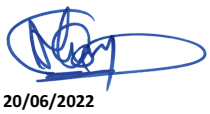
أدنـوك
ADNOC

ADNOC GROUP PROJECTS & ENGINEERING

PIPING MATERIAL SPECIFICATION

APPROVED BY:



20/06/2022

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شركة بترول أبوظبي الوطنية
Abu Dhabi National Oil Company

GROUP PROJECTS & ENGINEERING FUNCTION/ PT&CS DIRECTORATE

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

REVISION HISTORY

DATE	REV. NO	PREPARED BY (Designation/ Initial)	REVIEWED BY (Designation/ Initial)	ENDORSED BY (Designation / Initial)	ENDORSED BY (Designation / Initial)
24/06/2020	1	Arun Kumar Mehta/Sr. SPLT Piping	Ashwani Kumar Kataria/ A/MES,TC-Eng Reuben Yagambaram/ SPM-GPE	Abdulla Al Shaiba/VP-GPE	Zaher Salem/ SVP-GPE
30/05/2022	2	Arun Kumar Mehta Sr. SPLT Piping ARUN KUMAR MEHTA cn=ARUN KUMAR MEHTA, o=ADNOC ONSHORE, ou=Sr, SPLT. ENGINEER TC ENGG., email=amehta@adnoc.ae, c=AE 2022.06.03 13:41:36 +04'00'	Mahmoud Abdel Hakim / HOD Pipelines Eng. - GPE Mahmoud Abdel Hakim Digitally signed by Mahmoud Abdel Hakim Date: 2022.06.06 08:49:23 +04'00' Reuben Yagambaram/ Manager Proj. Portfolio-GPE Reuben Yagambaram Digitally signed by Reuben Yagambaram Date: 2022.06.06 11:21:32 +04'00'	Najem Qambar/ VP Group Eng - GP&E 17/06/2022 Ali AlBreiki/ VP Upstream Projects – GPE 17/06/2022	Ebraheem AlRomaithi / SVP – GPE 20/06/2022

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.

Definitions:

'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 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 and pipe classes attached in Appendix F1 shall be used as the standard piping classes. Service index indicated in pipe class index sheet is for general guideline only and may be updated based on project specific service. Additional piping material classes may be further developed/amended to suit specific Project requirements like process conditions and Material selection report. Any additional pipe classes 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 classes 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 fully rated design conditions (limited to class 900) , 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, ASME B31.8 and DNV-OS-F101

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: means Basic engineering or Define stage of project.

EPC: means Execute stage of project.

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. This 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.

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.

[PSR]' indicates a mandatory Process Safety Requirement.

"PROJECT MANAGEMENT CONSULTANT (PMC)" means persons, firms, companies, or partnerships appointed by COMPANY to perform PROJECT Management services for the PROJECT, on behalf of the COMPANY.

"PROJECT MANAGEMENT TEAM (PMT)" means the COMPANY authorized party responsible for the overall day-to-day execution of the PROJECT, consisting of COMPANY and PMC personnel. PMT is to serve as liaison between COMPANY and the CONTRACTOR(s) on the PROJECT.

'shall' indicates mandatory requirements

'should' means a recommendation

"Specification" means this Piping Material Specification "

MANUFACTURER / SUPPLIER / VENDOR" means the party (parties) which manufactures and / or supplies equipment, technical documents and / or drawings, and / or services to perform the duties specified by COMPANY and CONTRACTOR

"**QUALITY ASSURANCE"** means 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" means a Document setting out the general quality policies, procedures and practices of an organization.

"QUALITY MANAGEMENT SYSTEM": The structure organization, responsibilities, activities, resources and events that together provide organized procedures and methods of implementation to ensure the capability of the organization

"QUALITY PLAN": A document prepared by the CONTRACTOR/SUPPLIER setting out the specific quality practices, resources and activities relevant to a particular project. .

"**SUB-CONTRACTOR / SUB-SUPPLIER / SUB-VENDOR"** means the party (parties), which carry out all or part of the design, procurement, installation and testing of the System(s) as specified by the CONTRACTOR / SUPPLIER / VENDOR.

"TPA" means Third Party Agency, in other words, a company contracted to undertake the third-party inspection and verification tasks on behalf of ADNOC.

"WARRANTY": The party(s) undertaking manufacture of any part of the equipment shall give warranties for workmanship and materials.

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 rate of corrosion determined based on the piping system intended service life.

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 PIPE 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
ADNOC	Abu Dhabi National Oil Company
API	American Petroleum Institute
ACSCC	Alkaline Carbonate Stress Corrosion Cracking
ASCC	Amine 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
CLSCC	Chloride stress corrosion cracking
CLA	Clamp Connector
CLR	Crack Length Ratio
CMTR	Certified Material Test Report
CNAF	Compressed Non-Asbestos Fibre
CONC	Concentric
CR	Chromium
CRA	Corrosion Resistant Alloys
CS	Carbon Steel
CSCC	Caustic Stress Corrosion Cracking
Cu	Copper
DEG	Degree
DPT	Dye-penetrant Testing

Abbreviations	
DNV	Det Norske Veritas
EB	Extended Bonnet
ECC	Eccentric
EFW	Electric Fusion Welding
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
FCCU	Fluid Catalytic Cracking Unit
Fe	Iron
FF	Flat Face
FFG	Female Ring Joint Groove
FKM	Fluorocarbon Elastomer
FLEX	Flexible
FLGD	Flanged
FRP/GRP	Fibre Reinforced Plastic / Glass Fibre Reinforced Plastic
FS	Fire Safe
FV	Full Vacuum
GALV	Galvanised
GEAR	Gear Operated
GO	Gear Operated
GRE	Glass Reinforced Epoxy
GRUP	Glass Reinforced Unsaturated Polyester
GRVE	Glass Reinforced Vinylester
GTAW	Gas Tungsten Arc Welding
H_2S	Hydrogen Sulphide
HAZ	Heat Affected Zone

Abbreviations	
HB	Brinell Hardness Number Symbol per ASTM E10
HNBR	Hydronated Nitrile Butadiene Rubber
HC	Hydrocarbon
HDPE	High Density Polyethylene
HEX	Hexagonal
HF	Hard Facing
HIC	Hydrogen Induced Cracking
IAA	Integrity Assurance Authority
ID	Inside Diameter
IDBB	Integral Double Block and Bleed
IN	Inches
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
LR	Long Radius
LTCS	Low-temperature Carbon Steels
MANUF	Manufacturer
MAX	Maximum
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/NDT	Non-Destructive Examination
Ni	Nickel
Ni-Al-Br	Nickel Aluminium Bronze
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
PCTFE	Polychlorotrifluoroethylene
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	Pressure-Temperature
PTFE	Poly-Tetrafluoro-Ethylene
PVC	Poly Vinyl Chloride
PWHT	Post Weld Heat Treatment

Abbreviations	
Q & T	Quenched & Tempered
QA	Quality Assurance
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
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
SOUR	Sour Service
SPWD	Spiral Wound Gasket
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
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
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 contract award.

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

Deviations from this specification are only acceptable where the CONTRACTOR has listed in his quotation the requirements he cannot comply with, and the COMPANY has accepted in writing with technical justification for the deviations taken before the order is placed. In the absence of a list of deviations, it will be assumed that the CONTRACTOR complies fully with this specification.

Any technical deviations to the Purchase Order and its attachments including, but not limited to, the Data Sheets and Narrative Specifications shall be sought by the MANUFACTURER only through Concession Request Format. Concession requests require CONTRACTOR'S and COMPANY'S review / approval, prior to the proposed technical changes being implemented. Technical changes implemented prior to COMPANY approval are subject to rejection.

8 QUALITY CONTROL AND ASSURANCE

a. SUPPLIER's Quality Management Systems shall comply with all the requirements of ISO 9001 "Quality Management Systems – Requirements" and ISO 9004 "Quality management - Quality of an organization - Guidance to achieve sustained success".

b. Materials and services shall only be procured from and supplied by MANUFACTURERS and CONTRACTORS approved by COMPANY.

c. To ensure that all work is being performed consistently and accurately and to the requirements of the Project Specifications, CONTRACTOR shall ensure that the SUPPLIER shall have in effect, at all times, a QA program which clearly establishes the authorities and responsibilities of those responsible for the Quality System. Persons performing Quality functions shall have sufficient and well-defined authority to enforce Quality requirements that they initiate or identify and to recommend and provide solutions for Quality problems and thereafter verify the effectiveness of the corrective action.

d. Quality System and Quality Control requirements shall be identified and included in the CONTRACTOR's Purchase Documentation. Based on these requirements the SUPPLIER will develop a QA/QC program which shall be submitted to the CONTRACTOR for review and approval. The SUPPLIER's QA/QC program shall extend to SUB-CONTRACTORS and SUB-SUPPLIERS.

e. On request, the SUPPLIER shall provide objective evidence of QA/QC surveillance for all levels of the SUPPLIER activity.

f. COMPANY/ CONTRACTOR reserves the right to inspect materials and workmanship at all stages of manufacture and to witness any or all tests. The SUPPLIER shall provide the CONTRACTOR with a copy of its manufacturing Inspection and Test Plan and with copies of all related/ referenced procedures for review and approval in accordance with the agreed document schedule.

g. SUPPLIER Inspection and Test Plan will be reviewed by COMPANY for inclusion of any mandatory COMPANY/ CONTRACTOR witness or hold points.

8.1 QUALITY PLAN

a. The CONTRACTOR'S Quality Manual shall provide details for the preparation of a Quality Plan in accordance to AGES-GL-13-001-Contractor QA/QC Requirements, which shall include provisions for the QA/QC activities. The Quality Plan shall be submitted to COMPANY for approval. Moreover, in case of any revision in the Quality Plan due to change in Quality Management System, then the revised QP shall be submitted for COMPANY approval before initiating any service activities.

b. The level of detail required in the Quality Plan shall be commensurate with the scope of services provided.

c. During services / activities, Quality Assurance / Quality Control issues are the responsibility of the SUPPLIER and shall be approved and certified by the Third-party Authority (TPA).

d. All Conflicts among CONTRACTOR, SUPPLIER & TPA shall be reported in writing to COMPANY for resolution.

8.2 SUBCONTRACTORS/SUBVENDORS

a. The VENDOR shall assume unit responsibility and overall guarantee for the pipes, fittings and flanges supplied by VENDOR.

b. The VENDOR shall transmit all relevant purchase order documents including specifications to his SUB-VENDORS and SUB-CONTRACTORS.

c. It is the VENDOR'S responsibility to enforce all Purchase Order documents including specifications to his SUB-VENDORS and SUB-CONTRACTORS.

d. The VENDOR shall submit all relevant SUB-VENDOR and SUB-CONTRACTOR drawings and engineering data to the CONTRACTOR.

e. The VENDOR shall obtain and transmit all SUB-VENDOR and SUB-CONTRACTOR warranties to the CONTRACTOR/COMPANY, in addition to the system warranty.

f. Piping components 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 component.

9 CRITICALITY RATING FOR MATERIALS AND INSPECTION CLASS

a. A Criticality Rating (CR) shall be assigned to material components and shall be stated on Material requisitions by CONTRACTOR. Criticality Rating (CR) requirements shall be as specified in AGES-SP-13-001.

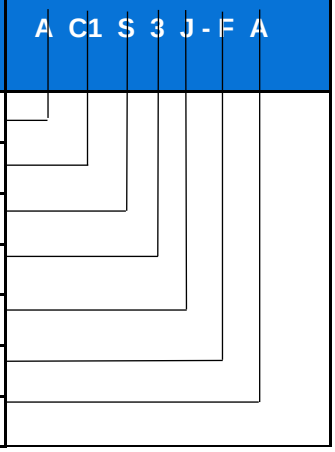
b. Material certification and inspection class of pipes and piping components shall be in accordance to Specification for Procurement Inspection & Certification Requirement in Projects, AGES-SP-13-002.

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
1st	Pressure Rating	Alphabetic	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

Basic Material	Basic Material Detail	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/ A671-C65 CL22	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
	ASTM A312-TP347 CL1	S5
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

Basic Material	Basic Material Detail	Code
	5CR - 1/2MO (P5)	G2
	9CR - 1MO	G3
Corrosion Resistant Alloy / Special alloy	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
	GRUP	P5
	GRVE/GRUP	P6

10.3 Third Symbol - Service Identifier

Service Identifier	Code
Non Sour	A
Mandatory PWHT-Sour	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

10.5 Fifth Symbol - Valve Trim Identification

Valve Trim	Code	Remark
Stainless Steel Type 316	A	
13CR/SS 316	B	Trim 13 Cr for all valves. SS 316 for ball valve only
Alloy 825	C	
Alloy 625	D	
Super Duplex Stainless Steel	E	
Aluminium Bronze	F	
Monel 400/500	G	
Alloy 20	H	
Hastalloy 276	I	
Plastic CPVC	J	
Titanium	K	
AISI 321	L	

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
Combination of High Temperature(>200°C) and Cryogenic (< -50°C)	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 Hydrocarbon and Sour hydrocarbon piping services, including in VENDOR package piping (subject to these services) 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
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 Critical service as defied in Piping design basis (AGES-SP-09-001) 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 Normal service as defied in Piping design basis (AGES-SP-09-001) (including Plant air, Steam etc.) provided it is not subject to vibration.

11.4 Wet H_2S/Sour Services

The applicability of “wet H2S / Sour Service” requirements shall be as defined in NACE MR0103 / ISO 17945, for Refinery Service and NACE MR0175/ISO 15156 (including its supplements, modified narrative) for Upstream Services.) in addition to “Requirements for Materials in Sour Service”, AGES-SP-07-003

Following additional requirements shall apply

a) For requirements such as CE, Sulphur content, HIC requirements, hardness etc refer to clause 12.1 below, the document “Materials Selection Guidelines” Doc. No. AGES-GL-07-001 and “Requirements for Materials In Sour Service”, AGES-SP-07-003.

b) 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. SS piping specified to NACE MR0103 / ISO17945 shall have Stainless steel trim SS 316 as minimum (complying with NACE MR0103 / ISO 17945 hardness).

c) Austenitic stainless steel and DSS / Super DSS (SDSS) is susceptible to CLSCC / SSC in sour service / wet H2S environments dependent on the concentration level of chlorides as well as other variable limits in line with AGES-SP-09-003 and NACE MR0175 / ISO 15156-3..

d) The longitudinal welds of fabricated piping shall 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 pressure leak tested prior to initial operation.

f) Valves in sour service shall be required to meet fugitive emission class BH 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 contain very large amounts of H_2S (H2S> 500ppm) in liquid or vapour phase or containing Hydrofluoric Acid Service are identified as “Lethal service”. lethal service definition is based on Facility Layout and 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. All such piping systems categorised as ‘Toxic / Lethal’ the following requirements shall apply to piping or piping components.

a) 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.

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

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

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

e) Valves shall be required to meet fugitive emission class AH as per ISO 15848 Parts 1 & 2 as indicated in Piping & Pipeline Valve specification AGES-SP-09-003

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, Produced water Fire water etc.), non-metallic piping (for example Fibre- Reinforced Plastic (FRP i.e. GRE/GRVE/GRUP) / HDPE/CPVC etc.) may be used as specified in material selection report.

a) For Plant drain service (Sour /non-sour), Glass Reinforced Epoxy (GRE) can also be used if it meets the Pressure & Temperature limits and as per material section reports recommendations

b) 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 and shall be in accordance to AGES-SP-10-008. 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 50° C based on AGES-SP-10-008.

- 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 50° C.
- Piping to be used for fire water services shall have Factory Mutual approval (i.e., comply with FM Approval Standard Class No. 1613 latest edition)

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. The Maximum allowable operating pressure for elevated temperature shall be calculated after applying suitable de-rating factor of Table A.1 as per ISO 4427-1 (up to 40ºC) or as per Raw material manufacturers recommendation based on regression analysis as per ISO 9080 (when the temperature exceeds 40ºC).

c) 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 / Glass Fibre Reinforced Piping (FRP/ GRP)

a) FRP pipe systems shall be in accordance with AGES-SP-09-014, Fibre Reinforced Plastic Piping and Pipeline Systems and 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) FRP for use in potable water service, pipe system shall be certified to WRAS standards

c) 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.

d) 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

e) 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) FRP 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 FRP piping shall be provided to cater to storage, handling and installation for both above ground and buried application.

k) FRP piping should not be used in services where significant vibration will occur. Direct hook up with rotating equipment should therefore be avoided

l) Electrical conductivity requirements for FRP shall be assessed during project stage based HSE risk studies.

m) Fire and blast scenario: Risk assessment of the GRP piping shall be carried out duly considering the connected equipment and adjacent equipment in the facility. The risks to be assessed shall be including but not limited to:

- Jet Fire
- Pool fire
- Flame Impingement
- Blast
- Steam formation
- Smoke emission, visibility and toxicity
- Heat release and spread of fire

The method of risk assessment shall be as per HSE studies and as agreed by the COMPANY

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) Piping shall be designed for full vacuum irrespective of size.

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 Services

a) Caustic service with any concentration shall be considered as severe service in line with “Requirements For Materials In Sour Service”, AGES-SP-07-003

b) 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.

c) Carbon steel welds in Caustic Service shall be stress relieved including attachment welds irrespective of thickness. (Refer section 12.1.2)

d) Piping for Caustic 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 Service shall be clearly marked “CAUSTIC 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 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 and the same shall indicated in piping drawings and models.
- Supports shall not be welded to the pipe and if welded shall be PWHT
- Maximum velocity limit for caustic service shall be in accordance with AGES-SP-08-001 Process Design Criteria

e) Requirements of API RP 571 / NACE SP0472 shall be applicable for caustic service and carbonate severity services

11.10 Sulphuric Acid Services

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

b) Dilute Sulphuric Acid service shall use PVDF / PTFE lined carbon steel piping or as specified in material selection report.

c) 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.

d) Carbon steel piping for Sulphuric Acid Service shall comply with the following requirements:

i. The number of pipe bends and elbows shall be restricted to the absolute minimum.

ii. Pipe bends shall have a radius of at least 5D (where D is the nominal pipe diameter) or use two 45-degree LR elbows with at least 10 D straight section between the elbows.

iii. Standard elbows, which shall be used for sweep-in connections, shall be of the long-radius type with a radius of 1.5D.

iv. Pipe reducers shall be avoided as far as possible. Where a reduction is necessary, the reducer shall reduce not more than one size and be concentric (in vertical pipe runs only) , 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.

v. For equal branches, factory-made wrought buttwelding tees shall be used.

vi. For unequal branches other than instrument connections/drains/vents, 45° laterals, Y-type or sweep-in junctions shall be used

vii. Fabricated pipe to pipe connections, or fabricated fittings shall not be used.

viii. Flat ring gaskets, with ID dimensions matching the bore of the pipes and a thickness of minimum 2 mm, should be used for class 150.

ix. For sulphuric acid service, GTAW shall be used for piping NPS 2 and smaller and for the root pass of larger size piping

x. For all piping systems in sulphuric acid service (for all concentrations), horizontal pipes shall be self-draining, having a slope of at least 1:100 unless specified otherwise.

xi. All drawings for the fabrication of carbon steel piping intended for this service shall be clearly marked “SULPHURIC ACID SERVICE."

xii. Carbon steel piping shall be clearly identified, either by painting or fixing an adhesive tape around the parts, to show that it is in SULPURIC ACID SERVICE.

11.11 Chlorine Services

Chlorine shall be treated as a very toxic-environment. The following shall be considered for dry chlorine service

a) Piping shall be defined as Critical service in line with AGES-SP-09-001

b) For chlorine service, piping arrangements should be as simple as possible, with a minimum of welded or flanged connections.

c) Horizontal pipes shall be self-draining with a slope of at least 1:100.

d) The number of field welds should be minimized

e) GTAW shall be used for piping NPS 2 and smaller and for the root pass of larger size piping

f) Hydrostatic testing shall be carried out before the system is finally cleaned and dried (i.e., use test gaskets).

g) Piping shall be clearly identified, either by painting or fixing an adhesive tape around the parts, to show that it is in CHLORINE SERVICE

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

11.12 Low Temperature

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 and up to -46°C

a) 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 AGES-SP-09-013, AGES-SP-07-008,

b) Valves in pipe class with minimum design temperature up to -50°C (non-cryogenic pipe class) and if they are operating in continuous operating temperature between -10°C and -46°C then extended bonnet valves shall be provided in line with EEMUA 192.

c) 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 Cryogenic Services

“Cryogenic service” is defined as piping with design temperature from -50°C to -196°C with continuous operating temperature typically below -46°C. For Cryogenic service the following shall be applied as applicable.

a) Valves in cryogenic services (i.e., design temperature below - 50°C) and with continuous operating temperature below - 10°C shall be provided with an extended bonnet and cryogenic acceptance testing in accordance with the requirements of BS 6364.

b) However, if the valves are only operating for short term low temperature excursion below -50°C (with normal operating temperature mainly above -10°C) then non-extended bonnet is acceptable provided

the valve seals and packing are designed for minimum design temperature. Typical example of such cases are non-operable valves during depressurization and/or non-insulated valves.

c) Spectacle blinds should not be used in Cryogenic service to avoid icing issues. Spacer and blinds shall be used instead.

11.14 Brine Service

Glass Reinforced Epoxy pipe (GRE) shall be used for brine services. Materials and installation shall be in accordance with AGES-SP-09-014 and ISO 14692 Part 1 and 2 'Requirements for Fibre Reinforced Plastic (FRP) Pipes and Fittings'

11.15 Waste and Open Drain Piping

Waste and Drain system (gravity system for Onshore application) piping for unpolluted Rainwater, Oily Water, and Sanitary Waste water are not covered as part of this specification and shall be covered as part of Civil specification (AGES-SP-01-007). However, the recommended materials are as below

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

11.16 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. (Example 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..

11.17 Fire Water Piping

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

The below are recommended materials unless specified otherwise by material selection report for fire water system based on the type of water sources. In case of conflict the material section recommendation shall govern:

i. **Seawater- Fire water network (Wet)** - 90/10 Cu-Ni and GRE.

ii. **Freshwater-Fire water network (Wet) -** For Onshore only - GRE (Underground), Carbon Steel FBE Lined (Above ground for NPS 3 and above) and SS 316/SDSS/Cu-Ni based on Material selection report (Above ground for NPS 2 and below)

iii. **Dry Fire Systems** – Galvanised CS / 90/10 Cu-Ni / Super Duplex Stainless Steel (SDSS)

iv. **Foam System (concentrated)** - Stainless Steel Type 316/316L

v. **Foam Solution (wet system with Fresh water)** - Carbon Steel FBE Lined

. The following are recommended for fire water piping: -

a) The use of FRP piping is normally avoided for onshore above ground applications. This is because these are prone to mechanical damage and fire damage.

b) Where FRP pipe shall be mandatory to be specified and supplied with a UV protective coating for both above ground and underground application.

c) For use in Fire Water services, FRP shall be supplied with Fire endurance properties and product be certified by a certifying authority such as Factory Mutual (FM). Fire performance test shall be carried out as per ISO 14692

d) Additional if identified in HSE studies, in above ground applications in critical areas (offshore applications like well platform, etc.), fire retardant topcoat shall be applied.

e) 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 impeller 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.

11.18 Vacuum Service

All metallic piping class sizes up to and including NPS 24 shall meet the design condition of full vacuum at ambient temperature by default irrespective of service condition.

a) 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.

b) Pipe and fittings larger than NPS 24 shall be designed for vacuum condition when specified in process documentation like line list, etc. However, all piping components in containing condensable gasses such as steam services and in situations where sub-atmospheric pressure may occur as the result of liquid surge or steam-outservices or as identified in the line list shall be designed for full vacuum irrespective of size.

c) Vacuum rings shall only be used with COMPANY approval (specify the minimum spacing between the rings)

11.19 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, Amine service with any concentration shall be considered as severe service in line with “Requirements For Materials In Sour Service”, AGES-SP-07-003. The following shall be considered for Amine service piping

a) API RP 945 requirements shall be applied for amine service piping including closure welds.

b) For amine service, carbon steel piping and piping component welds including attachments 9 such as supports, weldolet branches, etc) 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 12.1.2)

c) FKM (fluorinated, carbon-based synthetic rubber) and CAF (silicon-based sealant) shall not be used in amine services, however CNAF suitability for amine service shall be confirmed by MANUFACTURER.

d) Maximum velocity limit for amine service shall be in accordance with AGES-SP-08-001 Process Design Criteria

11.20 Acoustically Induced Vibration & Flow Induced Vibration Study

a) 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.

b) 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 of high-pressure drops of pressure-reducing device in vapor/gas services like a relief valve, control valve, depressuring valves, choke valves, blowdown valves etc. The actual extent of the affected piping and the sound power level / piping class is provided by Process Engineering.

c) One of the primary prevention measures to avoid pipe failure other than line size change or RO size change, is the pipe wall thickness to be thickened (in sections determined to be affected). Hence additional AIV related piping classes may be required to be developed. These classes shall include the requirement for thickened pipe wall and other support locations. Applicable pipe classes shall be suitably amended for optional thickness.

d) 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.

e) Energy Institute guidelines for 'Avoidance of Vibration Induced Fatigue Failure in Process Pipework' shall be followed to mitigate impact of AIV/FIV. Refer "Specification For Piping System Stress & Flexibility Analysis", AGES-SP-09-004 for further details on AIV and FIV

11.21 Seawater Service

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

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

- NPS < 2: 90/10 CuNi
- NPS ≥ 2: FRP with UV protection / CS +FBE or Cement lined

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

Maximum velocity limit for seawater service shall be in accordance with AGES-SP-08-001 Process Design Criteria

11.22 Sodium Hypochlorite Service

Filament-wound fiberglass reinforced vinyl ester (GRVE) pipe or as specified in the material selection report shall be used for sodium hypochlorite service.

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.

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 as specified in applicable piping AGES standards like AGES-SP-09-003, AGES-SP-09-013, AGES-SP-09-014, AGES-SP-09-015, etc , 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% and maximum carbon equivalent of 0.43%. 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:

a) 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.

b) “Silicon Killed” carbon steel has been specified for all Piping Classes where the materials of construction are specified as carbon steel.

c) CS / LTCS forgings shall be supplied in the normalized or normalized & tempered condition. .

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

e) Stainless steel, duplex stainless steel and SDSS shall be Solution Annealed condition when specified in the relevant material standard,

f) Inconel 625/ Incoloy 825 forged materials shall be furnished in the annealed condition and castings shall be solution annealed condition in accordance with relevant material standard unless specified otherwise

g) Cast iron shall not be used in Hydrocarbon services.

h) Impact testing on steels shall be in accordance with ASME B31.3 based on minimum design metal temperature (MDMT) and pipe wall thickness with additional requirements as specified in AGES-SP-09-013. 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 with additional requirements as specified in AGES-SP-09-013

i) LTCS material, shall be impact tested at a temperature of minus 46 °C

j) Impact testing is required for ASTM A694 material at applicable piping class minimum design temperature.

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

l) SDSS material shall have minimum 25% Cr and PREN>40. Duplex steel shall have minimum 22% Cr and PREN > 34

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

n) SS316/SS316L shall be supplied in Dual Certification.

o) All 90/10 and 70/30 Copper Nickel shall be in compliance with manufacturing and heat treatment requirements mentioned in EEMUA 234 and shall be supplied in annealed condition.

p) Alloy 20 pipe and components shall be furnished in stabilized-annealed condition.

q) All Titanium pipe and components shall be finished in the annealed condition.

r) Hastelloy 276 pipe and components shall be furnished in solution annealed and descaled condition

s) All Clad piping shall comply with AGES-SP-09-015

t) Positive Material Identification (PMI) test shall be carried out for all Stainless steel, CRA, Cu-Ni alloy materials prior to packing in accordance to AGES-GL-13-002. 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.

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

12.1.1 Sour Service

For “Sour Service” and Wet H2S service application, all material shall comply with NACE MR0175/ISO 15156 for upstream processes, NACE MR0103/ISO 17945 for downstream processes and “Requirements for Materials in Sour Service”, AGES-SP-07-003.. Material in sour service shall meet the requirements of AGES-SP-07-003 for chemical composition, hardness, etc

a. For Sweet (Non sour) and Sour service, Carbon Equivalent (CE) based on the Ladle Analysis shall not exceed 0.43, calculated by the following formula (all values in weight %)

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

b. For sour service the carbon content shall be as below in in accordance with AGES-SP-07-003.Carbon equivalent shall be 0.43.

- Seamless Piping : 0.23%
- Welded Piping : 0.20 %
- Forging : 0.23%
- Casting : 0.21%

c. For sour service the sulphur shall be limited as below in in accordance with AGES-SP-07-003.

- Seamless Piping : 0.010%
- Welded Piping : 0.003%
- Plate : 0.003%
- Forging : 0.02%
- Casting : 0.02%

d. Neither the yield strength nor the ultimate tensile strength for carbon steel shall not exceed minimum value by more than 20,000psi

e. No HIC / SSC testing is required for seamless piping that comply with the chemical compositional limits, CE of 0,43, Carbon content of 0.23 and Sulphur content below 0.01%, etc. in line with AGES-SP-07-003

f. HIC testing & cross-weld SSC testing is required for welded pipe and shall be as per, AGES-SP-07-003.

g. HIC testing for CS & LTCS plate material in sour service in accordance to AGES-SP-07-003

h. No HIC / SSC testing is required for conventional forgings that comply with the chemical compositional limits, CE of 0,43, Carbon content of 0.23 and Sulphur content below 0.02%, etc in line with AGES-SP-07-003

i. No HIC / SSC testing is required for cast material complying with the composition limits chemical compositional limits, CE of 0,43, Carbon content of 0.21 and Sulphur content below 0.02%, etc in line with AGES-SP-07-003

j. Carbon and low alloy steel subject to cold deformation resulting in permanent outer fiber deformation greater than 5% shall be stress-relieved in accordance with NACE MR0175 / ISO 151516-2 and meet the final hardness specified.

k. Hardness requirement of base material and production welds for upstream and downstream refinery application shall be as per AGES-SP-07-003 including NACE MR0175 / ISO 15156, and NACE MR0103 / ISO 17945 / NACE SP0472 as applicable. The maximum value of hardness in Carbon steel pipe weld, HAZ and parent material shall be as below unless otherwise specified for special product form in the above specifications is 22 HRC or 248 HV10

l. Monel shall not be used at temperatures above 90 °C in sour service / wet H2S service

m. For DSS & SDSS piping, NORSOK M650 / ISO 17782 qualification for specific sizes and product forms or process route is mandatory in sour service / wet H2S service applications

n. NDE Coverage for CS, SS & CRA piping shall be 100% for all thickness for sour service / wet H2S service applications

o. Non-Destructive Examination (NDE) at the manufacturing stage of the materials in sour and severe service shall be in accordance with the requirements of the AGES-SP-07-003, AGES-SP-13-002, AGES-SP-09-013, AGES-SP-09-015 applicable ASTM material specifications and the approved Inspection & Test Plan (ITP).

p. All Elastomers in sour service shall be qualified in accordance with ISO 23936 part 1 and part 2., NORSOK M710, NACE TM0187 in line with AGES-SP-07-003 section 9.2. Nitrile Butadiene Rubber (NBR) shall not be used in sour service / wet H2S service.

12.1.2 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:

i. ASME B31.3 – Process Piping

ii. API RP 582 - Recommended Practice Welding Guidelines for the Chemical, Oil, and Gas Industries

iii. NACE MR0175/ ISO 15156 - Material for Sour Environment' for Upstream applications

iv. NACE MR0103/ISO 17945 - Metallic materials resistant to sulphide stress cracking in corrosive petroleum refining environments'

v. NACE SP0472 - Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments

vi. Requirements for Materials in Sour Service", AGES-SP-07-003

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 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, 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 service pipe work, including conditions where caustic carryover may occur (e.g., downstream of caustic injection points) in accordance with API 571 / NACE SP0403

ii. All Amine service piping work in accordance with API RP 945 and NACE SP0472

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. All Alkaline Carbonate piping (particularly in FCC unit) as per NACE SP0472 for “MODERATE” and “HIGH” severity categories of ACSCC service as defined in AGES-SP-07-003

vii. PWHT is specified by Licensor

c) For Non-Sour services PWHT is required in accordance to ASME B31.3 including code exemption as applicable.

d) Upstream and Mid-stream Sour Application: For carbon and low alloy steel in “Sour oil and gas production and in natural-gas sweetening plants in H2S-containing environments” (i.e. following NACE MR0175/ ISO 15156), PWHT is required. However, Code exemptions for PWHT is permitted only for following conditions.

i. Thickness is less than and equal to 19 mm, provided if hardness requirement of NACE MR0103/ NACE SP0472 is met. In such case all requirement of Table 331.1.3 of ASME B 31.3 including multilayer welding for thickness >5mm are met

ii. Welds are not double sided i.e., Flange Girth welds

iii. No Internal weld repair and internal weld build up for dissimilar thickness joints

e) Refinery Sour Application: For carbon and low alloy steel in “Sour Refining and related processing environments” (i.e. following NACE MR0103/ISO 17945) the following are applicable:

i. For piping in Class 600 and above PWHT is mandatory irrespective of sour severity or thickness without exception

ii. For “HIGH” severity service PWHT is required for all thickness without exception irrespective of class rating.

iii. For LOW” and “MODERATE” severity service with class 300 and below: PWHT is required for all thickness to meet the hardness requirements as defined in NACE MR0103/ISO 17945

& NACE SP0472. However, Code exemptions for PWHT is permitted only for thickness are less than and equal to 19 mm, provided if hardness requirement of NACE MR0103/ NACE SP0472 is met. In such case all requirement of Table 331.1.3 of ASME B 31.3 including multilayer welding for thickness >5mm are met and

- Welds are not double sided i.e Flange Girth welds,
- No Internal weld repair and internal weld build up for dissimilar thickness joints

Note "High severity" and "Low and Moderate severity" shall be defined in process line list and material selection report and the same shall be reflected in the project specific pipe class index

12.2 Pipe

a) All metallic pipes shall conform to requirements of AGES-SP-09-013.

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

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

d) Pipe NPS 1¼, 2½, 3½, 5, 7, 9 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.

e) 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 with prior approval from COMPANY

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

g) 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/DS/SDSS/Inconel/Monel/ Cu-Ni/Titanium	All	Zero

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

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

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

j) 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

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

l) 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.

m) 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. 5 - 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

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

o) 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
- -29ºC to 427ºC : Killed Carbon Steel / CR-Mo Steel

- Above 427ºC (for B 31.3) : Cr-Mo steel

p) Impact test for Carbon steel & LTCS material shall be required in accordance with following:

i. Carbon steel Material: All pipe, fitting, flanges in CS material with governing Nominal Thickness > 5.08 mm, Charpy impact tests shall be carried out in accordance with ASTM A370 at a temperature of -29 °C (-20 ˚F) with CVN ⩾ 27 J (full-size specimens).

ii. LTCS Materials: All pipe, fitting, flanges in LTCS material, shall be impact tested at a temperature of minus 46 °C. Impact test results as an average of three tests shall be at least 27 J for standard size specimens (10 mm x 10 mm). Only one result may be lower than 27 J, but it shall be at least 21 J

iii. 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

q) API 5l pipes with grades higher than X65 shall not be used of ASME B 31.3 piping unless specially approved by COMPANY

r) 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.

s) Copper Nickel pipe shall be as per EEMUA 234 complying with all material, dimensional details and tolerances. The nominal rating of Cu-Ni pipe shall be of 20 bar rating. Any usage of 16 bar rating Cu-Ni piping shall be with prior approval from COMPANY

12.2.1 Seamless Pipe

a) 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 16 inches. Stainless steel and Nickel alloy pipes up to and including NPS 6 shall be seamless.

b) The joint efficiency value 1.0 and mill tolerance value minus 12.5% shall be used in the wall thickness calculations for seamless pipe.(refer table below)

c) Material and testing shall be according to applicable material standards (such as ASTM) and with additional requirements as stated in this specification and relevant applicable specification like AGES-SP-09-013. For sour and severe service, additional requirements of , AGES-SP-07-003 is required.

12.2.2 Welded Pipe

a) 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.

b) 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 not permitted in sour service.

c) 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. Circumferential welded joints are not permitted

d) Heat treatment, Radiography, NDEs and Hydrotest shall be according to applicable material standards (such as ASTM) and with additional requirements as stated in this specification and relevant applicable specification like AGES-SP-09-013.

e) In Sour and severe service, welded Carbon steel pipe fabricated from plate material shall be tested for resistance to HIC in accordance with the method and procedure described NACE TM0284 in line with AGES-SP-07-003. Cross –weld SSC test is also required for sour service as per NACE TM0316 in line with AGES-SP-07-003.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.

f) For welded pipes, the joint efficiency used is 1.0.

12.2.3 **Manufacturing Tolerances**

The below table defines the manufacturing tolerances for pipe and pipe components

Size range	Basic Material	Pipe	Fittings (including Olets)	Flanges	Remarks
NPS 16 and below	CS and LTCS	±12.5%	±12.5%	±12.5%	Seamless pipe and fittings
NPS 18 and above	CS and LTCS	As per applicable ASTM/API 5L	+ 12.5% (-) 0.254mm as per MSS SP 75 Section 13.3	+12.5% (-) 0.254mm as per MSS SP 75 Section 13.3	- Welded pipe and fittings - Under tolerance of fittings and flanges shall not be less than pipe
All size	SS, SDSS, CRA and CU-Ni	±12.5%	±12.5%	±12.5%	

It may me noted that the current pipe classes in Appendix F are based on 12.5% mill tolerances, however the above tolerances shall be applied in project pipe classes during project stage. When applying the reduced tolerances, it shall be ensured that under tolerance considered in wall thickness calculation shall be highest among the piping components of particular piping class and in compliance with applicable Standard. For example, if under tolerance of pipe is -12.5% and that of the fitting is 0.254 in accordance to MSS SP 75, the mill tolerance selected in wall thickness calculation shall be -12.5%.

12.3 Flanges

a) All metallic flanges shall conform to requirements of AGES-SP-09-013.

b) 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. In addition all flanges shall conform to requirements of AGES-SP-09-013

c) Material and testing requirements shall be as per applicable ASTM with additional requirements as stated in this specification and relevant applicable specification like AGES-SP-09-013. For sour and severe service, additional requirements of “, AGES-SP-07-003 is required.

d) All forged Carbon Steel flanges shall be normalized.

e) Copper-Nickle Alloy Flanges shall be to EEMUA 234

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

g) Flanges machined from forged Bars / Billets are not permitted.

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

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

j) 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.

k) Flange facing finish of various type of flanges shall be as per AGES-SP-09-013.

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

m) 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.

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

o) Piping class pressure-temperature ratings for clad pipe classes shall specify lower pressure-temperature rating of base pipe material or solid CRA. Refer AGES-SP-09-015 for requirements of clad flanges.

p) Clad on flange shall extend to include the flange facing (gasket seating area for both RF & RTJ) in addition to the flange bore as a minimum.

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

r) The groove hardness for RTJ flanges shall be as defined in AGES-SP-09-013. The mating face of ring joint groove shall be harder than RTJ gasket by 15HB to 20HB.

s) Flanges, blind flanges, Flageolet, spectacle blinds, paddle blind & spacer used for API 5000 and API 10000 class, shall comply with requirements of API 6A, Table 6 and shall comply with PSL 3 requirements of API 6A

t) For API 6A (API 10,000 /5000 PSI) line classes the selected nominal size of API 6A flanges shall be selected such that there is minimum dimensional difference between the API 6A flange bore and the bore of the mating piping system. In addition, API 6A flanges shall be supplied with integral transition spool of 75mmto match the pipe OD and schedule.

u) 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 and pipe thickness 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”

12.3.1 Raised Face and Ring Type Joint Flanges

General recommendation is to have RF flanges up to class 900 and RTJ flanges for class 1500 and above. However, in consideration of current established practices and brown field applications in various COMPANY Business units, use of RF and RTJ lower or higher classes than above may be adopted. The same shall be agreed with COMPANY during the initial stage of projects and project specific pipe classes shall be developed/amended if not available in Appendix F.

12.4 Hub Connectors

a) 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.

b) Use of Hub connector in place of flanged joints is by prior acceptance with COMPANY. If allowed by COMPANY, Hub connectors may be considered in sizes

- Class 2500 : NPS 14 and above
- API 10000 : NPS 6 and above

c) In such cases pipe classes shall be updated/amended in project stage where applicable.

d) Pressure Temperature capabilities, Load carrying capacities, Dimensions for example shall be carefully evaluated as they differ largely among different manufacturers. Refer AGES-SP-09-13 for further requirements of Hub Connectors.

e) The design of the hubs and clamps shall be in accordance with ASME B31.3, Chapter IX or ASME VIII Div 2 part 4 or part 5.

f) Hub connectors shall be supplied 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.

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

h) 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

a) Compact Flanges are specified as a preferred option compared to Hubs and usage shall be restricted for the sizes outside ASME B16.5 / ASME B16.47 Series A.. Compact flanges to be manufactured in accordance with Specification BS EN ISO 27509. Refer AGES-SP-09-13 for further requirements of Compact flanges.

b) The use of Compact Flanges shall be limited to 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 on project specific consideration.

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

d) 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

a) All metallic orifice flanges shall conform to requirements of AGES-SP-09-013.

b) Orifice flanges conform to ASME B16.36 with a maximum size of NPS 24. Minimum size shall be NPS 2.

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

d) Tap sizes for the orifice flanges in Carbon and Alloy steel materials shall be NPS 1/2 unless specified otherwise.

e) Orifice pressure tapping's shall be connected to the orifice flange with a Nippoflange 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.

f) Orifice flanges in sour and lethal service shall be supplied with single tapping (no spare tapping) unless specifically required. Taps shall not have socket-welded or threaded connections.

g) Orifice flanges shall be supplied as a complete assembly including pair of orifice flanges each having NPS ½ tapping by the orifice flange manufacturer.

12.7 Spectacle Blinds (Fig-8 Flanges), Spacer and Blinds

a) All spectacle blinds, spacer and blinds shall conform to requirements of AGES-SP-09-013

b) 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.

c) 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.

d) Material and testing requirements shall be as per applicable ASTM with additional requirements as stated in this specification and relevant applicable specification like AGES-SP-09-013. For sour service, additional requirements of AGES-SP-07-003 including HIC testing of parent plate (if manufactured from plates) is required..

e) 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)

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

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

h) Flange spreaders shall be used when removing blinds and spacers. Use of jack screw is not recommended. However, project to ensure adequate Flange spreaders are supplied accordingly or are available at site.

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

j) Unless noted otherwise, use of Spectacle Blinds (Figure - 8 Flanges) shall be as per the Pipe Class and are 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

k) Spades, instead of spectacle blinds, shall be installed for pipes with continuous operating temperatures below 0 °C to prevent icing issues. For Cryogenic service Spectacle blinds shall not be used

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

m) 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.

n) 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

a) All metallic fittings shall conform to requirements of AGES-SP-09-013

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

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

d) Material and testing requirements shall be as per applicable ASTM with additional requirements as stated in this specification and relevant applicable specification like AGES-SP-09-013. For sour and severe service, additional requirements of “, AGES-SP-07-003 is required.

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

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

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

g) All CS 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.

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

i) For integrally reinforced branch outlet fittings (such as Weldolet, Nipolet, Latrolet etc.) the design, essential dimensions, finish, tolerances, testing etc. shall conform to MSS SP 97.

j) 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.

k) Mitre(fabricated) bends shall not be used

l) All welds shall undergo radiographic examination and hardness testing when specified in the referenced codes and standard and relevant COMPANY specifications.

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

n) Cross shall not be used.

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

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

q) Carbon and low alloy steel fitting rated higher than ASTM A860/A860M grade WPHY65 shall not be used of ASME B 31.3 piping unless specially approved by COMPANY

r) All welded fittings shall be subject to 100% radiography throughout the entire length of each weld seam.

s) All Inconel 625 Fittings shall have minimum yield strength of 60 KSI and minimum, ultimate tensile strength of 120 KSI and other mechanical properties in accordance with ASTM B444 UNS N06625 Gr.1.

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 should 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. Higher size weldolets may be allowed if there are specific issue like space constrains etc. subject to COMPANY approval.

e) Sweepolet shall be used for lines subjected to vibration like reciprocating compressor lines instead of weldolets

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

g) 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

h) 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.

i) 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.

j) 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.

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

l) Usage of elbowlet shall be avoided and specific usage shall be subject to COMPANY approval.

m) 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.

n) Drain and vent connections shall not be installed on elbows or tees.

o) Thermowell installation shall be at 90 degrees 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 (i.e. Nippoflange / weldoflange). Minimum header size for thermowell connection shall be NPS 4. Wake frequency calculations are required for thermowell connections.

p) The branch table indicated in piping classes are not applicable for the hot tap connections. Refer AGES-SP-09-009 for Hot tapping requirements.

12.9 Gaskets

12.9.1 General

Gaskets shall be in accordance to AGES-SP-09-005 and 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.

a) Gaskets specified for Sour services shall meet the latest requirements of AGES-SP-07-003 and NACE MR0175/ISO 15156. Graphite filled gaskets shall not be used in seawater service

b) 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.

c) 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.

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 AGES-SP-09-005)

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) .ASME B16.20 ring joint gaskets confirming to Octagonal-type R is generally used

f) 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.

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

h) 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. Selection of Non graphite filler such as PTFE, RPTFE etc. based on service compatibility requirements and material selection report.

a) In CS, LTCS and low alloy pipe classes, , SPWD gaskets shall have a 316 SS inner and CS outer ring.

b) In SS and CRA pipe classes shall have gaskets with inner rings suitable to the service fluid and outer ring as SS316 as minimum.

c) 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.

d) 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

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

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

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.

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.

f) For FRP/GRP piping system, in order to achieve reliable flange sealing, even with relatively low bolt tensioning, steel reinforced (G-ST) soft elastomer profile gasket with shore hardness within the range of A65 to A75 should be used. The recommended gasket for FRP/GRP piping is Kroll

& Ziller (G-ST-P/S) or approved equivalent with spacer to maintain the full-face connection of the flange

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.
b) Insulating gasket kits in Hydrocarbon service shall be fire safe tested type.
c) The insulating gasket kit shall be suitable for installation on RF and RTJ flanges without modification to the standard flange assembly as well as between pair of mismatched RTJ to RF flanges. The gasket will also be capable of joining RF flanges to RTJ Flanges without modification to the flange or bolting.
d) Unless specifically agreed fire safe gaskets shall have minimum two seals. With prior approval from COMPANY, non-metallic (GRE based) core material for the gasket may be accepted for insulation kits in non-hydrocarbon services with pressure class rating 300# and below.
e) All wetted area, all sealing area and core material shall be suitable for the service media and temperature.
f) Insulation gaskets kits are are not recommended to be used conjunction with spectacle blinds and dual plate check valve.
g) Refer AGES-SP-09-005 for further requirements of insulating gasket.

12.10 Fasteners

a) 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). Also refer AGES-SP-09-005 for further requirements for fasteners

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

c) 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.

d) All bolting in sour service shall meet all requirements of applicable NACE standards and AGES-SP-07-003.

e) Unless noted otherwise, dimensions for Fasteners shall be as follows:

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

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

g) 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.

h) 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.

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

j) Nuts shall be double chamfered and Heavy Hexagonal type.

k) 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

l) 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.

m) 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.)

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

o) Bolting used in conjunction with GRE flanges shall be provided with two numbers of plain circular carbon steel washers to prevent damage to the GRE flanges when the stud bolts are tightened. The washers shall comply with ASTM F436 Type 1.

p) Bolting materials for API.5000 and API 10000 rating flanges shall meet all requirements of API 6A

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

12.11 CLAD Piping

a) Material and testing requirements shall be as per applicable ASTM with additional requirements as stated in this specification and relevant applicable specification like AGES-SP-09-005CRA Clad piping

b) 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 AGES-SP-09-015.

c) Design of CRA-clad piping shall meet the requirements of ASME B31.3, specifically, it shall be in accordance with paragraphs 323.4.3, M323.4.3 (for category M fluids) and K323.4.3 (for high pressure piping), including the requirements of ASME BPVC VIII Division 1, UCL30 to UCL52, as applicable

d) Metallurgical bonded cladding is manufactured by Roll Bonding, Cold extrusion and by Weld overlay process. Mechanically lined pipes are not permitted for piping applications.

- Seamless clad pipes can be manufactured by the coextrusion process or by the weld overlay process.
- Welded clad pipes can be manufactured by the Explosive/hot-rolled bonding process or by the weld overlay process.

e) 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).

f) No HIC testing of base material is required for Cladded pipes in sour service, however all other requirements of AGES-SP-07-003 like chemical composition, CE, hardness, etc has to be met.

g) CS / LTCS base materials shall be supplied with technical delivery conditions suitable for cladding like with plain ends, minimum thickness, additional lengths for fittings and flanges, etc. These shall be verified and confirmed with Clad vendor.

h) Where Alloy 825/625 cladding 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 minimum LTCS base pipe 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 up to -29 deg C, or above for sizes NPS 6 and larger are specified with carbon steel base pipe 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, only solid Alloy 825/625 shall be used in place of clad irrespective of size.

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.

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 Speciality piping (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.

Refer Appendix G1 for Sample Speciality item datasheet. These shall be further developed based on project specific requirements

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, AGES-SP-07-004.

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]
Non Sour	A193-B7	A194-2H	-29 °C to 410 °C	½ ≤ d ≤ 4
Sour Service	A193-B7M	A194-2HM	-29 °C to 400 °C	½ ≤ d ≤ 4
Non Sour	A320-L7 A320-L43	A194-7 A194-7	-101 °C to 400 °C	½ ≤ d ≤ 2 ½ > 2 ½ ≤ d ≤ 4
Sour Service	A320-L7M	A194-7M	-73 °C to 343 °C	½ ≤ d ≤ 4
High temperature service	A193-B16	A194-7	-29 °C to 525 °C	½ ≤ d ≤ 4
Non Sour/Sour	A193-B8M Class 2	A194-8	-200 °C to 538 °C	½ ≤ d ≤ 1 ½
Non Sour/Sour	ASTM B637 UNS N09925	ASTM B805 UNS N09925	-200 °C to 400 °C	-

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. Bolting calculations shall be carried out during project stage

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 A961	Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
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 B861	Standard Specification for Titanium and Titanium Alloy Seamless Pipe
ASTM B862	Standard Specification for Titanium and Titanium Alloy Welded Pipe
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

American Society for Testing of Materials (ASTM)	
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
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 E165	Standard Practice for Liquid Penetrant Testing for General Industry
ASTM E709	Standard Guide for Magnetic Particle Testing
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
ASTM G28	Standard Test Methods for Detecting Susceptibility to Intergranular Corrosion in Wrought, Nickel-Rich, Chromium-Bearing Alloys
ASTM G 48	Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

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

American Petroleum Institute (API)	
API RP 571	Damage Mechanisms Affecting Fixed Equipment in the Refining Industry,
API RP 582	Recommended Practice Welding Guidelines for the Chemical, Oil, and Gas Industries
API RP 941	Recommended Practice for Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plant
API RP 945	Avoiding Environmental Cracking in Amine Units

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 9934-1/2/3	Non-destructive testing- Magnetic Particle Testing
ISO 9001	Quality Management Systems – Requirements
ISO 10204	Metallic Products – Types of Inspection Documents
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
ISO 17781	Test Method for QC of Microstructure of Ferritic/Austenitic (DupleX) Stainless Steel
ISO 27509	Petroleum and natural gas industries – Compact flanged connections with IX seal ring

Manufacturers Standardization Society - Standard Practice (MSS)	
MSS SP-6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
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 43	Wrought and Fabricated Butt-Welding Fittings for Low Pressure, Corrosion Resistant Applications
MSS SP 44	Steel Pipeline Flanges
MSS SP 55	Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components – Visual Method for Evaluation of Surface Irregularities
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 95	Swage(d) Nipples and Bull Plugs
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
NACE TM 0177	Laboratory Testing of Metals for Resistance to Sulphide Stress racking and Stress Corrosion Cracking in H2S environments
NACE TM 0284	Standard Test Method – Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking

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-SP-07-003	Requirements for Material in Severe Service
AGES-SP-07-004	Painting and Coating Specification
AGES-SP-07-005	Requirements for Cr-Mo / Cr-Mo-V Steel in High Temperature, High Pressure Hydrogen Service
AGES-SP-07-007	Welding & Non-Destructive Examination
AGES-SP-07-008	Prevention of Brittle Fracture
AGES-SP-07-009	Galvanising

AGES-SP-07-011	Preservation and Export Packing Specification
AGES-SP-07-012	Chemical Treatment and Corrosion Monitoring System Specification
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
AGES–SP-09-004	Specification for Piping System Stress & Flexibility Analysis
AGES–SP-09-005	Specification for Gaskets and Fasteners
AGES–SP-09-009	Piping Tie-ins & Hot Tapping
AGES–SP-09-010	Jacketed Piping & Steam Tracing Specification
AGES–SP-09-012	Specification for Metallic Expansion Joints
AGES–SP-09-014	Fibre Reinforced Plastic Piping and Pipeline Systems
AGES–SP-09-015	Clad Pipes, Fittings and Flanges Specification
AGES-SP-10-008	HDPE For Pipeline and Piping system Specification
AGES-SP-13-002	Procurement Inspection and Certification Requirement in Projects
AGES-SP-13-003	Traceability of Shop & Field Piping Materials

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APPENDIX F1 - DETAILED PIPE CLASSES

SECTION –G

APPENDIX G1 – SAMPLE SPECIALIALITY ITEM DATASHEETS