteria AGES-GL-08-001

Unless specifically warranted by process service conditions, metallic pipework shall be designed with a minimum corrosion allowance as follows:

Basic Pipe Material	Service	Min. C.A.
Carbon Steel	Non-Corrosive	1.5 mm
Carbon Steel	Corrosive	3 mm
SS/DSS/Inconel/Monel/ Cu-Ni/Titanium	All	Zero

The corrosion allowance for sour service may be 3 mm, 4.5mm or 6 mm depending upon the severity.

Minimum pipe schedules for Carbon Steel pipework shall be as follows:

1. Threaded Pipework : Schedule 80
2. Non sour pipework and Offshore, NPS ≤ 1½ : Schedule 80
3. For sour service (, NPS ≤ 2) : Schedule 160

Minimum pipe schedules for CRA material shall be as below.

1. Up to NPS 1½ : Schedule 80S
2. NPS 2 : Schedule 40S

3. Other Sizes : Schedule 10S

Additionally, Schedule 5S shall not be used for CRA materials,

Structural Minimum Thickness: Minimum required thickness without corrosion allowance, based on the mechanical loads other than pressure that result in longitudinal stress. It does not include thickness for corrosion allowance or mill tolerances.

Pipe Wall Thickness: Unless otherwise specified, wall thickness specified in the individual piping classes are based on considerations of design pressure and temperature, corrosion allowance, manufacturing tolerance, any allowance for threads. Where the calculated wall thickness based on these parameters are not sufficient to guarantee the structural integrity of the pipe or piping components, structural minimum thickness in accordance with below table is applied.

NPS	MINIMUM STRUCTURAL THICKNESS (mm)
0.75 - 1	1.6
1.5	1.8
2	2.1
3	2.3
4	2.6
6	2.8
8 - 24	3.1
≥26 - 36	3.8
≥36 - 36	4.6
48 -50	5.3
>50	0.006 x OD

Bevel Ends shall be as per ASME B16.25 Figures 2a and 3a. Flame cut bevel ends are not permitted.

Minimum Basic pipe materials shall be as follows whenever temperature is the governing factor:

- -46ºC & Below : Austenitic Stainless Steel & Nickel Alloy Steel
- -46ºC to -29ºC : Impact-Tested Carbon Steel
- -28ºC to 427ºC : Killed Carbon Steel / CR-Mo Steel
- Above 427ºC (for B 31.3) : Cr-Mo steel

Carbon steel shall be impact tested as per ASME B31.3 Para. 323.2.2 Depending upon the wall thickness and design minimum temperature

- API-5L Gr. B PSL2 seamless pipes and ASTM A106 Gr. B Pipes are acceptable substitutes for each other provide API 5L B is impact tested up to -29°C
- The pipe dimensions (such as OD, Schedule etc.) shall be in accordance with ASME B 36.10M for carbon steel, ASME B 36.19M for Stainless Steel and CRA material.

12.2.1 Seamless Pipe

Seamless Pipe shall be used in sizes as specified in the Piping Classes. Generally, seamless carbon steel pipe shall be used for all process lines up through 24 inches. Stainless steel and Nickel alloy pipes up to and including NPS 6 shall be seamless.

The joint efficiency value 1.0 and mill tolerance value minus 12.5% shall be used in the wall thickness calculations for seamless pipe.

Material and testing shall be according to applicable material standards (such as ASTM) and with additional requirements applicable MESC SPEs.

12.2.2 Welded Pipe

Welded Pipe having a longitudinal weld joint quality factor of 1.00 (fully radiography of seam) shall be used in sizes as specified in the Piping Classes.

Electric Fusion Welded (EFW), Submerged Arc Welded (SAW), Gas Metal Arc Welded (GMAW) or a combination of SAW and GMAW are permitted. No Furnace Butt Welded or Electric Resistance Welded (ERW) pipe is permitted, HFW is permitted.

Welded Pipe shall only be straight seam; spiral seam pipe is not permitted. Pipe can be welded by a single or a double seam weld.

Heat treatment, Radiography, NDEs and Hydrotest shall be according to applicable material standards (such as ASTM) and with additional requirements applicable MESC SPE.

Carbon steel plate material shall be tested for resistance to HIC in accordance with the method and procedure described NACE TM0284 for Sour service pipes fabricated from the plates.

The calculation of pipe wall thickness shall be in accordance with the code ASME B31.3 for piping classes considering the corrosion allowance, mechanical allowance and mill tolerance as applicable.

For welded pipes, the joint efficiency used is 1.0. A mill tolerance of 12.5% in conformance with the requirements for fittings (e.g. ASME B16.9) is applied. Reduced tolerances where applicable may be considered if the fittings involve manufacturing as per MSS SP 75 for piping classes with API 5L X60 and X 65 materials

12.3 Flanges

All forged Carbon Steel flanges shall be normalised.

Flanges shall conform to ASME B16.5 for the sizes up to NPS 24 and ASME B16.47 Series A for larger sizes NPS 26-60.

Material and testing requirements shall be as per applicable ASTM with additional requirements as per applicable MESC SPEs.

Copper Alloy Flanges shall be to EEMUA 234

Bolt holes shall straddle the centrelines and shall be spot faced as per MSS-SP-9.

Flanges machined from forged Bars / Billets are not permitted.

Flange ‘Bore’ shall match the ID of the corresponding pipe.

Slip-on flanges are not permitted on CS, Alloy Steel, CRA metallic piping systems and piping within the package equipment.

Smooth Finish or Stock Finish for RF/FF Flange face shall mean 'Serrated Concentric' finish as specified in the relevant flange specification and/or Purchase description.

Flange facing finish shall be as given below.

- Finish for RF/FF – Ra 3.2 to 6.3 µm (125 – 250 µin)
- Finish for Ring joint groove – Less than 1.6 µm Ra (63 µin)

Unless noted otherwise, Flat Face Flanges with Full Face gaskets shall be used when connecting piping to Cast Iron or Non-Metallic piping.

Flange sizes above NPS 12 for 2500# rated classes required to mate equipment nozzles shall be as per ASME Section VIII/ Compact flanges as applicable. Wellhead mating flanges shall comply with API 6A weld neck type flanges. API 6B flanges shall be specified for the Wellhead mating flange up to API 5000# rating whereas API 6BX shall be applicable for higher rated Wellhead flanges.

Marking of flanges shall be in accordance with MSS-SP-25.

Piping class pressure-temperature ratings for clad pipe classes shall specify lower pressure-temperature rating of base pipe material or solid CRA.

Clad on flange shall extend to include the flange facing in addition to the flange bore as a minimum.

Flanges developed for special applications shall at least meet the requirements and service rating of the highest rated component in the relevant system.

The groove hardness for RTJ flanges shall be as mentioned below. The mating face of ring joint groove shall be harder than RTJ gasket by 15HB to 20HB.

- CS/HSCS (with soft iron gasket) Min 120 HB
- CS /HSCS (with SS 316L gasket) Min 150 HB
- LTCS Min 160 HB
- Stainless Steel SS316L Min 150 HB
- Stainless Steel SS 321 Min 160 HB
- 6 Moly Min 170 HB
- Alloy 625/825 Min 230 HB
- For API 10,000 material, hardness shall be as per API 6A requirements.

For API 10,000 /5000 line classes the selected nominal size and bore of API SPEC 6A transition flanges (with integral transition piece of 75mm long) shall be such that there is minimum dimensional difference between the weld neck end dimensions OD and ID and the end dimensions (OD and ID) of the mating piping system. For every NPS a project requires, respective API SPEC 6A flange size shall be designated and included for information in the relevant project piping class. Typically, the following flange size specified when joining to the NPS pipe size shown below which shall be reviewed during each project execution.

ASME Pipe Size (NPS)	API 10,000 Flange Size	
	CS	SS316 /Alloy 625/Alloy 825
1	1 13/16"	1 13/16"
1.5“	1 13/16"	1 13/16"
2	1 13/16"	1 13/16"
3	2 9/16” /3 1/16”	3 1/16”
4	3 1/16” / 4 1/16”	4 1/16"
6	5 1/8”/ 7 1/16	7 1/16"
8	7 1/16"	7 1/16"
10	9”	9”

Note: The above size shall be selected by ensuring that the minimum bore of the connecting pipe ID is maintained

ASME Pipe Size (NPS)	API 5000 Flange Size
2	2 9/16”
3	3 1/8”
4	4 1/16”
6	7 1/16
8	9”
10	11”

12.4 Hub Connectors

The Manufacturer designed hub connectors shall be used in the following cases subjected to COMPANY approval and or when specified in pipe class.

- Where flange standards do not cover the size range
- When the weight of the piping needs to be reduced by using hub joints based on project specific consideration.

Pressure Temperature capabilities, Load carrying capacities, Dimensions for example shall be carefully evaluated as they differ largely among different manufacturers.

Hub connectors shall be complete with two hubs, a clamp, a seal ring and bolting. All hub connector components shall be designed, and their performance warranted by the same Manufacturer. Components from different manufacturers shall not be permitted in the same joint.

Hub connectors shall be Grayloc/Techlok or equivalent approved by COMPANY.

Manufacturers of hub ended valves and equipment shall supply hub connectors for their equipment including mating hubs to be welded to the pipe.

12.5 Compact Flanges

Compact Flanges are specified as a preferred option to Hubs and usage shall be restricted for the sizes outside ASME B16.5 / ASME B16.47 Series A range. Usage of compact flanges shall be subject to COMPANY approval. Compact flanges to be manufactured in accordance with Specification BS EN ISO 27509.

The use of Compact Flanges shall be limited to following cases subjected to ADNOC approval:

- Where flange standards do not cover the size range
- When the weight of the piping needs to be reduced on project specific consideration.

Pressure Temperature capabilities, Load carrying capacities, Dimensions for example shall be carefully evaluated as they differ largely among different manufacturers.

Bolting material selection for Compact flanges shall comply with the minimum strength as specified in BS EN ISO 27509 (Note A193 B7M /2HM will not meet this requirement)

12.6 Orifice Flanges

Orifice flanges conform to ASME B16.36 with a maximum size of NPS 24.

Orifice flanges in class 150 shall have class 300 rated flanges with class 150 flanged taps.

Tap sizes for the orifice flanges in Carbon and Alloy steel materials shall be NPS 3/4.

Tap sizes for the orifice flanges in CRA material shall be NPS 1/2 for class 150, 300 and 600 and NPS 3/4 for class 900, 1500 and 2500.

Orifice pressure tapping's shall be connected to the orifice flange with a weldolet or weldoflange using a full penetration weld as an improvement for hydrocarbon/flammable/toxic service. However, for other utility service threaded connections shall be used as applicable

Orifice flanges shall be supplied as a complete assembly including connected tappings.

12.7 Spectacle Blinds (Fig-8 Flanges) & Blinds

The thickness of spectacle blinds (Figure-8) and blinders (Spade & Spacer) shall be calculated in accordance with the applicable ASME B31.3. Detailed calculations shall be submitted for approval. Dimensions of spectacle blinds and blinders shall be as per ASME B16.48. Material shall be as per relevant piping material class.

For sizes and pressure class that are not within the scope of ASME B16.48, vendor shall propose a standard and with justifiable design calculation in compliance with ASME B31.3 which shall be subject to approval.

Material and testing requirements shall be as per applicable ASTM with additional requirements as per applicable MESC SPEs.

Components shall have a corrosion allowance equal or larger than that of the Piping Class. Corrosion allowance will only be applied once (i.e. it will not be applied to both sides of the spectacle blind and blinder)

Flange bore and bore of spectacle blind shall match with the ID of the connected pipe.

Face finish for spectacle blinds (Figure - 8 Flanges), spade and spacers, shall be same as for the mating flanges.

Flange spreaders shall be used when removing blinds and spacers. Use of jack screw is not recommended.

Lifting eyes or shackles shall be fitted with spectacle blinds and spacers blanks weighing more than 25 kg, to facilitate installation and removal.

Unless noted otherwise, use of Spectacle Blinds (Figure - 8 Flanges) shall be as per the Pipe Class and generally limited to the following sizes (above these, Spades and Spacers should be used).

1. NPS <12 for Class rating 150 & 300
2. NPS < 8 for Class rating 600 & 900
3. NPS < 4 for Class rating 1500
4. NPS < 4 for Class rating 2500
5. NPS < 4 for Class rating 5000
6. NPS < 2 for Class rating 10000

Spacer/Spade racks shall be made available and adjacent to spading point locations.

Spectacle blinds fabricated from the plate material corresponding forging material given in the pipe class, shall be acceptable as an alternative (in sour service application plate shall be subject to HIC testing) subject to the approval by the COMPANY.

Handles of spade and spacer shall have identification details die-stamped on both sides with a minimum letter size of 10 mm. Identification detail shall include size, rating, type (“SPACER” or ”BLANK”) and face finish (RF or RTJ). Identification detail shall be outside the flange OD and shall be easily readable in the assembled condition. Additionally, handles of spacers shall be provided with Ø8 mm hole for remote visual indicator. Note blank handles shall not be supplied with any holes for any purpose to avoid misinterpretation

12.8 Fittings

Threaded caps and plugs shall only be used downstream of isolation valves for vents and drains.

Only Butt-welding fittings shall be used for all ASME classes in Sour Service.

Material and testing requirements shall be as per applicable ASTM with additional requirements as per applicable MESC SPEs.

For metallic fittings, unless otherwise noted, dimensions and manufacturing tolerances shall be as per the following specifications:

1.	Butt weld fittings in Steel (Except SR Elbows)	ASME B16.9/MSS SP 75
2.	Socket weld / Screwed fittings	ASME B16.11
3.	Branch Outlet fittings (‘O’lets)	MSS-SP-97
4.	Flanged Fittings, if required	ASME B16.5
5.	BW, SR Elbows, if required (subject to COMPANY's Approval)	ASME B16.9
6.	High strength CS fittings	MSS SP 75
7.	90/10 CuNi fittings	EEMUA 234

All fittings shall be “factory made”. Use of non-factory made fittings including Mitre Bends are not permitted unless otherwise specified.

All forged steel fittings shall be normalized. Free machining steels and fittings made from cold rolled steel bar stock are not permitted. Weld repair of parents fitting material is NOT permitted.

For fittings made from welded tubular elements, the finished thicknesses of the fitting must be within the tolerance required by the referenced standards.

All welds shall undergo radiographic examination and hardness testing when specified in the referenced codes and standard and relevant MESC SPE.

For process and utility services, reduction in pipe size shall be made using Reducers or Swages. Use of bushings is not permitted.

Cross shall not be used.

Lateral tees are special type fittings and their usage (limited to Flares) requires prior approval from COMPANY.

Unions shall only be used for threaded piping system installations and shall conform to MSS SP-83.

12.8.1 Branch Connections

Branch connection shall be made in accordance with the relevant 'Branch Table' under each piping class and shall comply with the requirements of ASME B31.3 (304.3.2 and 304.3.3).

The branch Tables represent minimum requirements for branches for pressure containment. Branch connection table shall be upgraded on a case-by-case basis to meet pipe stress requirements,

Integrally reinforced branch fittings shall meet the requirements of ASME B31.3 Clause 304.3.2.

The basis for the development of these Branching Tables as follows:

a) Equal size branches shall be made with a straight tee with end connections

b) All branches from headers in size NPS 2 and below shall be using Tees. (equal or reduced).

c) All other connections shall be made using branch outlet fittings or "O-let" such as weldolets, sockolets, sweepolets etc., for branch sizes less than half the header size only.

d) The use of weldolets shall be limited up to branch NPS 8 to avoid the risk of welding thermal distortion. Reducing tee plus reducer or Sweepolet shall be used instead. Sweepolet shall be used for lines subjected to vibration like reciprocating compressor lines instead of weldolets

e) BW reducing tees to be used as available in sizes as per ASME B 16.9.

f) Branch Connection made by welding set-on type branches onto the main header, with or without reinforcing pad is not allowed for line subject to acoustic vibration, lines in sour service, toxic/lethal service, lines subject to slugging, cryogenic lines, amine, caustic or other services considered critical and also requiring mandatory PWHT

g) Branch Connection made by welding set-on type branches onto the main header, with or without reinforcing pad (depending on calculation results) is allowed in utility of class 150 rating. Such connection shall be supported by a calculation accordance with chapter 304.3 of ASME B31.3 and shall be submitted for review. The reinforcing pad width shall be equal to half the branch nominal diameter, rounded up to the nearest 5 mm dimension above that value; its thickness shall be equal to the header nominal thickness. Material of the reinforcing pad shall the same as the header pipe.

h) With prior approval of company, Flare header branching (limited to class 150 and non-Lethal service) involving Lateral connection (45 Deg) , pipe to pipe with reinforcement pad may be allowed and shall be supported by a calculation accordance with chapter 304.3 of ASME B31.3 and shall be submitted for review . Oblique connections at 45° may be accepted only for flare, with header above NPS 4.

i) Reinforcing pad shall be provided with a tell-tale hole and shall be tight plugged after the hydrostatic test of the line. Branch connection table shall be submitted with all supporting calculation.

j) Butt welding tee fittings should be used in severe cyclic service (as defined in ASME B31.3).

k) Usage of elbolet shall be avoided and specific usage shall be subject to COMPANY approval.

l) Whenever O' let type branch connections is used for schedule 10/10S header, care has to be taken during welding of such connection to avoid distortion during welding.

m) Drain and vent connections shall not be installed on elbows.

n) Thermowell installation shall be at 90o to the pipe header only, deviation is not allowed. Thermowell connections shall be completed using a flanged thermowell connection, with the design in accordance with ASME B31.3 and flanges as per the requirements of this specification. Where it is practical, branch connections of a weldolet and flange can be replaced with a flanged branch connection.

o) The branch table indicated in piping classes are not applicable for the hot tap connections

12.8.2 Pipe Elbows/Bends

Only long-radius Elbows (R=1.5D) shall be used. Short-radius Elbows shall not be used unless specifically warranted by space constraint and usage shall be subject to Company's approval.

- Mitre bends shall not be used

12.9 Gaskets

12.9.1 General

Gaskets shall comply with the following general requirements.

a) Gaskets shall comply with the applicable piping class.

b) Asbestos or Asbestos filled materials shall not be used for gaskets.

c) Corrugated metal, metal grooved, and spiral-wound gaskets shall be considered as "metallic".

d) Gaskets specified for Sour services shall meet the latest requirements of NACE MR0175/ISO 15156.

e) Graphite filled gaskets shall not be used in seawater service

f) All gaskets shall be suitable for installing between ASME16.5 flanges up to NPS 24 pipe size and ASME B16.47 series 'A' for pipe sizes above NPS 24.

g) Gaskets shall conform to ASME B16.20 for spiral wound type and Ring joint type and ASME B16.21 for flat ring type. Type of gaskets shall be RX or R in line with API 6A requirements. Additional requirements of MESC SPEs like SPE 85/101, SPE 85/103.SPE 85/105 & SPE/112 etc. as applicable, shall also be complied.

12.9.2 Ring Joint Gaskets

a) The RTJ gaskets shall be softer than the RTJ flange groove hardness by minimum 15-20 HB. (Refer section 12.3)

b) Soft iron ring joint gaskets shall be galvanized with electro-galvanizing process for on shelf-protection of the gasket (stock protection only).

c) Ring joint gaskets shall be supplied in seamless construction.

d) Material construction for the gasket for subsea application shall be minimum Inconel 625.

e) Additional requirement of MESC SPE 85/112 is applicable for ring joint gasket.

f) ASME B16.20 ring joint gaskets confirming to Octagonal-type R is generally used However, exact type of ring joint gasket shall be as per purchase description.

g) API 5000 gaskets, confirming to RX is generally used for size upto size 11". BX gaskets are used for size 13 5/8" and above. However, exact type of ring joint gasket shall be as per purchase description.

h) API 10000 gaskets shall confirm to API 6A BX.

i) No welding or weld repairs are permitted on the gasket.

12.9.3 Spiral Wound Gaskets

Spiral wound gaskets with flexible graphite filler shall be used, for all general process services or PTFE, PTFE reinforced as specified in the material description.

a) Flexible Graphite compounds shall contain min. 95% pure carbon grade, except where specific service requirement is determined otherwise.

b) As a standard, SPWD Gaskets shall have a 316 SS inner and CS outer ring. This will be for CS, LTCS and approved NACE specs and 316 SS classes. Other CRA classes shall have gaskets and inner rings suitable to the service fluid.

c) The materials of the spiral wound gasket components, e.g. Filler, windings, outer and inner rings shall be as specified in the material requisition and piping material class requirements.

d) All spiral wound gaskets for use in class 150 services shall be of low stress type which are designed to seat at reduced bolt loads.

e) Graphite based gaskets or where used for filler materials in spiral wound gaskets shall be suitable for temperatures up to 400 Deg C. For design temperatures above 400 °C (Limited to 550 Deg C) pure graphite with an oxygen inhibitor shall be used

f) Graphite based filler in SPWD shall be coated by an adequate corrosion inhibitor in order to prevent possible galvanic corrosion.

g) Gasket components manufactured from Austenitic stainless steel to ASTM A240 Gr 316L shall be provided in solution annealed condition.

h) Additional requirement of MESC SPE 85/103 is applicable for spiral wound gasket.

i) Graphite based fillers shall incorporate an adequate corrosion inhibitor in order to prevent from possible galvanic corrosion.

j) Metal jacketed gasket shall be of double jacket type and shall be in accordance with the requirements of ASME B16.20.

12.9.4 Non-Metallic Flat Gaskets

a) The dimensions of non-metallic flat gaskets shall be in accordance with ASME B16.21 and to match the relevant flange standard and additional requirements as per MESC SPE 85/101.

b) Synthetic rubber gaskets shall be, in general, 3mm thick for diameters up to NPS 6 and 5mm thick for diameters NPS 8 and above.

c) All other non-metallic flat gaskets shall be 2mm thick for diameter up to NPS 14 and 3mm thick for diameters NPS 16 and above.

d) Flat gaskets shall have an anti-sticking coating on both sides. The coating shall be suitable for the temperature range specified in the purchase description

e) To avoid galvanic corrosion, graphite containing gasket should not be used with:

- Austenitic stainless steel piping systems on corrosive aqueous duties.
- Oxidising duty where temperatures may rise above 500°C.

12.9.5 Insulating Gasket

a) For assembly of dissimilar materials, an insulating gasket kits shall be used to avoid galvanic corrosion at the locations specified in the in the material selection report/corrosion risk assessment or at high potential galvanic corrosion locations. Insulating kits in Hydrocarbon service shall be fire safe tested type.

b) The insulating kit shall be suitable for installation on RF and RJ flanges without modification to the standard flange assembly as well as mismatched RTJ to RF flanges. The gasket will also be capable of joining RF flanges to RJ Flanges without modification to the flange or bolting.

c) Each Isolation kit shall contain:1 x Isolating Gasket per kit, 1 x isolating sleeve per bolt, 2 x isolating washers per bolt & 2 x back up washers per bolt. And shall have installation instructions including recommended Bolt torque figures and lengths.

d) Insulating kit assembly shall provide more than 25 MΩ (mega Ohms) of resistance when subject to 1100 DC current and 1500 Volt AC current even after 3 Bolt-up operations.

e) Isolating gasket shall be designed to suit installation with RF flanges with smooth or serrated finish and standard commercial flange face finish as available in the RTJ flanges.

f) The gasket will locate and centre within the bolt circle and shall be maintenance free. The gasket shall have a solid steel core of minimum SS316 (or higher grade suitable for the service) extending from the bore to the outer edge. The steel core will be laminated with GRE G10 or GRE G11 (or approved retainers). The gasket inside diameter will match the pipe bore. Unless specifically agreed fire safe shall have minimum two seals. With prior approval from COMPANY , non-metallic (GRE based) core material for the gasket may be accepted for kits in non-hydrocarbon services with pressure class rating 300# and below.

g) All wetted area, all sealing area and core material shall be suitable for the service media and temperature.

h) In cases where isolation kits are used in conjunction with spectacle blinds or dual plate check valves due notice shall be given in the purchase order.

i) Additional requirement of MESC SPE 85/201 is applicable for insulating gasket.

12.10 Bolting

Bolting shall comply with the requirements of applicable piping class and Material selection guideline AGES-GL-07-001.Also for bolt selection table refer Section C (section 13.1).

Machine bolt shall not be used for flange joints unless specifically required for the application.

Bolting shall be selected to consider strength, NACE and Temperature requirements. Lower strength of sour service bolting material shall be taken into consideration in the flange joint design.

All bolting in sour service shall meet all requirements of NACE

Unless noted otherwise, dimensions for Bolting shall be as follows:

- Bolts: ASME B18.2.1
- Nuts: ASME B18.2.2

Stud bolts shall be continuous full length threaded with minimum two heavy hex nuts,

The stud bolt length shall be determined as shown in ASME B16.5 or ASME B16.47 including allowances for positive tolerances in the flanges, nuts and gaskets. Where spectacle blinds, wafer valves, orifice plate, insulating gaskets are installed, the stud bolt length shall be increased by the thickness of such devices and the extra gaskets.

Threads shall be unified (UNC for bolt diameter ≤1 in. and 8 UN for bolt diameter >1.125 inches as per ASME B1.1, with class 2A fit for bolts and class 2B fit for nuts.

Each Stud shall be complete with 2 Heavy Hex Nuts. Machine-head bolts, where permitted, shall be complete with one Heavy Hex Nut each.

Nuts shall be double chamfered and Heavy Hexagonal type.

The requirements for bolt tensioning shall be as follows unless specified otherwise:

Bolt Diameter	ASME Rating	Service
≥ 1 1/2inch	≥1500	All (other than Hydrogen & Lethal)
≥ 2inc	All	All (other than Hydrogen & Lethal)
≥ 1 1/2inch	≥ 600	Hydrogen service
≥ 1 inch	All	For lethal service

Stud Bolts subject to bolt tensioning shall be supplied with 3 nuts. Bolts in sizes below the range shown above shall be subjected to hydraulic torqueing. Accordingly bolt lengths shall be increased to facilitate attachment of bolt tensioning equipment.

The direct substitution of codes or material specifications shall not be permitted unless specifically approved by the COMPANY. (For example, BS 4882 B7 bolting shall not be substituted for ASTM A193 B7 bolting.)

High temperature (>538°C) bolting may require calculations to evaluate thermal differential strain and the possible need for “Belleville” washers.

All low alloy bolting in service temperature up to 200 Deg C shall be provided with Non Metallic coating (like Xylan 1070 or Takecoat 1000 or approved equivalent) in accordance to Material section Guideline AGES-GL-07-001. Bolting coating above this temperature suitable proprietary coatings with prior COMPANY approval shall be proposed.

Material and testing requirements shall be as per applicable ASTM with additional requirements as per applicable MESC SPEs like SPE 81/001, SPE 81/002 & SPE 81/007.

12.11 CRA Clad piping

The Corrosion Resistant Alloys (CRA) clad Carbon Steel pipe shall be manufactured in accordance with API SPEC 5LD and shall also comply with the requirements of applicable MESC SPE 74/038 & SPE 74/039.

As per API 5LD the cladding is done by metallurgical bonded CRA layer produced by Roll Bonding, Cold extrusion and by weld overlay process.

The thickness of CRA clad layer shall not be taken into consideration for pressure design thickness of base line pipe. Thickness of clad CRA layer shall be 3.0 mm (-0.0 mm/ +2 mm).

A detailed Manufacturing Procedure Specification (MPS) should be prepared prior to manufacture, addressing all factors that influence the quality, reliability and integrity of the product.

The chemical analysis shall be performed in the weld metal in accordance with the requirements of ASME Section IX. For Inconel 625 overlays, the iron (Fe) dilution factor should be controlled and shall be limited to maximum 5%.

For sour service, the Rockwell "C" hardness test results shall comply with NACE MR0175. The maximum Vickers hardness for carbon & low alloy steel shall be 248 HV10, and for Inconel 625 overlay the maximum hardness shall be 345 HV10

a) Wherever 6 Mo overlay is specified, the filler metal used shall be ERNiCrMo-3.

b) Wherever alloy 825/625 overlay is specified, the filler metal used shall be ERNiCrMo-3

c) Where austenitic stainless steel is required, the usage of carbon steel housing with minimum 3mm austenitic stainless steel cladding/weld overlay shall be maximized as an added assurance to prevent external chloride stress cracking in an offshore, salt-laden environment. Piping classes (150 and

above) shall have NPS 4 and smaller solid austenitic stainless steel, and sizes NPS and larger shall be specified as clad. For line classes with a minimum design metal temperature lower than -45 deg C, solid stainless steel shall be used in place of clad.

Where Alloy 825/625 is required, the piping classes specify materials of construction as follows:

- For line classes with a minimum design metal temperature up to -46deg C, for sizes NPS 6 and larger are specified with carbon steel/LTCS housing with minimum 3mm Alloy 825/625 cladding/weld overlay. For size NPS 4 and smaller piping is specified as solid Alloy 825/625
- For line classes with a minimum design metal temperature lower than -46deg C, solid Alloy 825/625 shall be used in place of clad
- For Alloy 825/625 weld over lay Clad Piping, the minimum base pipe thicknesses shall be verified with the cladding vendor. Typically, base pipe thickness is limited to 9mm for weld overlay process

12.12 Valves

Valves shall be selected based on the requirements of the individual piping classes, with regard to type, size range, rating, end connections and materials. Full details of the valves are included on the valve data sheets and in Specification Number AGES-SP-09-003 ‘Specification for Manual Piping and Pipeline Valves’ and applicable MESC SPEs.

12.13 Special Piping (SP) Item

Any items that are not included within the Piping Material Class shall be assigned a Special Piping (SP) Item Number, to enable specific design data to be included, these items will be detailed on SP data sheets and will assigned a unique number to enable them to be shown on the Piping & Instrument Diagrams (P&ID) and also located in the correct position in the design. Typically piping SP items are Strainers, Corrosion monitoring items, Injection quills/fittings, Sampling connection, Hose coupling, Hoses, etc.

12.14 Painting and Colour Coding

All piping after fabrication shall be painted in accordance with the requirements of the COMPANY Paint Specification & Colour Coding Specification.

SECTION C

13 BOLTING SELECTION TABLE

13.1 Bolting selection table

Piping material	Bolt material [ASTM]	Nut material [ASTM]	Allowable design temperature range	Diameter range [inch]
Carbon steel Low alloy steel Stainless steel Duplex stainless steel Super duplex stainless steel Non-ferrous metal Non-Metal	A193-B7	A194-2H	-29 °C to 410 °C	½ ≤ d ≤ 4
Carbon steel (Note 2) Super duplex stainless steel	A193-B7M	A194-2HM	-29 °C to 400 °C	½ ≤ d ≤ 4
Carbon steel LT Stainless steel Duplex stainless steel Super duplex stainless steel Non-ferrous metal	A320-L7 A320-L43	A194-7 A194-7	-101 °C to 400 °C	½ ≤ d ≤ 2 ½ > 2 ½ ≤ d ≤ 4
Carbon steel LT (Note 2) Stainless steel Duplex stainless steel	A320-L7M	A194-7M	-73 °C to 343 °C	½ ≤ d ≤ 4
Low alloy steel	A193-B16	A194-7	-29 °C to 525 °C	½ ≤ d ≤ 4
Low alloy steel	20CrMoVTiB4 -10	20CrMoVTiB4-10	-29 °C to 600 °C	½ ≤ d ≤ 4
Stainless steel	A453-660 Class B or C A193-B8 Class 2	A453-660 Class B or C A194-8	-29 °C to 565 °C -200 °C to 538 °C	½ ≤ d ≤ 3 ½ ½ ≤ d ≤ 1 ½
Very high temperature, Stainless steel flanges	A193-B8 Class 1	A194-8	538 °C to 815 °C	½ ≤ d ≤ 3 ½
Stainless steel LT	A193-B8 Class 2 A193-B8M2 Class 2B	A194-8	-200 °C to 300 °C -200 °C to 300 °C	½ ≤ d ≤ 1 ½ > 1 ½ ≤ d ≤ 3

Piping material	Bolt material [ASTM]	Nut material [ASTM]	Allowable design temperature range	Diameter range [inch]
Notes:				
1. Stud bolts to ASTM A320-L7M with sizes over 63 mm (2½ in) can be supplied with guaranteed mechanical properties as referenced in ASME B31.3. 2. “High sour service” in refinery/gas plant applications and “Sour service” in Upstream applications.				

SECTION D

14 REFERENCE DOCUMENTS

14.1 International codes and standards

American Society of Mechanical Engineers (ASME)	
ASME B 1.1	Unified Inch Screw Threads
ASME B 1.20.1	Pipe Threads General Purpose (Inch)
ASME B 16.5	Pipe flanges and Flanged Fittings
ASME B 16.9	Factory Made Wrought Steel Butt Welding fittings
ASME B 16.10	Face-to-Face and End-to-End dimensions of Valves
ASME B 16.11	Forged fittings, Socket Welding and Threaded
ASME B 16.20	Metallic Gaskets for Pipe flanges
ASME B 16.21	Non-metallic Gaskets for Pipe Flanges
ASME B 16.25	Butt Welding Ends
ASME B 16.34	Valves – Flanged, Threaded and Butt Welding Ends
ASME B 16.36	Orifice Flanges
ASME B 16.47	Large Diameter Steel Flanges
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ASME B 16.48	Line blanks
ASME B 18.2.1	Square and Hex Bolts and Screws (Inch Series)
ASME B 18.2.2	Square and Hex Nuts (Inch Series)
ASME B 31.1	Power Piping
ASME B 31.3	Process Piping
ASME B31.4	Pipeline Transportation Systems for Liquids and Slurries
ASM B31.8	Gas Transmission and Distribution Piping Systems
ASME B 36.10M	Welded and Seamless Wrought Steel Pipe
ASME B 36.19M	Stainless Steel Pipe
ASME Section V	Non-destructive Examination
ASME Section VIII	Boiler and Pressure Vessel Code

American Society for Testing of Materials (ASTM)	
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 105	Carbon Steel Forging for Piping Application
ASTM A 106	Seamless Carbon Steel Pipe for High Temperature Service
ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 182	Forged or Rolled Alloy Steel Pipe Flanged Forged Fittings and Valves and Parts for High Temperature Service
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service

American Society for Testing of Materials (ASTM)	
ASTM A 216	Steel Castings, Suitable for Fusion Welding for High Temperature Service
ASTM A 217	Steel Castings, Martensitic Stainless and Alloy for Pressure Containing Parts Suitable for High Temperature Service
ASTM A 234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Services
ASTM A 240	Heat Resisting Chromium and Chromium – Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
ASTM A 262	Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A275	Test Method for Magnetic Particle Examination of Steel Forgings.
ASTM A 312	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A 320	Alloy Steel Bolting Material for Low Temperature Service
ASTM A 333	Seamless and Welded Steel Pipe for Low Temperature Service
ASTM A 335	Seamless Ferritic Alloy Steel Pipe for High Temperature Service
ASTM A 350	Carbon and Low Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
ASTM A 351	Steel Castings, Austenitic, Duplex for Pressure Combining Parts
ASTM A 352	Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts Suitable for Low Temperature Services
ASTM A358	Electric Fusion Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High Temperature Service and General Applications
ASTM A 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A380	Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A388	Ultrasonic Examination of Steel Forgings.
ASTM A 395	Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 403	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 420	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Low Temperature Services
ASTM A 453	High Temperature Bolting with Expansion Coefficients Comparable to Austenitic Stainless Steels
ASTM A 494	Castings, Nickel and Nickel Alloy
ASTM A 515	Pressure Vessel Plates, Carbon Steel for Intermediate and Higher Temperature Services
ASTM A 516	Pressure Vessel Plates, Carbon Steel for Moderate and Low Temperature Services
ASTM A563	Carbon and Carbon Alloy Steel Nuts
ASTM A 671	Electric Fusion Welded Steel Pipe for Atmospheric and Lower Temperatures
ASTM A 672	Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures
ASTM A 694	Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
ASTM A744	Casting, Iron-Chromium-Nickel, Corrosion resistant, for Severe Service

American Society for Testing of Materials (ASTM)	
ASTM A 788	Steel Forgings, General Requirements
ASTM A 789/789M	Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM A 790/790M	Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe
ASTM A 815	Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
ASTM A 890	Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application
ASTM A 928	Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal
ASTM A 995	Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts
ASTM B 148	Aluminum – Bronze Castings
ASTM B 150	Aluminium Bronze Rod, Bar and Shapes
ASTM B 151	Copper-Nickel-Zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar
ASTM B 165	Nickel-Copper Alloy Seamless Pipe and Tube
ASTM B 169	Aluminium Bronze Sheet, Strip and Rolled Bar
ASTM B 265	Titanium and Titanium Alloy Strip, Sheet, and Plate
ASTM B 363	Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings
ASTM B 366	Factory made Wrought Nickel and Nickel-Alloy Welding Fittings
ASTM B 381	Titanium and Titanium Alloy Forgings
ASTM B 423	Nickel-Iron-Chromium-Molybdenum-Copper (UNS N08825, N08221 and N06845) Seamless Pipe and Tube
ASTM B 424	Nickel – Ferrous – Chromium – Molybdenum – Copper Alloy (UNS N08825 and UNS N08221) Plate, Sheet and Strip
ASTM B 443	Nickel – Chromium – Molybdenum – Columbium Alloy (UNS N06625) Plate, Sheet and Strip
ASTM B 444	Nickel – Chromium – Molybdenum – Columbium Alloy (UNS N06625) Seamless Pipe and Tube
ASTM B 466	Seamless Copper-Nickel Pipe and Tube
ASTM B 564	Nickel Alloy Forgings
ASTM B 637	Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service
ASTM B 705	Nickel-Alloy (UNS N06625, N06219 and N08825) Welded Pipe
ASTM G 48	Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution
ASTM D 1784	Classification System and Basis for Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2467	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

American Society for Testing of Materials (ASTM)	
ASTM D 2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 439	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASME F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

American Petroleum Institute (API)	
API RP 941	Recommended Practice for Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plant
API 6A	Specification for Wellhead and Christmas Tree Equipment
API 6D	Specification for Pipeline Valves (Gate, Plug, Ball and Check)
API 6FA	Specification for Fire Test for Valves
API 5L	Specification for Line Pipe
API 5LD	Specification for CRA Clad or Lined Steel Pipe
API 594	Wafer and Wafer Lug Check Valves
API 598	Valve Inspection and Testing
API 600	Steel Gate Valves Flanged and Butt Welding Ends
API 602	Compact Carbon Steel Gate Valves
API 603	Class 150, Cast, Corrosion Resistant Flanged Gate Valves
API 607	Fire Test for Soft seated Quarter - Turn Valves
API 609	Lug and Wafer Type Butterfly Valves
API 615	Valve Selection Guide
API 622	Type Testing of Process Valve Packing for Fugitive Emissions.
API 623	Steel Globe Valves Valves—Flanged and Buttwelding Ends, Bolted Bonnets
API 624	Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive Emissions
API RP 582	Recommended Practice Welding Guidelines for the Chemical, Oil, and Gas Industries

British Standards Institution (BS)	
BS 4882	Specification for Bolting for Flanges and Pressure Containing Purposes
BS EN ISO 14692	Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 1: Vocabulary, symbols, applications and materials
BS EN ISO 27509	Petroleum and Natural Gas Industries. Compact Flanged Connections with IX Seal Ring

Engineering Equipment and Material Users Association (EEMUA)	
EEMUA 234	90/10 Copper Nickel Alloy Piping for Offshore Applications

International Standards Organisation (ISO)	
ISO 4427	Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply
ISO 13761	Plastics pipes and fittings — Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20 degrees C
ISO 14692	Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 1: Vocabulary, symbols, applications and materials
ISO 15848	Industrial valves — Measurement, test and qualification procedures for fugitive emissions

Manufacturers Standardization Society - Standard Practice (MSS)	
MSS SP-9	Spot Facing for Bronze, Iron, and Steel Flanges
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges, and Unions
MSS SP-75	High-Strength, Wrought, Butt-Welding Fittings
MSS SP-83	Class 3000 and 6000 Pipe Unions, Socket Welding and Threaded (Carbon Steel, Alloy Steel, Stainless Steels, and Nickel Alloys)
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends

National Association of Corrosion Engineers (NACE)	
NACE MR0103/ISO 17945	Petroleum, Petrochemical and Natural Gas Industries -- Metallic Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments”
NACE MR0175/ISO 15156	Petroleum and Natural Gas Industries—Materials for Use in H_2S-Containing Environments in Oil and Gas Production
NACE SP0472	Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments

Energy Institute Guidelines	
---	Avoidance of Vibration Induced Fatigue Failure in Process Pipework

14.2 ADNOC Specifications

In addition to below ADNOC Specifications, COMPANY specific Piping Specifications, Process Specifications, Quality Specifications, Criticality Rating Specification, Painting and Coating specification, Material & Corrosion Specifications, Civil Specifications etc. as applicable shall be applied as applicable and shall be read in conjunction to this specification.

AGES-GL-07-001	Material Selection Guidelines
AGES-GL-08-001	Process Design criteria

AGES-SP-04-005	Emergency Shutdown and On/Off Valves Specification
AGES-SP-09-001	Piping Basis of Design
AGES-SP-09-003	Specification for Manual Piping and Pipeline Valves

14.3 MESC SPE

MESC SPE	Title
MESC SPE 74/001	Carbon steel pipe (Amendments/ supplements to API Spec. 5L)
MESC SPE 74/002	Carbon Steel Pipe (Amendments/Supplements to ASTM A 106)
MESC SPE 74/004	Carbon Steel Pipe (Amendments/Supplements to ASTM A 333)
MESC SPE 74/008	Stainless Steel Pipe (Amendments/Supplements to ASTM A 312)
MESC SPE 74/014	Pipe, Duplex/Super Duplex Stainless Steel ASTM A 790
MESC SPE 74/017	Pipe, Nickel – Copper Alloy ASTM B 165
MESC SPE 74/019	Nickel alloy Pipe to ASTM B 423
MESC SPE 74/026	Nickel alloy Pipe to ASTM B 444
MESC SPE 76/030	Branch Outlets
MESC SPE 76/100	Flanges (Amendments/Supplements to ASME B16.5)
MESC SPE 76/101	Flanges (Amendments/Supplements to ASME B16.47)
MESC SPE 76/110	Fittings (Amendments/Supplements to ASME B16.9)
MESC SPE 76/200	Carbon and Alloy Steel Fittings (Amendments/Supplements to ASTM A234)
MESC SPE 76/201	Carbon Steel Fittings (Amendments/Supplements to ASTM A 420)
MESC SPE 76/202	Stainless Steel Fittings (Amendments/Supplements to ASTM A 403)
MESC SPE 76/210	Carbon Steel Forgings (Amendments/Supplements to ASTM A 105)
MESC SPE 76/211	Carbon and Alloy Steel Forgings (Amendments/Supplements to ASTM A 350)
MESC SPE 76/212	Alloy and Stainless Steel Forgings (Amendments/Supplements to ASTM A 182)
MESC SPE 76/213	Nickel Alloy Forging to ASTM B 564
MESC SPE 76/220	Carbon Steel Plate (Amendments/Supplements to ASTM A 516)
MESC SPE 76/221	Alloy Steel Plate (Amendments/Supplements to ASTM A387)
MESC SPE 76/222	Stainless Steel Plate (Amendments/Supplements to ASTM A 240)
MESC SPE 76/223	Nickel Copper Plate (Amendments/Supplements to ASTM B127)
MESC SPE 77/100	Ball Valves to. BS 5351
MESC SPE 77/101	Gate, Globe and Check Valves (Amendments/Supplements to ISO 15761)
MESC SPE 77/102	Gate Valves (Amendments/Supplements to ISO 10434)
MESC SPE 77/103	Globe Valves (Amendments/Supplements to BS 1873)
MESC SPE 77/104	Check Valves (Amendments/Supplements to BS 1868)
MESC SPE 77/105	Gate, Globe and Check Valves to BS 5154 Copper Alloy, Flanged or Threaded Ends
MESC SPE 77/110	Ball Valves (Amendments/Supplements to ISO 17292)
MESC SPE 77/130	Ball Valves (Amendments/Supplements to ISO 14313)

MESC SPE	Title
MESC SPE 77/131	Through Conduit, Rising Stem Gate Valves to ISO 14313
MESC SPE 77/132	Swing Check Valves to ISO 14313 and API 6D.
MESC SPE 77/133	Dual Plate Check Valves to API 594
MESC SPE 77/134	Butterfly valves to API 609
MESC SPE 77/160	Gate, Globe and Swing Check Valves to ASME B16.34
MESC SPE 77/170	Process to instrument valves
MESC SPE 77/190	Ball and Check Valves, Lined, to Manufacturers Standard, Flanged
MESC SPE 77/200	Valves in Low Temperature and Cryogenic Services
MESC SPE 77/208	Gate, Globe, Ball and Butterfly Valves with Restricted Gland Packing Tolerances Used for Special Services as Listed in SPE 77/303 Section 1.1
MESC SPE 77/211	Valve stem, adapter and bracket dimensions for floating Ball valves
MESC SPE 77/302	Technical Specifications-Valves – General Requirements
MESC SPE 77/303	Technical Specifications-Valves in Special Service
MESC SPE 77/307	Production Testing of Valves in Vacuum services
MESC SPE 77/309	Production Testing of Soft Seated Gate Valves Used for Double Block & Bleed Service
MESC SPE 77/311	Lining for Valves
MESC SPE 77/312	Technical Specifications-Fugitive Emission Production Testing
MESC SPE 77/313	Valves with Corrosion Resistant Alloy (CRA) Weld Overlay Cladding
MESC SPE 77/315	Electro less Nickel Plating sealant surface
MESC SPE 81/001	Alloy and Stainless Steel Bolts (Amendments/Supplements to ASTM A 193)
MESC SPE 81/002	Carbon and Alloy Steel Nuts (Amendments / Supplements to ASTM A 194)
MESC SPE 81/003	Stud Bolts, ASTM A 320
MESC SPE 81/006	Nickel Alloy Bolts & Nuts (Amendment/ Supplement to EN 10269)
MESC SPE 81/007	Coating Requirements for bolts and nuts
MESC SPE 85/100	Gasket, Metal Grooved to BS EN 12560 -6
MESC SPE 85/101	Non-Metallic Flat Gaskets, With or Without Insert (Amendments/Supplements to ASME B16.21)
MESC SPE 85/103	Spiral Wound Gaskets (Amendments/Supplements to ASME B16.20)
MESC SPE 85/112	Metal Ring Joint Gasket to ASME B 16.20
MESC SPE 85/201	Flange Insulation Sets
MESC SPE 85/203	Graphite (Amendments/Supplements to ASTM F 2168)
MESC SPE 85/204	Packing material, graphite and carbon braided yarn (amendments / supplements to ASTM f 2191)
MESC SPE 85/301	Toroidal sealing ring (O-ring) test Procedure (amendments / supplements to Norsok M-710)
MESC SPE 85/201	Flange Insulation Sets

SECTION –E

15 APPENDIX E1 - PIPE CLASS INDEX

Piping materail class index Appendi

SECTION –F

APPENDIX F1 - DETAILED PIPE CLASSES (TO BE ADDED LATER)