



ADNOC GROUP PROJECTS AND ENGINEERING

SPECIFICATION FOR METALLIC PIPE, FITTINGS AND FLANGES

Specification

APPROVED BY:

24/02/2022




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GROUP PROJECTS AND ENGINEERING / PT&CS DIRECTORATE

CUSTODIAN	Group Projects and Engineering / PT&CS
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This specification will be reviewed and updated in case of any changes affecting the activities described in this document.

INTER-RELATIONSHIPS AND STAKEHOLDERS

- a. The following are inter-relationships for implementation of this Specification:
 - i. ADNOC Upstream and ADNOC Downstream Industry, Marketing and Trading Directorate.
 - ii. ADNOC Onshore, ADNOC Offshore, ADNOC Sour Gas, ADNOC Gas Processing. ADNOC LNG, ADNOC Refining, ADNOC Fertil, Borouge, Al Dhafra Petroleum, Al Yasat
- b. The following are stakeholders for the purpose of this Specification:
 - iii. ADNOC PT&CS Directorate
- c. This Specification has been approved by the ADNOC PT and 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.
- d. 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 & 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.

“**Specification**” means this Specification for Metallic Pipe, Fittings and Flanges.

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TABLE OF CONTENTS

1	GENERAL.....	7
1.1	INTRODUCTION.....	7
1.2	PURPOSE.....	7
1.3	SCOPE.....	7
1.4	DEFINITIONS AND ABBREVIATIONS.....	8
	SECTION A – GENERAL.....	13
2	REFERENCE DOCUMENTS	13
2.1	INTERNATIONAL CODES AND STANDARDS.....	13
2.2	ADNOC SPECIFICATIONS	18
2.3	STANDARD DRAWINGS	19
3	DOCUMENT PRECEDENCE	19
4	SPECIFICATION DEVIATION / CONCESSION CONTROL	20
	SECTION B – TECHNICAL REQUIREMENTS	21
5	GOVERNING CODES	21
6	DESIGN CONSIDERATIONS / MINIMUM DESIGN REQUIREMENTS	21
6.1	PIPE	21
6.2	FITTINGS	21
6.3	FLANGES	22
7	DESIGN & MANUFACTURING	22
7.1	GENERAL.....	22
7.2	PIPE	23
7.3	FITTINGS	25
7.4	FLANGES	26
8	MATERIAL	33
8.1	GENERAL.....	33
8.2	PIPE	37
8.3	FITTINGS	38
8.4	FLANGES	39
8.5	SPECTACLE BLINDS	40
9	INSPECTION AND TESTING REQUIREMENTS	40
9.1	GENERAL.....	40
9.2	MECHANICAL PROPERTIES	41
9.3	NON-DESTRUCTIVE TEST.....	41
9.4	CORROSION TESTING.....	42
9.5	POSITIVE MATERIAL IDENTIFICATION (PMI)	43
	SECTION C – OTHER REQUIREMENTS.....	44

10	QUALITY CONTROL AND ASSURANCE.....	44
10.1	QUALITY CONTROL AND ASSURANCE	44
10.1	QUALITY PLAN.....	44
10.1	CRITICALITY RATING FOR MATERIALS AND INSPECTION CLASS	44
11	SUB-CONTRACTORS/SUB-VENDORS	45
12	MATERIAL CERTIFICATION REQUIREMENTS	45
13	SPARE PARTS	47
14	PAINTING, PRESERVATION, MARKING AND SHIPMENT	47
14.1	PAINTING	47
14.2	PRESERVATION AND PACKING	47
14.3	MARKING	48
14.4	SHIPMENT	49
15	DOCUMENTATION / MANUFACTURER DATA RECORDS	50
15.1	DOCUMENTATION AND MANUALS	50
15.2	INFORMATION REQUIRED WITH BID	51
16	GUARANTEES AND WARRANTY	51
	APPENDIX-1 ADDITIONAL REQUIREMENTS	52
17	ADDITIONAL REQUIREMENT OVER THE APPLICABLE INTERNATIONAL STANDARDS (ASTM, ASME, ETC.).....	52
17.1	PIPE, CARBON STEEL, API SPEC 5L	52
17.2	PIPE, STEEL, ASTM A672	52
17.3	PIPE, CARBON STEEL, ASTM A106	52
17.4	PIPE, STEEL, ASTM A671, LOW TEMP	52
17.5	PIPE, STEEL, ASTM A335	52
17.6	PIPE, STEEL, ASTM A691	54
17.7	PIPE, STAINLESS STEEL, ASTM A312.....	55
17.8	PIPE, STAINLESS STEEL, ASTM A358.....	55
17.9	PIPE, DUPLEX AND SUPERDUPLEX STAINLESS STEEL, ASTM A790.....	55
17.10	PIPE, NICKEL ALLOY , ASTM B 423	56
17.11	PIPE, TITANIUM , ASTM B 861.....	56
17.12	PIPE, DUPLEX AND SUPERDUPLEX STAINLESS STEEL, ASTM A 928.....	56
17.13	PIPE, NICKLE ALLOY, ASTM B 705	57
17.14	PIPE, NICKLE ALLOY, ASTM B 444	58
17.15	PIPE, TITANIUM, ASTM B 862.....	58
17.16	PIPE COPPER-NICKLE , EEUMA 234.....	59
17.17	FITTINGS, BUTT-WELD, ASTM A234M	59
17.18	FITTINGS, BUTT-WELD, ASTM A420M	61

17.19 FITTINGS, BUTT-WELD, ASTM A403	62
17.20 FITTINGS, DUPLEX AND SUPERDUPLEX STAINLESS STEEL, ASTM A815	63
17.21 FITTINGS, NICKLE ALLOY, ASTM B366	63
17.22 FITTING, TITANIUM, ASTM B 363	64
17.23 FORGING, CARBON STEEL, ASTM A105	64
17.24 FORGING LOW TEMP. CARBON STEEL, ASTM A350	64
17.25 FORGING, STAINLESS STEEL, ASTM A182	64
17.26 FORGING, NICKLE ALLOY, ASTM B564	66
17.27 PLATE, CARBON STEEL, ASTM A516	67
17.28 PLATE, ALLOY STEEL, ASTM A387	67
17.29 PLATE, STAINLESS STEEL, ASTM A240	67
17.30 PLATE, NICKEL ALLOY, ASTM B443	67
17.31 PLATE, NICKEL ALLOY, ASTM B424	67

1 GENERAL

1.1 Introduction

This specification describes the minimum requirements for the supply of metallic pipe, fittings and flanges for ADNOC facilities. This specification shall be read in conjunction with material requisitions, description (if any) and the relevant Codes and Standards referred within.

This specification shall also be applicable for the substrate (base) material used in the clad pipes, fittings and Flanges. Additional applicable requirements as stated in the COMPANY specification AGES-SP-09-015 Clad Pipes, Fittings and Flanges Specification shall apply.

1.2 Purpose

The purpose of this specification is to ensure consistency in procurement of metallic pipe, fittings and flanges. This specification covers the technical requirements for design, material, manufacturing, inspection, testing, marking, and handling and storage criteria. The specification shall also apply to pipeline flanges under ASME B31.4, ASME B31.8 and DNV.

1.3 Scope

1.3.1 Pipe

This specification shall be applied for Seamless and Longitudinal welded pipes.

Types of Pipes Excluded from this Specification are as follows:

- a. Non-metallic pipe.
- b. All Tubing (instrument & hydraulic).
- c. Line pipes for DNV-ST-F101/ASME B31.4/31.8 application

1.3.2 Fittings

This specification shall be applied for the standard forged and wrought (Seamless & Welded) piping fittings used in Company

Types of Fittings Excluded from this Specification are as follows:

- a. Non-metallic pipe fittings.
- b. Special fittings if any.
- c. Mitred fittings.
- d. Pipeline fittings.
- e. Instrument fittings

1.3.3 Flanges

This specification shall be applied for the following types of flange:

- a. Welding neck flange, Socket weld flange, Threaded flange, slip on, blind flanges and flanged piping components.

- b. Pipeline Flanges & Subsea flanges, with additional requirements for corrosion protection.
- c. Compact Flanges.
- d. Orifice Flanges (refer to ASME B16.36)
- e. API 6A Flanges
- f. Spectacle blinds, spades and spacers.
- g. Hub connectors.

Where the use of types other than those stated above is necessary, a separate project specification shall be developed.

Types of Flanges Excluded from this Specification are as follows:

- a. Lap – joint flanges.
- b. Non-metallic flanges.

1.4 Definitions and Abbreviations

1.4.1 Definitions

The following defined terms are used throughout this specification:

“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

“COMPANY” means ADNOC, ADNOC Group or an ADNOC Group Company, and includes any agent or consultant authorized to act for, and on behalf of the COMPANY.

“CEO” means chief executive officer.

“CONCESSION REQUEST” means a deviation requested by the SUB-SUPPLIER or SUPPLIER, usually after receiving the Contract package. Often, it 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. A CONCESSION REQUEST is subject to COMPANY approval.

“CONTRACTOR” means the parties that carry out all or part of the design, engineering, procurement, construction, commissioning or management for ADNOC projects. CONTRACTOR includes its approved MANUFACTURER(s), SUPPLIER(s), SUB-SUPPLIER(s) and SUB-CONTRACTOR(s).

“DRAWINGS” means drawings provided by the CONTRACTOR/SUPPLIER.

“ENGINEER”: The Engineering COMPANY or entity responsible for specifying the insulation design

“EPC” means Execute stage of project

“FEED” means Basic engineering or Define stage of project.

“ITP” means Inspection and Test Plan prepared by the MANUFACTURER reviewed and approved by COMPANY highlighting the principal hold and witnessing points during the production of line pipe.

‘may’ means a permitted option

“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.

“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.

‘[PSR]’ indicates a mandatory Process Safety Requirement

‘shall’ indicates mandatory requirements

‘should’ means a recommendation

“Specification” means this Metallic Pipe, Fittings and Flanges Specification.

“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.

1.4.2 Abbreviations

The abbreviations used throughout this Specification are shown in Table 1.1.

Table 1.1 List of Abbreviations

Abbreviations	
AOD	Argon Oxygen Decarburization
API	American Petroleum Institute
ASCC	Alkaline Stress Corrosion Cracking
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BE	Bevelled End
BHN	Brinell Scale Hardness Number
BPVC	Boiler and Pressure Vessel Code
BS	British Standard
BW	Butt Weld
CA	Corrosion Allowance
CE	Carbon Equivalent
CL	Class
CLR	Crack Length Ratio
CR	Criticality Rating
CRA	Corrosion Resistant Alloy
CS	Carbon Steel
CSR	Crack Sensitivity Ratio
CTR	Crack Thickness Ratio
Cu-Ni	Copper Nickel
DEG	Degree
DN	Diameter Nominal
DNV	Det Norske Veritas
DPT	Dye Penetrant Test
DSS	Duplex Stainless Steel
ECC	Eccentric
EFW	Electric Fusion Welding
ENP	Electroless Nickel Plated
EPC	Engineering, Procurement & Construction
Ext WE	Extended Weld End
FF	Flat Face
FL	Flange
FN	Ferrite Number
FV	Full Vacuum

Abbreviations	
GALV	Galvanised
GTAW	Gas Tungsten Arc Welding
H ₂ S	Hydrogen Sulfide
HB	Brinell Hardness
HBW	Brinell Hardness Value; H from Hardness, B from Brinell & W from the material of the indenter, Tungsten (Wolfram) Carbide
HIC	Hydrogen Induced Cracking
HRB	Rockwell Hardness – B Scale
HSE	Health, Safety & Environment
ID	Inside Diameter
IGC	Intergranular Corrosion
ISO	International Organisation for Standards
ITP	Inspection & Test Plan
OEM	Original Equipment Manufacturer
LPT	Liquid Penetrant Test
LR	Long Radius
LTCS	Low Temperature Carbon Steel
MOC	Material of Construction
MRB	Manufacturing Record Book
MSS SP	Manufacturers Standardisation Society – Standard Practice
MT	Magnetic Particle Test
MTC	Material Test Certificate
NACE	National Association of Corrosion Engineers
NDE / NDT	Non-destructive Examinations / Non Destructive Test
NPS	Nominal Pipe Size
Ni-Al-Br	Nickel Aluminium Bronze
OD	Outside Diameter
PMI	Positive Material Identification
PO	Purchase Order
PPM	Parts Per Million
PQR	Procedure Qualification Record
PQRT	Procedure Qualification Record Test
PT	Pressure-Temperature
PTFE	Poly Tetra Fluoro Ethylene
PUB	Publication
PWHT	Post Weld Heat Treatment
QA	Quality Assurance
QAS	Quality Assurance System

Abbreviations	
QC	Quality Control
QMS	Quality Management Systems
QP	Quality Plan
Ra	Roughness Average
RF	Raised Face
RT	Radiography Test
RTJ	Ring Type Joint
SAW	Submerged Arc Welding
SBE	Socket Both Ends
SCC	Stress Corrosion Cracking
SCH	Schedule
SCRD	Screwed
SDSS	Super Duplex Stainless Steel
SI	System International Units
SMYS	Specified Minimum Yield Strength
SP	Specification
SS	Stainless Steel
STD	Standard
SW	Socket Weld
SWL	Safe Working Load
TE	Threaded End
TPA	Third Party Agency
UNS	Unified Numbering System
UT	Ultrasonic Test
VOD	Vacuum Oxygen Decarburization
WPS	Welding Procedure Specification
WN	Weld Neck
13CR	13% Chrome Steel

SECTION A – GENERAL

2 REFERENCE DOCUMENTS

2.1 International Codes and Standards

The following Codes and Standards shall form a part of this specification. When an edition date is not indicated for a Code or Standard, the latest edition in force at the time of the contract award shall apply.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms)
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
ASME B16.9	Factory-Made Wrought Buttwelding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.20	Metallic gaskets for pipe flanges-Ring-joint, spiral-wound, and jacketed
ASME B16.25	Buttwelding Ends
ASME B16.36	Orifice Flanges
ASME B16.47	Large Diameter Steel Flanges (NPS 26 through NPS 60)
ASME B16.48	Line Blanks
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.4	Pipeline Transportation Systems for Liquids and Slurries
ASME B31.8	Gas Transmission and Distribution Piping Systems
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B36.19M	Stainless Steel Pipe
ASME B46.1	Surface Texture (Surface Roughness, Waviness and Lay)
ASME BPVC SEC II	Materials – Part A-1 & A-2 Ferrous Materials Specifications
ASME BPVC SEC II-C	Specifications for Welding Rods Electrodes and Filler Metals-Materials
ASME BPVC SEC V	Non -Destructive Examination
ASME SEC VIII DIV.1	Rules for Construction of Pressure Vessels
ASME SEC VIII Div. 2	Rules for Construction of Pressure Vessels (Alternative Rules)
ASME BPVC.SEC IX	Welding, Brazing and Fuzing Procedures Qualifications

AMERICAN PETROLEUM INSTITUTE (API)

API 5L	Specification for Line pipes
API 6A	Specification for Wellhead and Christmas Tree Equipment
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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A105	Standard Specification for Carbon Steel Forging for Piping Applications
ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A123	Standard Specification for zinc (hot-dip galvanized) coatings on iron and steel products
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A182	Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings and Valves and Parts for High-Temperature Service
ASTM A203	Standard Specification for Pressure Vessel Plates, Alloy Steel, Nickel
ASTM A204	Standard Specification for Pressure Vessel Plates, Alloy Steel, Molybdenum
ASTM A216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service
ASTM A 217	Standard Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
ASTM A234	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A262	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A275	Test Method for Magnetic Particle Examination of Steel Forgings
ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A333	Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness
ASTM A 335	Seamless Ferritic Alloy Steel Pipe for High Temperature Service
ASTM A350	Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components

ASTM A352	Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A358	Electric Fusion Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High Temperature Service and General Applications
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A387	Standard Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum
ASTM A388	Ultrasonic Examination of Steel Forgings
ASTM A403	Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A420	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
ASTM A515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A671	Electric Fusion Welded Steel Pipe for Atmospheric and Low Temperatures
ASTM A672	Electric Fusion Welded Steel Pipe for High Pressure Service at Moderate Temperatures
ASTM A691	Carbon and Alloy Steel Pipe, Electric Fusion Welded for High Pressure Service at High Temperature
ASTM A694	Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
ASTM A 788	Steel Forgings, General Requirements
ASTM A790	Standard Specification for Seamless and Welded Ferritic / Austenitic Stainless Steel Pipe
ASTM A815	Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
ASTM A860	Standard Specification for Wrought High-Strength Ferritic Steel Butt-Welding Fittings
ASTM A923	Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels
ASTM A928	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 B151	Standard Specification for Copper-Nickel-Zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar
ASTM B265	Titanium and Titanium Alloy Strip, Sheet, and Plate
ASTM B363	Standard Specification for Seamless and Welded Unalloyed Titanium and Titanium Alloy Welding Fittings
ASTM B366	Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings
ASTM B381	Standard Specification for Titanium and Titanium Alloy Forgings
ASTM B423	Nickel-Iron-Chromium-Molybdenum-Copper (UNS N08825, N08221 and N06845) Seamless Pipe and Tube
ASTM B424	Nickel – Ferrous – Chromium – Molybdenum – Copper Alloy (UNS N08825 and UNS N08221) Plate, Sheet and Strip
ASTM B443	Nickel – Chromium – Molybdenum – Columbium Alloy (UNS N06625) Plate, Sheet and Strip
ASTM B444	Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloys (UNS N06625 and UNS N06852) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Pipe and Tube.
ASTM B564	Standard Specification for Nickel Alloy Forgings
ASTM B637	Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service
ASTM B705	Nickel-Alloy (UNS N06625, N06219 and N08825) Welded Pipe
ASTM B829	General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube
ASTM B861	Standard Specification for Titanium and Titanium Alloy Seamless Pipe
ASTM B862	Standard Specification for Titanium and Titanium Alloy Welded Pipe
ASTM E165	Standard Practice for Liquid Penetrant Testing for General Industry
ASTM E709	Standard Guide for Magnetic Particle Testing
ASTM G28	Standard Test Methods for Detecting Susceptibility to Intergranular Corrosion in Wrought, Nickel-Rich, Chromium-Bearing Alloys
ASTM G48	Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

INTERNATIONAL ORGANIZATION FOR STANDARDISATION (ISO)

ISO 9001	Quality Management Systems – Requirements
ISO 9004	Managing for the sustained success of an organization – A quality management approach
ISO 9934-1	Non-destructive testing - Magnetic Particle Testing-Part 1: General Principles

ISO 9934-2	Non-destructive testing - Magnetic Particle Testing-Part 2: Detection media
ISO 9934-3	Non-destructive testing - Magnetic Particle Testing-Part 3: Equipment
ISO 17781	Test Method for QC of Microstructure of Ferritic/Austenitic (Duplex) Stainless Steel
ISO 10204	Metallic Products – Types of Inspection Documents
ISO 10893	Non Destructive testing of Tubes
ISO 13847	Petroleum and natural gas industries — Pipeline transportation systems — Welding of pipelines
ISO 15590-3	Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 3: Flanges
ISO 19011	Guidelines for auditing management systems
ISO 27509	Petroleum and natural gas industries – Compact flanged connections with IX seal ring

ENGINEERING EQUIPMENT and MATERIALS USER'S ASSOCIATION (EEMUA)

EEMUA 234	90/10 Copper nickel alloy piping for offshore applications Specification
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NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE TM 0177	Laboratory Testing of Metals for Resistance to Sulphide Stress racking and Stress Corrosion Cracking in H ₂ S environments
NACE TM 0284	Standard Test Method – Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking
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 ₂ S Containing Environments in Oil and Gas Production. Part 1: General principles for selection of cracking-resistant materials. Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons. Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys.
NACE SP0391	Materials for the Handling and Storage of Commercial Concentrated Sulphuric Acid
NACE SP0472	Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE and FITTINGS INDUSTRY (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 95	Swage(d) Nipples and Bull Plugs
MSS SP 97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends

AMERICAN SOCIETY FOR NON-DESTRUCTIVE TESTING (ASNT)

SNT-TC-1A	Recommended Practice for Personnel Qualification and Certification in Non-destructive Testing
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DET NORSKE VERITAS (DNV)

DNV-ST-F101	Offshore Standard: Submarine Pipeline Systems
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2.2 ADNOC Specifications

AGES-GL-07-001	Material Selection Guideline
AGES-GL-13-001	Contractor QA/QC Requirements
AGES-GL-13-002	Positive Material Identification of Equipment & Piping
AGES-SP-07-002	External Pipeline Coatings Specification
AGES-SP-07-003	Requirements for Material in Severe Service
AGES-SP-07-004	Painting and Coating Specification
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-09-001	Piping Design Basis
AGES-SP-09-002	Piping Material Specification

AGES-SP-09-004	Piping System & Flexibility Analysis
AGES-SP-09-010	Jacketed & Steam Tracing Specification
AGES-SP-09-005	Gaskets & Fasteners Specification
AGES-SP-09-015	Clad Pipes, Fittings and Flanges Specification
AGES-SP-10-001	Specification for Line Pipe
AGES-SP-10-002	Specification for Subsea Pipeline System
AGES-SP-10-012	HFW Line Pipe Specification
AGES-SP-13-001	Criticality Rating Specification
AGES-SP-13-002	Procurement Inspection and Certification Requirement In Projects
AGES-SP-13-003	Traceability of Shop & Field Piping Materials

2.3 Standard Drawings

Not applicable.

3 DOCUMENT PRECEDENCE

The specifications and codes / standards referred to in this document 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 on the requirements and 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:

- a. UAE Statutory requirements
- b. ADNOC HSE Standards
- c. Equipment datasheets and drawings
- d. Project Specifications and standard drawings
- e. COMPANY Specifications
- f. National / International Standards

4 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.

SECTION B – TECHNICAL REQUIREMENTS

It is the CONTRACTOR's responsibility to ensure that all design considerations and minimum design requirements are established and documented such that integrity of the final installation is proven in accordance with the codes, standards and specifications quoted herein.

5 GOVERNING CODES

For governing codes pertaining to dimensions, tolerances, marking, facing, inspection and testing of pipe, fittings, and flanges, refer to ASME B31.3, AGES-SP-09-002 Piping Material Specification and this Specification for Pipe, Fittings and Flanges.

Pipe, fittings and flanges shall be designed in accordance with the requirements of ASME B31.3 and other relevant governing codes and standards. Dimensions, tolerances, marking, facing, inspection and testing shall be in accordance with the following, unless otherwise specified in this Specification.

In addition to international standards, the additional requirements mentioned in Section E Appendix E1 shall also be applicable

6 DESIGN CONSIDERATIONS / MINIMUM DESIGN REQUIREMENTS

6.1 Pipe

Dimensions, tolerances, marking, facing, inspection and testing shall be in accordance with the following, unless otherwise specified in this Standard:

- a. The dimensions for steel pipe shall be in accordance with ASME B36.10M, ASME B36.19M, or API 5L as applicable.
- b. For CS & LTCS pipes for which schedules 10, 40, 80 etc. are specified must be in accordance with standards API 5L or ASME B36.10M.
- c. For SS and CRA pipes for which schedules 10S, 40S, 80S etc. are specified must be in accordance with standard ASME B36.19M
- d. 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

6.2 Fittings

Dimensions, tolerances, marking, facing, inspection and testing shall be in accordance with the following, unless otherwise specified in this Standard:

- a. Factory made wrought butt-welding fittings shall be in accordance with ASME B16.9.
- b. Forged fittings, socket welding and threaded fittings shall be in accordance with ASME B16.11.
- c. High strength wrought butt-welding fittings shall be in accordance with MSS SP-75.
- d. Integrally reinforced branch outlet fittings ('O' lets) shall be in accordance with MSS-SP- 97. They shall meet the requirements of ASME B31.3 para 304.3.2.
- e. Swage nipple shall be in accordance with MSS-SP-95.
- f. Copper Nickel fittings shall be as per EEMUA 234 complying with all material, dimensional details and tolerances. The fittings end thickness shall match that of the corresponding Copper Nickle pipe.

6.3 Flanges

Flange pressure-temperature rating, dimensions, tolerances, marking, facing and testing shall be in accordance with the following, unless otherwise specified in this Standard:

Flange shall be designed in accordance with ASME/ANSI B16.5, B16.47, and API SPEC 6A. The following design codes are referenced for flanges:

- a. ASME/ANSI B16.5: Class 150 thru 2500. for sizes up to NPS 24 with the exception that in class 2500# its limited to NPS 12
- b. ASME/ANSI B16.47 Series A: Class 150 through 900 for larger sizes NPS 26-60.
- c. Compact type flanges are to be in accordance with BS EN ISO 27509.
- d. Flanges of API SPEC 6A pressure rating 10,000, 15,000 and 20,000 shall be of 6BX type and shall conform to API 6A.
- e. Flanges of API SPEC 6A pressure rating 2,000, 3,000 and 5,000 shall be of 6B type and shall conform to API 6A.
- f. Spectacle blinds and spacer and blanks shall be as per ASME B16.48.
- g. Orifice flanges shall be in accordance with ASME B16.36.
- h. Bore of flange and spectacle blind/Spacer shall match with ID of the connected pipes
- i. 90/10 Cu-Ni flanges shall confirm to EEMUA Publication 234. The fittings end thickness shall match that of the corresponding Copper Nickle pipe.
- j. Subsea flanges shall be as per DNV-ST-F101, ISO 15590-3, ASME VIII Division 2 and ASME B16.5/B16.47 as applicable (Refer Section 7.4.8.2 of this specification).
- k. Pipeline flanges shall be as per ISO 15590-3, MSS SP-44, ASME VIII Division 2 and ASME B16.5/B16.47 as applicable (Refer Section 7.4.8.1 of this specification).
- l. For Flanges in diameters and ratings not covered by ASME B16.5, B16.47, B16.48, API 6A ISO 15590-3, MSS SP-44 and/or BS EN ISO 27509, VENDOR shall submit flange design calculations in accordance with the requirements of ASME VIII Division 2 for all sizes, ratings or classes and types of flanges to be supplied. The calculation shall include maximum applied bending moment and axial loads due to functional and environment. The VENDOR shall supply supporting calculations, dimensional drawings to scale and sealing gasket details for flange design prior to manufacture of the flanges. Minimum required bolt pre-tensioning for flange connection shall be specified in design calculations. The external forces and moments will be provided to VENDOR as part of Purchase Requisition for approval. Flange design to consider the requirement for the bolt tensioning (specific to bolt spacing) for bolts in size NPS 1 1/2 and above.
- m. For large diameter flanges in cooling water service (above ASME B16.47/B16.5 size range), if specifically stated in the purchase description, the design as per manufacturer standard and AWWA C207 is acceptable provided design calculation report shall be submitted by the VENDOR

7 DESIGN & MANUFACTURING

7.1 General

Pipes and piping components shall be designed and manufactured to comply with applicable design codes, standards and specifications. CONTRACTOR remains responsible for assuring all design criteria and loadings on the pipe system with bearing on the integrity of the pipe system are evaluated and the appropriate specification is selected.

7.1.1 End connections

- a) Dimension of pipe, fitting and flange end connections shall be as per applicable standards listed at Section 2 above.
- b) When bevelled ends are specified, ends shall be as per ASME B16.25.
- c) When socket ends are specified, ends shall be as per ASME B16.11.
- d) When threaded ends are specified, ends shall be as per ASME B1.20.1 Taper requirements.
- e) For pipe supplied with Plain Ends, the plain end profile shall be at 90 degrees to the pipe axis, smooth and is to ensure the welding gap requirements stated in ASME B16.11 Section 6 are met.
- f) Pipes NPS 2 (except for galvanized carbon steel and cement lined) or larger shall be furnished with bevelled ends, in accordance with ASME B16.25.
- g) The ends of galvanized steel pipes up to NPS 2 shall be threaded in accordance with the standard ASME B1.20.1. Threads of galvanized pipes shall be free of galvanizing and shall be in accordance with ASME B1.20.1.(NPT)
- h) Butt weld end preparation for 90/10Cu-Ni shall be as per EEMUA Publication 234.

7.1.2 Manufacturing tolerance

Unless otherwise specified in the purchase description, the below manufacturing / mill tolerances shall be applicable

Table 1.2 Manufacturing Tolerance

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%	

Note: 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%.

7.2 Pipe

Pipe materials shall be supplied conforming to the material properties stipulated in Section 8 below. Additionally, pipe materials shall be supplied ensuring the material is consistent with relevant design codes and standards.

Pipe material shall be supplied ensuring the material is consistent with design calculations and numerical code factors, including Allowable Stress, Weld Joint Quality Factor.

Unless specified otherwise, Pipes shall be supplied in lengths as indicated below.

- a. All pipes in size NPS 6 and larger shall be supplied in double random length as defined in the applicable standard.
- b. All pipes in size NPS 4 and smaller shall be supplied in single random lengths, as defined in applicable standard.
- c. For large diameter pipes in size NPS 60, and above the supplied length shall be agreed with COMPANY.
- d. Cu-Ni pipes shall be supplied in lengths in accordance with standard EMMUA 234
- e. To satisfy the purchase order required pipe length, the delivered quantities of random lengths shall amount to at least the calculated aggregate length. Circular weld jointers to attain the required length shall not be acceptable.

7.2.1 Seamless Pipe

- a) Seamless pipe shall be provided up to and including NPS 16 sizes for CS, LTCS and Low alloy steel.
- b) For SS, SDSS and CRAs, seamless pipe shall be provided up to and including NPS 6 sizes. Cu-Ni pipes up to and including NPS 6 shall be seamless.

7.2.2 Welded pipe

- a) All EFW & SAW pipes as per Piping Material Classification (larger sizes) may be produced by rolling & longitudinal welding.
- b) Welded pipes shall be supplied in single longitudinal seam for CS & LTCS pipes up to NPS 48. Two longitudinal weld seams may be allowed for larger diameter pipes but subject to COMPANY approval.
- c) Welded pipes shall only be supplied with a straight seam (i.e., no girth seams), spiral welding is not permitted.
- d) Circumferential welded joints are not permitted
- e) All weld seam shall be subjected to full length 100% radiography & it shall be accepted as per criteria mentioned in relevant ASTM standards. . For welded pipe, the weld quality factor shall be 1.0 according to ASME B31.3.
- f) API 5L Welded pipe shall be made by the automatic submerged-arc process (electric fusion welded) in accordance with API SPEC 5L/ISO 3183.
- g) For welded SS/Nickel alloy pipes manufactured by EFW method, the WPS shall be submitted for COMPANY approval.
- h) For welded Cu-Ni pipes above NPS 6 manufactured by EFW method, the WPS shall be submitted to COMPANY for approval. Electric Resistance Welded (ERW) pipe are not acceptable.
- i) All pipes (seamless and welded) shall be supplied with mill tolerance in accordance with AGES-SP-09-002

7.2.3 Pipe Nipples

Pipe nipples shall be supplied meeting the requirements of MSS SP-95.

7.2.4 General

Weld repair of parent pipe material is NOT permitted. Flame cut weld bevel ends are not permitted. The internal surface of the line pipe shall be made free from mill scale after quenching and tempering. Undulations inside the pipe are not acceptable. Manufacturer shall conduct 100% visual inspection of the inner surface of the pipes and perform cosmetic grinding to remove any undulations inside the pipe before offering for inspection. Offered material may be rejected in case internal undulations are observed during inspection.

7.3 Fittings

- a. Welded fittings shall have a welding quality factor of 1.0 according to ASME B31.3.
- b. High strength, wrought butt-welding fittings shall be in accordance with MSS-SP-75 Para 6.2. Welded fittings designed as per MSS SP 75 shall undergo radiographic examination and hardness testing in accordance with the reference codes and standards. Circumference seam (girth seam) to increase the length of branch is NOT permitted
- c. For manufacturing tolerances refer Section 7.1.2 above. The VENDOR shall confirm to COMPANY that all fitting dimensions meet ASME B16.9. Wall thickness negative tolerance of welded fitting shall not be less than that of welded pipe. The welded end and manufacturing tolerances of welded CS and LTCS fittings in sizes > NPS 16 shall be in accordance with MSS SP-75 Section 13.3, unless specified otherwise.
- d. Butt weld elbows shall be long radius type (radius is 1.5 times the Nominal Pipe Size) unless otherwise specified by COMPANY.
- e. Fittings designed for API 5,000 and API 10,000 pipe classes shall be in compliance with API SPEC 6A. Fittings shall comply with PSL-3 requirements of API 6A. API 6A fittings shall be supplied with the transition piece to suit pipe diameter as applicable.
- f. The design of fittings in sizes > NPS 24 shall be established by the mathematical analyses contained in ASME VIII, Division 1 or ASME B31.3. The design of fittings for which these standards do not provide mathematical analyses shall be established by proof testing in accordance with ASME B16.9 Section 9.
- g. For larger size elbows and branch fittings (above NPS 24), VENDOR shall provide the SIF details accordance with ASME B31J with manufacturing report
- h. All butt weld Tees shall comply with ASME B 16.9 & and also comply with crotch radii and crotch thickness dimensions in accordance with ASME B 31J.
- i. For tees with a header size > NPS 24, the crotch thickness and external contour radius shall be in order to allow a flexibility characteristic in accordance with ASME B31J. VENDOR shall provide the SIF details along with manufacturing report
- j. The dimensions of caps in sizes > NPS 24 shall be in accordance with MSS SP-75, Table 8 with length E1
- k. Locations where solid CRA fittings are to be welded with clad pipes, fittings shall be procured with higher thickness of the fitting at the clad pipe end equal to the connected pipe thickness including cladding thickness. Bevels at the end connection of the fittings shall match the schedule/thickness of connecting pipe.
- l. Fitting thickness (other than integrally reinforced fittings) and the bore dimensions shall confirm to the thickness stated in the purchase description. Schedules/thickness and bore dimensions shall be as per ASME B36.10M or B36.19M as applicable. The replacement of fittings of specified schedule by a higher or lesser schedule is not acceptable unless approved by COMPANY.

Note. A specified schedule of a standard fitting may be replaced by a higher schedule or wall thickness selection provided that appropriate taper is machined with proper method statement and procedure in accordance with the reference codes and standards and subject to the COMPANY prior approval. This taper shall allow for a geometric profile acceptable by the design code for welding the connecting pipework.

- m. 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. The branch fitting shall be manufactured as an integrally reinforced forging in one piece. The following additional requirement over MSS SP 97 applies
 - The designated consolidation gap distance between the run pipe radius and the fitting inlet radius shall not exceed 1.0 mm.
- n. For integrally reinforced branch outlet fittings the VENDOR shall satisfy the CONTRACTOR/COMPANY that the design has been proven by means of burst or proof and fatigue tests and those fittings have been designed to minimize stress concentration. Reinforcement calculations shall be performed by the nominated VENDOR in accordance with the requirements of ASME B31.3. Calculation sheets shall be produced if requested by CONTRACTOR, VENDOR shall advise at bid stage the range of run dia metres on which the same fitting can be welded.
- o. Use of integral forged flanged fittings, long weld neck flanges, Nipoflange / Weldoflanges are permitted wherever necessary. The dimensions for Nipoflange / Weldoflange, shall be in accordance with purchase order requirements or as per Manufacturer's standard with prior approval. The face of the flange to Crotch dimension of Nipoflange / Weldoflange shall be 150mm unless specified otherwise. The base of the branch fitting, the branch outlet fitting, shall be designed in accordance with MSS SP-97 and the Flanged end shall be in accordance to B16.5.
- p. For unlisted components and specific components as defined in ASME B31.3 shall, the Manufacturer or stockist shall submit drawings, the design and SIF (Stress Intensity Factor in accordance to ASME B31J) calculation notes and proof test report to Company approval. Additionally, the Manufacturer or stockist shall submit sketch of the full manufacture sequence: details of method of manufacture, heat treatment (including PWHT), showing location of all welds, with joint details, test sampling, welding procedures and NDT methods to Company approval.
- q. Additional requirements for MSS SP-75 fittings
 - Shall also be applicable for austenitic and duplex stainless steels in addition to carbon and low alloy steel
 - Chemical composition, tensile properties, heat treatment, notch-toughness properties and NDE shall be as per the ASTM standard and additional MESC SPE requirements as specified in this specification
 - For tees with a header size > NPS 24, the crotch thickness and external contour radius shall be in order to allow a flexibility characteristic in accordance with ASME B31J. VENDOR shall provide the SIF details along with manufacturing report
 - The dimensions of caps in sizes > NPS 24 shall be in accordance with MSS SP-75, Table 8 with length E1

7.4 Flanges

7.4.1 Weld neck Flange

- a. The end thickness of welding-neck flanges and the bore dimensions for flanges shall confirm to the thickness stated in the purchase description. Schedules/thickness and bore dimensions shall be as per

ASME B36.10 or B36.19 as applicable and match that of the pipe. The replacement of flanges of specified schedule by a higher or lesser schedule is not acceptable unless specifically approved by Company.

- b. Bevel ends shall match the OD/ID of the connected pipe (bevel to B16.25) as provided in the purchase description.
- c. For manufacturing tolerances refer Section 7.1.2 above.
- d. API SPEC 6A flanges shall be supplied with integral transition piece (without any circumferential weld) of 75mm long to match the OD/ID of the connected pipe (bevel to B16.25) unless specifically agreed with COMPANY. Detailed drawings to show the hub details and calculations of the hub part of the flange shall be submitted to the COMPANY.
- e. Flanges, blind flanges, Flangeolet, 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
- f. Galvanization for galvanized flanges wherever specified in purchase description, implies application by hot dip process to both inside and outside and shall conform to with COMPANY specification for Galvanizing ,AGES-SP-07-009.
- g. Flanges designed to ASME and API 6A standards shall be designed for bolt tensioning as per AGES-SP-09-002, Piping material specification
- h. For flanges at specification and class rating breaks the following shall be clearly specified in the purchase description:
 - In case piping class break involves dissimilar class rating; class rating for flange and gasket at the joint shall be as per higher rating piping class.
 - Unless approved by Company, gasket material at piping class breaks shall be as per nobler piping class. Required flange face hardness and face finish shall be specified accordingly in the purchase description.
 - At the piping class specification break locations; flange face finish, flange groove hardness shall be generally as per the higher integrity piping class. It shall be clearly specified in the purchase description. Where specific hardness level can't be achieved VENDOR may propose for the weld overlay with approved CRA metallurgy. Weld overlay material shall be service compatible and agreed with Company prior to application.
- i. For non standard flanges specified in Section 6.3 (I) above , the Manufacturer shall submit on case-by-case basis for Company approval:
 - The dimensional drawings.
 - The sealing gasket details.
 - The calculation based on the requirements of ASME BPVC Section VIII Div. 2
- j. The gasket contact faces of the flanges may be of three main types:
 - Flat face
 - Raised face
 - Grooved for ring joint

These contact faces shall undergo finishing machining in accordance with MSS SP-6 for ASME Flanges and API 6A for API 5000 & 10000 flanges plus requirements indicated in below Table 1.1. Flange facing finish for smooth, serrated and very smooth finish shall be as given below.

Table 1.3 Flange Finish

Type of Flange Face	Type of Flange Finish	Roughness Value
Raised Face	Concentric-Smooth Finish	Ra 3.2 to 6.3 μm (125 - 250 μin).
Flat Face	Concentric-Serrated Finish	Ra 6.3 to 12.5 μm (250 -500 μin).
Ring Type Joint	Very smooth Finish	Less than 1.6 μm Ra (63 μin).
Ring Joint, API 6B flanges	Very smooth finish	Less than Ra 1.6 μm (63 μin)
Ring Joint, API 6BX flanges	Very smooth finish	Less than Ra 0.8 μm (32 μin)
Compact flanges	As per BS EN ISO 27509	As per BS EN ISO 27509

- k. The mating face of ring joint groove shall be harder than RTJ Gasket. Minimum difference between ring type joint gasket and mating face of ring joint groove should be minimum 15 to 20 Brinell hardness number (BHN). The groove hardness for RTJ flanges shall be as specified below:

Table 1.4 Ring Groove Hardness

Flange Material	Ring Groove Hardness	Remark
CS/HSCS	Min 120 HB	With soft iron gasket
CS /HSCS	Min 150 HB	With SS 316L gasket
LTCS	Min 120 HB	With soft iron gasket
Stainless Steel SS316L	Min 150 HB	With SS 316L gasket
6 Moly	Min 170 HB	With 6 Moly gasket
Alloy 625	Min 210 HB	With Alloy 625 gasket
Alloy 825	Min 180 HB	With Alloy 825 gasket
High Temp <-5%Cr:	150 HB	With SS 316L gasket
SDSS	245HB	With SDSS gasket

- In any case the ring groove hardness shall be greater of the ring joint gasket by 15 to 20 BHN.
 - For API 6A flanges, minimum hardness of ring joint grooves and maximum hardness of ring joints shall comply with API SPEC 6A.
- l. Where a blind flange is specified to ASTM A105 and the purchase description specifies lining with a 1.5 or 3 mm thick Cu-Ni overlay, the blind flange shall be as per ASME B16.5 and Cu-Ni overlay shall cover entire wetted area section.
- m. For Cu-Ni composite flanges as per EEMUA 234, the weld neck stub ends shall be manufactured by hot forging or cold forging followed by annealing. Friction welding is not permitted.
- n. Flanges in Cu-Ni piping class shall have serrated finish.

7.4.2 Slip on flange

Slip on flange dimensions shall confirm to ASME B16.5

7.4.3 Socket weld & Threaded flange

Socket weld and Threaded flange dimensions shall comply with ASME B16.5.

7.4.4 Orifice Flanges

- a. Orifice flanges shall conform to ASME B16.36 and shall be supplied in pairs.
- b. Minimum size shall be NPS 2
- c. Bolting material for orifice flanges shall be aligned to the applicable pipe class.
- d. Number of tapping's on each orifice flanges shall be stated in item description of the material requisition.
- e. 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.
- f. The tap hole shall extend radially from the outside diameter to the inside diameter of the flange. In case two tappings per flange are specified, the position shall be diametrically opposite
- g. Orifice flanges in sour or lethal service, pressure tapping shall be connected to Nipoflange / Weldoflange using a full penetration weld. Unless otherwise specified in material description, Nipoflange / Weldoflange rating shall be same as orifice flange rating. Diameter of the tapping on the Nipoflange / Weldoflange shall be same as that of orifice flange. However, for other utility service threaded / socket welded connections can be used as specified in the respective pipe class and purchase description.
- h. If specified in the purchase order for the requirement of jack screws on orifice flanges, jack screw tappings oriented at 180 degrees apart when assembled and shall not coincide with the pressure tapping. The material of Jack bolt shall be ASTM A193 B7 for Carbon and low alloy steel and ASTM A193 B8 for SS, SDSS and CRA flanges.
- i. Where Orifice plates with integral ring joint gaskets are provided, it shall be ensured flange groove hardness is higher than the gasket by 15 BHN and meet the hardness requirements as specified in Section 7.4.1 above.
- j. In the case of Orifice flanges of size and rating not covered in ASME B16.36, manufacturer shall submit complete proposal with justification that calculation and dimensions for Orifice flanges are in compliance to ASME B31.3 requirements for COMPANY approval.
- k. Tap size for orifice flanges shall be minimum NPS ½ unless specified otherwise.
- l. If PWHT is specified for Carbon Steel or Low Temperature Carbon Steel, PWHT shall be performed in accordance to ASME B 31.3.

7.4.5 Spectacle Blind/ Blanks

- a. Spectacle blinds shall comply with the requirements of AGES-SP-09-002.
- b. Bore of flange and spectacle blind/Spacer shall match with ID of the connected pipes.
- c. ASME B16.48 Spectacle blinds, spades and spacers shall have face (raised face, ring type or flat face) based on the applicable pipe class and the same shall be specified in purchase description. The gasket seating surface finish shall be in accordance with corresponding mating flanges (refer section 7.4.1 above).
- d. If specified in purchase orders two (2) nos. jackscrews shall be provided for RTJ flanges. Drilling and tapping for jack screws on the flange shall be carried out by the flange Manufacturer.
- e. All spectacle blinds, spacer and blanks over 25 kg shall be provided with certified lift lugs (apart from handle). Lifting lugs shall be of the same material as the plate. Spectacle blinds, spacers and blanks shall have the same face finish as the connected flange faces.
- f. Materials for handles, lifting lugs and web (tie bar) shall be equivalent to the base material of the spectacle blind, spade or spacer
- g. 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.

- h. Bolt holes shall straddle the centrelines and shall be spot faced as per MSS-SP-9. Jack screw shall be provided only when specified in the purchase description.
- i. Spectacle blinds shall be limited to size and ratings as specified in corresponding pipe class and Piping Material specification AGES-SP-09-002. 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. 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.
- j. API 6A Spectacle Blinds / Blanks
 - Calculations shall be submitted to the COMPANY for review.
 - The design of the line blanks is as per ASME B31.3 chapter IX, section K304.5.3.
 - Pressure temperature ratings, corrosion allowances are mentioned on the applicable drawings
 - For female ring-joint following shall be as per API 6A type 6BX flange:
 - Groove dimension
 - Pitch diameter
 - Roughness
 - tolerances
 - Tolerances for facings shall be in accordance with API 6A for Type 6BX Flanges
 - Each line blank shall be visually examined in accordance with ASME B31.3, Section K341.4 with acceptance criteria in accordance with Table K341.3.2.
 - Welds of Tie bars (web) and handles shall be 100 % Magnetic Particle or Liquid Penetrant examined as per section K344.3 or K344.4 of ASME B31.3, chapter IX.

7.4.6 Compact Flanges

- a. For compact flanges, flange surfaces and seal ring surfaces shall be machined to comply with the surface finish requirements specified in BS EN ISO 27509.
- b. Seal rings used along with the compact flange shall be IX seal ring as per BS EN ISO 27509. Seal rings shall be coated as per requirements specified in BS EN ISO 27509.
- c. The Compact Flange VENDOR shall be from COMPANY approved VENDOR list only.
- d. Prior to installing compact flange connectors, the piping system shall be checked to verify that flexibility is sufficient to allow the required separation to install and remove the seal ring.
- e. Corrosion Allowance for CS / LTCS Compact Flanges of 6mm shall be considered for design, analysis, calculations related to Compact Flanges.
- f. Compact Flanges for sizes NPS 26 and above, Class 2500 are not covered in BS EN ISO 27509. Hence Compact Flanges for these sizes shall be as per Manufacturer's standard. These Compact Flanges shall be designed, manufactured, tested in-line with requirements specified in BS EN ISO 27509 with proper design qualifications, calculations (including FEA) and documentation as below but not limited to.

- Perform detailed FEA and Flange Leakage Calculations for all the sizes and all the items (including integral compact flange on valves) to verify the mechanical stability of the assembly including sealing performance. The same shall be certified by independent third party.
- Scope of FEA verification shall include Compact Flanges (under compact flange vendor scope of supply) and respective mating Valve end Integral Compact Flange up to HW5 dimension as defined in ISO 27509.
- To perform the above analysis, required valve end details provided separately to compact flange vendor.
- FEA and Flange leakage calculation for flange to flange, flange-spacer-flange assembly shall also be performed.
- Applicable external loads and moments for the flanged joints shall be considered for FEA and Flange Leakage Calculations. The external forces and moments will be provided to VENDOR as part of Purchase Requisition.

7.4.7 Hub Connector

- a. 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.
- b. 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. The Manufacturer shall submit evidence of compliance to ASME B31.3 Chapter IX, section K304.7.2 Unlisted Components, to the COMPANY. Von Mises stresses shall be below allowable stresses as defined in ASME B31.3 chapter IX.
- c. The HUB connector VENDOR shall be from COMPANY approved VENDOR list only.
- d. The design of Hub connector shall be supported by a calculation using Finite Element Analysis (FEA) and shall include allowable external forces and moments envelopes as per ASME B31.3. The hub connectors shall be designed, manufactured, tested in-line with MANUFACTURER standard with proper design qualifications, calculations (including FEA) and documentation as below but not limited to.
 - Perform detailed FEA and Leakage Calculations for all the sizes and all the items (including integral compact flange on valves) to verify the mechanical stability of the assembly including sealing performance. The same shall be certified by independent third party.
 - Scope of FEA verification shall include hub connectors (under vendor scope of supply) and respective mating Valve end Integral hub connector.
 - To perform the above analysis, required valve end details provided separately to vendor.
 - Applicable external loads and moments for the hub joints shall be considered for FEA and Flange Leakage Calculations. The external forces and moments will be provided to VENDOR as part of Purchase Requisition.
- e. In addition, the following is required for Hub connector application.
 - Components from different OEMs shall not be used in a single assembly and are not considered interchangeable.
 - Seal ring size and material selection shall be compatible with the hub and the process medium. VENDOR shall confirm the suitability.
 - Impact testing shall be required in line with ASME B31.3

- Low alloy steel clamps and bolting shall be coated with a protective system suitable for the external environment and design life of the facility.
- Coatings for other clamp and bolting materials shall be agreed with the COMPANY. Sealing faces and hub front faces (seal ring rib contact areas) shall not be painted. If an external coating is specified for the pipe, a full high-build paint system shall be applied to the hub body up to the start of the 25-degree shoulder angle. The shoulder and hub outer diameter should remain uncoated.
- Pressure rating reduction due to external loads shall be in accordance with OEM recommendations and same limits of external loads shall be specified by VENDOR.
- Prior to installing connectors, the piping system shall be checked to verify that flexibility is sufficient to allow the required separation to install and remove the seal ring.
- Torque values and lubricant for clamp bolting shall be determined by the manufacturer to assure sufficient preload in the connection

7.4.8 Pipeline Flanges and Subsea Flanges

7.4.8.1 Pipeline Flanges

- a. Pipeline flanges shall be designed as per ISO 15990-3 and MSS SP 44 (PSL-2). In addition requirements of AGES-SP-10-003
- b. All pipeline flanges with dimensions NPS 24 and smaller shall be in accordance with ASME B 16.5 / MSS SP 44. All pipeline flange with dimensions NPS 26 and larger shall comply in accordance with ASME B 16.47 series A / MSS SP 44.
- c. The bore of the welding neck flanges shall correspond to the inside diameter of the connecting line pipe or fitting.
- d. In class 2500# for sizes NPS 14 and above, pipeline flanges shall be designed as per ASME Section VIII division 2.
- e. Ring gasket design shall be as per ASME B 16.20 and in accordance to AGES-SP-09-005
- f. In class API 5,000, 10,000 and above, the pipeline flanges shall be supplied in accordance with API 6A and shall comply with PSL-3.
- g. For Pipeline flanges including anchor flanges, the pressure class, design parameters and flange facing shall be in accordance with the data sheet. Pressure temperature rating shall be as per ISO 15590-3. Corrosion Allowance as per the pipeline design shall be considered in the flange design.
- h. Pipeline flange shall be made by forging process. Pipeline flanges shall be of welded neck type, and have smooth finish for pressure rating as defined in Section 7.4.1 above. Facing of pipeline flanges can be Raised face or RTJ based on pressure rating, and as specified in purchase description.
- i. Repair by welding on pipeline flanges is not permitted.
- j. The flange material shall be of same pipeline material grade and compatible for welding with line pipe material. The chemical composition & carbon equivalent (CE) of the flange shall be compatible with corresponding line pipe. The material shall be fully killed and shall comply with the material standards indicated in data sheet.
- k. Material grade of forged pipeline flange shall comply with MSS SP 44 (Table-1).
- l. In sour and severe service, the pipeline flange materials shall be as per NACE MR0175 / ISO 15156 Part 1-3 and AGES-SP-07-003.
- m. Maximum hardness of pipeline flanges in sour service shall comply with requirements of AGES-SP-07-003 and AGES-SP-10-001.

- n. Pipeline flanges shall be impact tested in accordance with ASTM A370. Charpy Impact energy value and test temperature requirements shall be in accordance with the applicable connecting Line pipe specification AGES-SP-10-001 and as indicated in the Data Sheet.
- o. NO HIC/SSC testing is required for pipeline flanges in sour service, provided that they meet the chemical composition limits in accordance with AGES-SP-07-003.
- p. Pipeline flanges shall withstand field hydrostatic test that will cause a circumferential fibre stress greater than 95 percent of the specified minimum yield strength of the connecting main line pipe material grade based on minimum wall thickness. The hydrostatic test pressure may be applied in several cycles (cyclic test).
- q. Gauging Test: Pipeline flange and Anchor flange internal diameters shall be matched with pipeline internal diameters and flanges shall allow to pass all types of pigs especially gauging pig. A gauging pig shall be passed through the main run of each pipeline flange and anchor flange as part of production test by the MANUFACTURER. The pig shall consist of two aluminium plates of at least 6mm thick, joined by a rigid rod through their centres. The diameter of the gauging plates shall be at least 98% of the nominal inside diameter of the main pipe. The pig shall pass without sticking or damage to the flanges.
- r. The material and inspection and certification requirements for pipeline flanges shall be in accordance with AGES-SP-13-002.

7.4.8.2 Subsea Flanges

- a. The use of subsea flanges is subject to review and approval of Company, however, if specifically accepted by Company, below shall be complied with.
- b. All flanges shall comply with the requirements of DNV-ST-F101, ISO 15590-3, ASME VIII Division 2 and ASME 16.5/16.47. VENDOR shall submit flange design calculations in accordance with the requirements of ASME VIII Division 2 for all sizes, ratings or classes and types of flanges supplied. The calculation shall include maximum applied bending moment and axial loads due to functional and environment. The VENDOR shall supply supporting calculations and dimensional drawings to scale for flange design prior to manufacture of the flanges. Minimum required bolt pre-tensioning for flange connection shall be specified in design calculations. The external forces and moments will be provided to VENDOR as part of Purchase Requisition.
- c. Subsea flanges shall have RTJ flange facing. To improve corrosion resistance, the sealing ring groove for sub-sea flanges shall be overlaid with 3 mm minimum Inconel 625 over the whole surface of the groove. Details for overlay qualification and requirements shall be submitted to COMPANY for approval. Material construction for the gasket shall be minimum Inconel 625.
- d. Project specific datasheet and specification for the subsea flanges shall be prepared under each project.

8 MATERIAL

8.1 General

All materials requirements shall be in line with Pipe material specification AGES-SP-09-002 (including respective pipe classes), this specification and their respective purchase description. In addition, additional requirements over and above the ASTM standard shall be applicable as specified in Appendix E1. Unless additional heat treatment is specified due to fluid characteristics, all welds shall, as a minimum shall have PWHT in accordance with the material grouping, thickness ranges and specific service requirements as defined in AGES-SP-09-002.

- a. All Material in sour application shall comply with AGES-SP-07-003 and applicable NACE standards including NACE MR0175/ISO 15156 and NACE MR0103/ISO 17945. For sour & severe service the following requirements as per AGES-SP-07-003 shall apply:

- Material, chemical composition restrictions, welding, heat treatment, testing and fabrication shall be in accordance with specification AGES-SP-07-003.
 - Brass is not permitted as a piping component.
 - As per AGES-SP-07-003 neither yield strength nor ultimate tensile strength of CS & LTCS pipes shall exceed the specified minimum value by more than 20,000 psi
 - All plates shall have tensile strength of less than 585MPa (85,000psi).
- b. Galvanized pipe and piping components shall be coated with zinc inside and outside by hot dip process in accordance to Galvanizing Specification AGES-SP-07-009. An Electrodeposited coating of zinc is not acceptable.
 - c. For welded material requirements of AGES-SP-07-007 Welding & Non-Destructive Examination (NDE) shall be applicable.
 - d. Materials requiring impact testing shall be in accordance with ASME B31.3 Para. 323.3. Method of testing to be in accordance with ASTM A370, Charpy V-Notch testing. Tensile shall also be performed in accordance with ASTM A370. In addition requirements of AGES-SP-07-008, Prevention of Brittle Fracture shall be met.
 - e. All materials shall be new, unused, clean, free from rust, pits and obvious defects.
 - f. Pipe and piping component material shall be as per details provided in the pipe classes and purchase description.
 - g. All welded pipes and fittings shall be subject to 100% Radiography throughout the entire length of each weld seam.
 - h. All welded pipes and fittings shall be heat treated after forming operations.
 - i. All steel grades shall be fully killed, vacuum degassed and melted to fine grain practice
 - j. SS steel and CRA material shall be manufactured from steel produced by the electric furnace process, and subsequently refined by vacuum oxygen decarburization (VOD) or argon oxygen decarburization (AOD). CRAs shall meet the requirements of the respective ASTM standards.

8.1.1 Chemical Composition

- a. The chemical composition (ladle and product analysis) shall be in accordance with the relevant material specification.
- b. All Carbon Steel material and Low Temperature Carbon Steel material, excluding screwed, galvanized and casting, shall have a carbon content of 0.23% maximum. A carbon content of 0.25% max may be permitted for castings.
- c. 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%
- d. 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%

e. The Carbon Equivalent (CE) based on the Product Analysis for CS & LTCS fittings shall not exceed 0.43, calculated by the following formula:

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

- f. For Carbon steel material. the following supplementary requirements should be considered in addition to the requirements in ASME B31.3:
- The manganese to carbon ratio shall be 5 or higher
 - Flanges in the normalized condition,
 - An ASTM grain size 7 or finer,
- g. For the carbon steel forged & seamless material in sour application, HIC testing is not required if Sulphur levels, Carbon content, Carbon equivalent, etc. are within the limits as specified above and in accordance AGES-SP-07-003.
- h. All materials specified for use in Sour & Severe service shall comply with the requirements of AGES-SP-07-003. In case of conflict with this specification, CONTRACTOR shall raise deviation proposing the stringent option subject to COMPANY review and approval.

8.1.2 CS & LTCS Material

- a. All carbon steel and alloy steel forgings shall be supplied in the normalized condition.
- b. Impact test shall be required in accordance with following:
- 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).
 - 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

8.1.3 SS, Duplex & Super duplex material

- a. In order to use austenitic Stainless steel at lower temperature, base metal, weld deposits, and heat affected zone shall be qualified as required by ASME B31.3 para. 323.2.2.
- b. SS 316 material specified as Dual Grade i.e., 316/316L shall be supplied certified to both the grades specified. All items shall be supplied with mechanical properties to the ASTM product specification for UNS S31600 (i.e., TP316) and chemical properties to the ASTM product specification for UNS S31603 (i.e., TP316L).
- Dual grade materials shall be supplied in the solution treated condition and shall be supplied with hardness test results demonstrating compliance to NACE MR01-75 / ISO 15156 where applicable.
 - The substitution of single grade material where dual grade is specified not permitted without prior COMPANY approval.
 - IGC (Inter Granular Corrosion) tests are required for Austenitic stainless steels (refer Section 9.4 below)

- In addition to marking specified as the applicable standards, all DUAL GRADE material shall be additionally marked as DUAL GRADE.
- c. Duplex, Super Duplex Stainless Steel shall be supplied in solution an
- d. nealing and water quenched condition.
- e. Stainless Steel material, Duplex Stainless Steel (22%Cr), Super Duplex Stainless Steel (25%Cr) shall undergo pickling and passivation as per ASTM A380 (descaled and acid cleaned). For machined surfaces pickling is not required.
- f. For ferritic-austenitic stainless steels ("22Cr and 25Cr"), the following shall apply:
 - For "22Cr" duplex (ferritic-austenitic) stainless steels, the Pitting Resistance Equivalent (PREN) shall be 34 or higher, the Mo mass fraction (wMo) 2.5% or higher and the N fraction (wN) 0.14% or higher.
 - For "25Cr" super duplex (ferritic-austenitic) stainless steels, the Pitting Resistance Equivalent (PREN) shall higher than 40 and the N fraction (wN) 0.20% or higher.
 - Corrosion test: Pitting tests shall be carried out in accordance with ISO 17781. The same section shall not be retested
 - Microstructure examination for deleterious phases shall be carried out in accordance with ISO 17781 section 5.2.
 - Ferrite content : The ferrite / austenite phase balance shall be determined in accordance with ISO 17781 section 5.3. For welded pipe, a full cross-section of the seam weld shall be examined as well. Here, the ferrite content shall be measured 1 mm (0.04 in) from both the internal and external surfaces of:
 - the parent material,
 - the weld metal,
 - the Heat Affected Zone within 0.2 mm (0.008 in) of the fusion line (FL)
 - Charpy impact testing shall be carried out in accordance with ISO 17781. The acceptance criteria of Quality Level 1 shall apply.
 - Detrimental phases: Microstructure examination for deleterious phases shall be carried out in accordance with ISO 17781 section 5.2.4. For welded pipe, a full cross-section of the seam weld shall be examined as well.
 - Ferritic-austenitic stainless-steel material shall be solution annealed as per ASTM standard and quenched rapidly by cooling in water.

8.1.4 Nickel alloy

- a. Inconel 625/ Incoloy 825 pipes and pipe components shall be furnished in the annealed condition in accordance with corresponding ASTM Specification.
- b. Surfaces finish for outside and inside surfaces of Inconel 625/ Incoloy 825 pipe shall be dull, matte (pickled) surfaces.
- c. For CRA materials, the chemical compositions shall be in accordance with respective ASTM standards. Elements not specified in standard shall not be intentionally added to the heat. Elements not specified and over 0.25% shall be reported. Total amount of residual elements shall not exceed 1.00% total.
- d. Compliance to NACE MR0175/ ISO 15156-3, NACE MR0103/ISO 17945 and AGES-SP-07-003 is also required for CRA material in sour and lethal application.

8.1.5 Cu-Ni

- a. All 90/10 and 70/30 Copper Nickel shall be in compliance with manufacturing and heat treatment requirements mentioned in EEMUA 234.
- b. 90/10 Cu-Ni and other Copper alloy pipe and components
- c. shall be supplied in annealed condition

8.1.6 Alloy 20

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

8.1.7 Titanium

- a. All Titanium pipe and components shall be finished in the annealed condition the base material shall be annealed.

8.1.8 Hastelloy 276

- a. Hastelloy 276 pipe and components shall be furnished in solution annealed and descaled condition.

8.2 Pipe

- a. Carbon steel shall be fully killed and manufactured by electric furnace/ basic oxygen process to fine grain, low hydrogen and clean steel practice, the internal surface of pipe shall be free from scale after heat treatment.
- b. All CS pipes shall be silicon killed
- c. HIC testing and SSC testing is not required for seamless pipe in sour & severe service provided it is compliant and meets the compositional limits of Section 8.1.1 and in accordance to AGES-SP-07-003
- d. HIC testing & SSC testing requirements for welded pipe are mandatory as specified in AGES-SP-07-003. Refer to AGES-SP-07-003 for HIC testing of welded pipe material.
- e. API-5L Gr. B PSL 2 seamless pipes and ASTM A106 Gr. B Pipes are acceptable substitutes for each other provided API 5L Gr. B is impact tested up to -29°C and approved by COMPANY.
- f. Pipes ASTM A106 & API 5L pipe materials shall be normalized or quenched and tempered.
- g. API 5L-Grade B and API 5L X-grade pipes shall be minimum to PSL-2 and shall be normalized or quenched and tempered if used in accordance with Curve-B figure 323.2.2A of ASME B31.3. TMCP pipes are not acceptable unless specifically agreed with COMPANY in prior.
- h. Impact test for shall be required in accordance with following:
 - Refer section 8.1.2 for CS & LTCS material
 - API 5L-Grade B and API 5L X-grade pipe shall be impact tested at -29 ° or at MDMT whichever is lower.
 - API 5L X-grade pipe if qualified as LTCS shall be tested as per ASME B31.3 Para. 323.3. Method of testing to be in accordance with ASTM A370 requirements at MDMT.
- i. All X60 and X65 grade pipes confirming to this spec shall be supplied either in quenched and tempered or normalized condition.
- j. Welded CS pipe shall be supplied to the following specifications and grades:
 - ASTM A672 class 22 gr C60 or C65.
- k. Welded LTCS pipe shall be supplied to one of the following specifications and grades:

- ASTM A671 class 22 gr C60 and C65.
- l. For CS & LTCS Welded pipe in Downstream Sour & Severe service application i.e. governed by NACE MR0103/ISO 17945, ASTM A671-CC65 Class 32 & ASTM A672-C65 Class 32 shall be used respectively in place of ASTM A671-CC65 class 22 & ASTM A672-C65 class 22.
- m. Manufacturing of pipe shall be in accordance with the relevant governing codes, standards, and the requirements hereinafter. VENDOR's obligation to meet the requirements on the latest issues of the standards and specifications referenced in this standard.
- n. Titanium pipes if cold worked shall be heat treated, Hot worked pipes finishing above 760 Deg. C need not be further heat treated.
- o. All Duplex and Super duplex stainless steel material shall meet the requirements specified in Company specification AGES-GL-07-001 and AGES-SP-07-003.

8.3 Fittings

- a. Fitting material shall be supplied as per details provided in the purchase description. Manufacturing of fittings shall be in accordance with the relevant governing codes, standards and the requirements hereinafter.
- b. Carbon steel used for the fabrication of fittings shall be manufactured by electric furnace or by basic oxygen process. All steel shall be fully killed and be of fine grain size. All seamless fittings shall be forged, formed or extruded as per applicable material standard.
- c. The fittings shall be manufactured either by wrought process or by forging. Fabricated tee and lateral tees (made by joining sections of pipes) are not acceptable.
- d. For Sour and severe service, HIC testing for wrought fittings is not required provided it comply with the compositional limits of AGES-SP-07-003.
- e. HIC and SSC testing requirements for fittings manufactured from plate are mandatory as specified in AGES-SP-07-003. Refer to AGES-SP-07-003.
- f. Fittings machined from cold rolled steel bar stock are not permitted. Fittings made from block forgings and machined to the required dimensions are not acceptable.
- g. Mitred type fittings and fabricated tees made by joining sections of pipe are not permitted.
- h. Tapered conical reducers without knuckle radius on both ends as illustrated in ASME B16.9, is not permitted. Straight cone as reducers are not acceptable.
- i. It is permissible to substitute seamless fittings in place of welded fittings of the same grade, wall thickness, size and specification. Substitution of seamless fitting with welded fitting is not permitted without Company approval.
- j. 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.
- k. All welded fittings shall be made from forming. The inside reinforcement of the weld must be ground-off at each end of the fitting; this machining shall be performed in such a way as to leave a gradual transition. All welded fittings shall be heat treated after forming operations.
- l. All welded fittings shall be subject to 100% radiography throughout the entire length of each weld seam.
- m. For welded fittings, the MANUFACTURER's Welding Procedure Specifications (WPS) and Procedure Qualification Records shall be reviewed & approved by Company. Welding procedures for sour service and non-sour service shall be separated as the chemical composition and hardness requirements are different.

- n. Surface defects which do not encroach on the specified dimensions shall be removed by grinding or further machining. Grinding or machining below minimum thickness is not acceptable.
- o. Repair of any defects or imperfection by welding is not permitted.
- p. All hot formed carbon steel fittings shall be supplied in the fully normalized or normalized and tempered or alternatively quenched and tempered condition.
- q. When galvanizing is specified, fittings shall be coated with zinc inside and outside by hot dip process in accordance to Galvanizing specification AGES-SP-07-009. Electrodeposited coating of zinc is not acceptable.
- r. 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.
- s. Titanium fittings if cold worked shall be heat treated, Hot worked fittings finishing above 760 deg C need not be further heat treated.

8.4 Flanges & Blind Flanges

- a. Carbon steel material shall be made by electric furnace or basic oxygen converter fully killed with fine grain practice. All steel grades shall be fully killed, vacuum degassed and melted to fine grain practice.
- b. Treatment for inclusion shape-control by addition of calcium is not permitted for flanges.
- c. All flanges are required to meet the definition of hot worked forgings in ASTM A788 and ASTM A961 and all other such appropriate general requirements:
 - Flanges shall be hot worked by press, hammer, or ring-mill of sufficient capacity to produce a substantially wrought structure throughout the rim.
 - Flanges shall be hot worked as close as practicable to finished dimensions.
- d. For forged flanges, the material shall be forged as close as possible to the final shape and size.
- e. Continuous-cast steel shall be hot-worked to a minimum 2:1 ratio before blanks are cut for die forgings.
- f. Blanks for open-die-forged flanges, hammer-forged flanges, and ring-rolled flanges shall be hot worked to a minimum reduction ratio of 2:1 before forging to shape or ring-rolling is initiated
- g. All flanges greater than 24 inch diameter shall be ring rolled unless alternate forming options can demonstrate the final product exhibits acceptable metallurgical structure and mechanical properties in the rim/hub region
- h. All flanges shall be hot forged and shall undergo the appropriate heat treatment after forging (rolling for plate material) in accordance with the corresponding ASTM standards/specific purchase requirement.
- i. Flange material shall be as per detail provided in the purchase description.
- j. For sour and severe service, HIC testing for forgings is not required provided within the compositional limits of AGES-SP-07-003.
- k. Impact test on flanges shall be as required as per ASME B31.3. Flanges required Impact testing shall be represented by tension test and Charpy V-notch specimens, as applicable with test axes transverse to the principal direction of hot work. Principle direction of hot work is defined as follows:
 - Ring rolled flanges - Tangential to the bore.
 - All other flanges - Radial to the bore, except for prolongations which shall be tangential to the bore.
- l. Manufacturing shall be in accordance with the relevant Specification and Standards for forging and plates. Materials shall be supplied in accordance with the purchase description. Substitutions shall not be made unless written authorization is obtained from Company. Such authorisation shall in no way diminish the

Vendor's obligation to meet the requirements on the latest issues of the standards and specifications referenced in this standard.

- m. Flanges, blind flanges, Nipoflange / Weldoflange, spectacle blinds, paddle blind & spacer used for API 5000 and API 10000 class, shall comply with requirements of API 6A, Section 6 and shall comply with PSL-3 requirements of API 6A.
- n. Carbon and low alloy steel flange rated higher than ASTM A694/A694M grade F65 shall not be used for B31.3 piping unless specifically agreed with COMPANY.
- o. Drilling and tapping for jack screws on the flange, when specified in the purchase description, shall be carried out by the MANUFACTURER and shall be identified at the detailed design stage. Jack screw material shall be as per applicable piping class bolt material.
- p. Spot facing of the flanges at the bolt holes shall be in accordance with MSS SP 9.
- q. Titanium Alloy Flanges shall be seamless and supplied in solution annealed. Titanium forgings shall be supplied in annealed condition
- r. Forged flanges requiring weld repairs are not acceptable.

8.5 Spectacle Blinds

The plate used for spectacle blinds, spades and spacers shall be cut using plasma arc method followed with machined finish of outer diameter. Plate cut by oxyacetylene flame is not acceptable to form inside or outside diameters. The handles or lifting lugs shall be of same material as plate. For sour service HIC testing is required for plate material in accordance to AGES-SP-07-1003.

9 INSPECTION AND TESTING REQUIREMENTS

9.1 General

For inspection and testing requirements, this specification shall be read in conjunction to AGES-SP-13-001 for Criticality Rating Specification, AGES-SP-13-002 Procurement Inspection and Certification Requirement in Projects and AGES-SP-13-004 Traceability of Shop and Field Piping Materials.

Unless additional inspection is specified in material requisition (attachments and technical requirements), inspection and testing shall be in accordance with their applicable ASTM, ASME, MSS including additional requirements as specified in Appendix E1 or other code or standards and, where required sour and severe service exists, in accordance with NACE MR0175/ISO 15156, NACE MR0103/ISO 17945, AGES-GL-07-001 and AGES-SP-07-003.

- a. VENDOR shall submit a detailed Inspection and Test Plan (ITP) for approval based on AGES-SP-13-002. Purchaser will complete the ITP with scheduling of tests, scope of test, standard followed for test, acceptance criteria their review, witness and hold points. Purchaser or its authorized representatives shall be permitted at all times free access to all parts of VENDOR's workshops that concern the construction, inspection and testing.
- b. Specific Inspection Requirements i.e., Quality requirements, including inspection, testing, surveillance, material certification and traceability for the Piping components shall be in conformance to the Purchase Order Quality Requirements.
- c. All items shall be visually examined over their entire external surface. Each pipe shall be visually examined over the entire external surface. The internal surface shall be visually examined from each end. For components with a size \geq NPS 24 the entire internal surface shall be visually examined.
- d. For sour and severe service additional inspection and testing shall be as per to AGES-SP-07-003 .

- e. For NDE requirements also refer to AGES-SP-07-007 Welding & Non-Destructive Examination (NDE) and AGES-SP-13-002 Procurement inspection and certification Requirement in Projects.
- f. Positive Material Identification (PMI) test shall be carried out before shipment for all high alloy material (like SS, CRA, etc) at least one piece per batch/heat as per AGES-GL-13-002.
- g. Hydrostatic testing shall be performed after heat treatment.
- h. Pressure testing of stainless steel/Nickel alloy components shall ensure only water containing fewer than 30 ppm (30 mg/litre) chloride ion shall be used for pressure testing.
- i. When requested VENDOR shall submit to CONTRACTOR for review and approval, a comprehensive test procedure describing the test equipment, jigs and fixtures, instrumentation, test media, frequency and duration of testing, all test data, measuring observations, photographs and any other information obtained during the testing.
- j. All personnel performing NDT activities shall be qualified in the technique applied, in accordance with ASNT ACCP level III, or CSWIP / PCN level II., subject to review and acceptance of the examination and training records by the CONTRACTOR and COMPANY.

9.2 Mechanical Properties

The mechanical properties shall conform to the requirements of the relevant Standards and Specification if no additional requirements are specified

- a. In case test blocks are used for the test sampling, the size and heat treatment shall be representative of the actual components.
- b. Hardness testing shall be conducted on the finished product.
- c. Maximum allowable hardness shall be as per the relevant specification if no additional requirements are specified.
- d. Hardness for Pipes/flanges/Fittings for non-sour service shall be as per relevant Material Specification & AGES-GL-07-001. Hardness for Pipes/flanges/Fittings for sour and severe service shall be as per AGES-SP-07-003.
- e. For high strength pipe, fittings, flanges, etc (SMYS 60 KSI and above), 100% hardness testing shall be required.
- f. The test specimen(s) shall be taken from a complete production forging or from separately forged blanks prepared from the stock which is used to make the finished product. Such blanks shall receive the same working (forging) as the finished product and shall be heat treated with the finished product.
- g. All carbon steel material shall be suitable for the impact test temperature requirements stated in material codes or by batch specific impact testing unless specifically agreed. The test locations, testing frequency and acceptance/rejection criteria shall be as per the relevant codes and standards.

9.3 Non-Destructive Test

Non-destructive tests shall be in accordance with the relevant specification if no additional requirements are specified. In addition following shall be ensured.

9.3.1 Pipe

All pipes shall be subject to mill hydrotest as per relevant applicable ASTM standards and other applicable standards.

9.3.2 Fitting

Non-destructive tests shall be in accordance with the applicable standards (ASTM, API, EEMUA etc) specification if no additional requirements are specified.

9.3.3 Flanges

Non-destructive tests shall be in accordance with the relevant applicable standards. However, for forged steel flanges the following additional requirements shall be applied:

- a. The neck of each flange shall be examined for laminations and other defects within 4t of the weld bevel, where 't' is the nominal thickness at the weld bevel, by ultrasonic testing in accordance with BS EN ISO 10893-8 or ASME Section V. Such examinations should be carried out prior to machining of the flanges.
- b. After final machining, each flange shall be examined as appropriate for surface defects by wet magnetic particle or dye penetrant inspection in accordance with ASTM E709, BS EN ISO 9934 or ASTM E165.
- c. Surface defects which do not encroach on the specified dimensions shall be removed by grinding or further machining. Grinding or machining below minimum thickness shall be cause for rejection.
- d. Repair of any defect or imperfection by welding is not permitted.

9.3.4 Orifice Flanges

Non-destructive tests shall be in accordance with the applicable standards. However the following additional requirements shall be applied

- a. Each orifice flange shall be visually examined in accordance with ASME B31.3, Section 341.4.
- b. Ferritic stainless steel welds shall be Magnetic Particle examined in accordance with ASME B31.3.
- c. Austenitic stainless steel welds shall be Liquid Penetrant examined in accordance with ASME B31.3, Chapter IX, Part 10.

9.3.5 Spectacle blinds

Non-destructive tests shall be in accordance with the applicable standards. However the following additional requirements shall be applied

- a. Each line blank shall be visually examined in accordance with ASME B31.3, Section 341.4

9.4 Corrosion Testing

- a. Corrosion testing shall be as per requirements of AGES-SP-07-003 & AGES-GL-07-001
- b. The method for Intergranular Corrosion (IGC) and Pitting testing shall be in accordance with below table. Weld overlays, welds, pressure and non-pressure retaining, shall be IGC tested in accordance with below standards. (Refer Table below)
- c. All SS material shall be tested for IGC and shall be capable of passing IGC test as per ASTM A262 Practice E or ISO 3651-2 method A.
- d. Where a service corrosion test is conducted it shall follow the requirements of EFC 17 and NACE MR0175/ISO 15156.

Table 1.5 Corrosion Testing

STEEL GRADE	CORROSION TEST	TEST CONDITIONS	ACCEPTANCE CRITERIA
UNS N08904 (F 904L)	ASTM G48 Method A	Test temperature 25°C Test duration:24 hours	No pitting at 20X magnification. Weight loss shall be less than 4.0g/m ²
UNS S31254 (F 44) UNS N08367 (F62) UNS N08926	ASTM G48 Method A	Test temperature:50°C Test duration:48 hours	No pitting at 20X magnification. Weight loss shall be less than 4.0g/m ²
UNS S32205 (F 60)	ASTM G48 Method A	As per ISO 17781	As per ISO 17781
UNS S32750 (F 53)	ASTM G48 Method A	As per ISO 17781	As per ISO 17781
UNS S32760 (F 55)	ASTM G48 Method A	As per ISO 17781	As per ISO 17781
UNS N8020 Alloy 20	ASTM A262 Method E	As per ASTM A262	As per ASTM A262
UNS N08810	ASTM G 28 Test Method A	As per ASTM 28	48 mpy (1.22 mm/y) maximum
UNS N08825	ASTM G28 Method A	Test temperature 120°C Test duration:120 hours	No preferential attack in grain boundaries at 50 X magnification Weight loss shall be less than 36 mpy (0.914 mm/y) maximum
UNS N06625	ASTM G28 Method A	Test temperature 120°C Test duration:120 hours	No preferential attack in grain boundaries at 50 X magnification Weight loss shall be less than 36 mpy (0.914 mm/y) maximum
UNS N10276	ASTM G28 Method B	As per ASTM G28	100 mpy (2.54 mm/y)

9.5 Positive Material Identification (PMI)

Positive Material Identification (PMI) shall be performed on low alloy and high alloy basic materials in accordance with AGES-SP-13-003.

SECTION C – OTHER REQUIREMENTS

10 QUALITY CONTROL AND ASSURANCE

10.1 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."

10.2 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.

10.3 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.

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.

11 SUB-CONTRACTORS/SUB-VENDORS

- 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.

12 MATERIAL CERTIFICATION REQUIREMENTS

- a. Certification requirements shall be in accordance with Project specification and as per COMPANY Criticality Rating Specification.
- b. For items intended for sour service, the MANUFACTURER shall provide a statement of compliance with NACE MR 0175/ISO 15156 in addition to the other material certificates required with all additional requirements of COMPANY specification.
- c. All certifications shall be in English language
- d. The requirements for certification, reports & any other documents shall be in accordance with the MESC specification, and "VENDOR Document Requirement List" (VDRL) attached with the material requisition.
- e. As a minimum, the Material Test Certificates (MTC) shall contain the following data:
 - Project Number, PO Number & Item Number.
 - Item Description, Size and Quantity.
 - Standard & Material Grade.
 - Heat/Melt/Manufacturing Number.
 - Heat Treatment Details.
 - Chemical Analysis for all components.
 - Mechanical Tests Result (Along with values required by specification) for all components.
 - Hardness Test Result (Along with values required by specification).
 - Pressure Test Result.
 - Cryogenic test results (if applicable)
 - Results of Supplementary Test(s) as called out in the Purchase Order (along with values required by specification).
 - I) NDE Results (as applicable).

- HIC Test Results: CSR, CLR, CTR values (where applicable).
 - Ferrite test results (if applicable)
 - Radiography report (where applicable).
 - NACE Compliance Statement (where applicable).
 - Dimensional Check Report.
 - WPS and PQR (for welds including weld repairs & overlays).
 - Painting report.
 - Certificate of compliance for valve operator.
- f. All materials shall have their chemical analysis certified by Product Check Analysis.
- g. Material Test Certificates (MTC) shall be furnished covering each heat supplied.
- h. Supplier shall ensure that appropriate certification showing mill heat or batch markings are received for all furnished materials. Materials furnished without documentation are not acceptable.
- i. Where applicable all certificates shall be original or authenticated mill certificates.
- j. All certificates shall state the MANUFACTURER's name, location. Forging, casting and plate certificates shall be from original steel MANUFACTURERS.
- k. In the case of procurement of small quantities from stockists, the following shall be met
- Prior approval from COMPANY is required and shall be as per approved SUPPLIER
 - The CONTRACTOR shall ensure that the testing and related acceptance requirements stated in this specification are fulfilled
 - Certificates issued by Material Stockists or Agents are not acceptable. The certificates of pipes, fittings and flanges shall be either original mill certificate or certified copy of the original mill certificate issued by the MANUFACTURER. (This is covered under AGES-13-SP-002).
 - Stockist Material Certificates shall not substitute the Manufacture (Origin/ Mill) Certificates and shall be unacceptable.
 - For all non-metallic components
 - For metallic joints
 - Original markings shall be easily visible on products. All piping bulk materials shall be fully traceable and correctly identified, particularly to the heat, heat treatment lot and test numbers of the matching certificates
 - In addition, the COMPANY reserves the right to require any counter-analysis or confirmatory tests (chemical analysis, mechanical tests, thickness measurements, etc.) and to undertake a technical assessment
- l. All materials shall have their chemical analysis certified by Product Check Analysis.
- m. VENDOR shall ensure that appropriate certification showing mill heat or batch markings are received for all furnished materials. Materials furnished without documentation are not acceptable.
- n. In order to assure traceability of materials and products, the MANUFACTURER shall keep a record of all quality control tests performed and shall maintain this record for a minimum period of five years from the date of manufacture in accordance with Project Specification AGES-SP-13-003, Traceability of Shop and Field Fabricated Piping Materials

Where applicable all certificates shall be original or authenticated mill certificates.

13 SPARE PARTS

Not Applicable

14 PAINTING, PRESERVATION, MARKING AND SHIPMENT

14.1 Painting

Painting and coating including colour coding, if required by requisition, shall be in accordance with AGES-SP-07-004 Painting and Coating Specification.

14.2 Preservation and Packing

- a. All equipment and material shall be preserved, and export packed in accordance with AGES-SP-07-011 Preservation and export Packing Specification.
- b. Packing, protection, preservation, identification, storage and handling of flanges shall as a minimum meet the requirements stipulated by AGES-SP-07-011. The Following to be taken care after testing.
- c. Materials supplied shall be dry, clean and free from moisture, dirt and loose foreign material of any kind.
- d. Pipes and piping components shall be protected to withstand ocean transit and extended period of storage at the jobsite for a minimum period of 18 months. Pipes and piping components shall be protected to safeguard against all adverse environments, such as: humidity, moisture, rain, dust, dirt, sand, mud, salt air, salt spray, and sea water.
- e. All Materials shall be supplied with protective coating for protection against rust, corrosion and mechanical damage during transportation and storage in offshore environment.
- f. Machined and threaded surfaces, internal and external, shall be adequately protected from corrosion and mechanical damages. Such surfaces (e.g. flange face and hub surface, welding bevel etc.) shall be protected by a coat of removable plasticized film, thick enough to ensure protection of the machined surfaces during transportation and storage in offshore environment. The coating used on machined surfaces to be welded, shall be easily removable with a petroleum solvent and shall not be harmful to welding.
- g. Threaded ends shall be greased and fitted with a plastic cap or plastic thread protector to ensure adequate thread protection. SW or BW ends shall be fitted with plastic end-cap to ensure that all openings are closed.
- h. Fittings smaller than NPS 14 shall be supplied in suitable sized crates with adequate packing to ensure full protection during transit. Fittings NPS 14 and larger may be supplied loose or strapped in manageable bundles.
- i. Steel strapping shall be stainless steel or plastic coated steel with a minimum thickness of 0.27mm.
- j. All items shall be shipped in suitable containers to give sufficient protection during transit and storage. Crates, boxes etc., shall be lined internally with waterproof plastic, minimum 150 μ -m thickness, with sufficient weep/vent holes to prevent internal condensation.
- k. Lifting-lug points shall be clearly indicated on the containers.
- l. Material Certificates shall accompany each lot or part lot to each and every delivery location.

- m. CRA & SS flanges, spade & spacer and spectacle blind shall be wrapped and packed using Polyethylene sheets or appropriate material to protect from inclusions of any dust, foreign particles etc.
- n. Flange gasket surfaces shall be protected by means of one-piece covers secured by a minimum of four bolts. The cover material shall be 10mm thick plywood or 3mm thick steel. In addition, a corrosion preventive shall be applied to all flange faces. When plywood flange covers are used, a Polythene sheet shall be placed between the coated flange face and the cover to prevent the wood absorbing the preventative. Flange covers are not to be used as surfaces for any marking or tagging.
- o. VENDOR may propose alternative means for protecting the flange face e.g., Plastic caps/covers or any other new technology in packing/protection, if he considers them more economical than that specified above. However, in all such cases, VENDOR shall guarantee that the end covers thus provided will remain secure throughout handling of the flanges during fabrication/installation. Complete technical details of the scheme shall be furnished, for Company's review/acceptance. Implementation of the proposal shall be only subject to Company's acceptance.

14.3 Marking

- a. Identification and marking of pipe, fittings and flanges shall be in accordance with MSS-SP-25 and other applicable material standards.
- b. In addition to the marking required by MSS-SP-25, the following information shall be marked by cold stamping on each fitting:
 - Specification and grade of material.
 - Heat Number.
 - Batch Number.
 - The nominal pipe size (NPS).
 - If specified as a Low Temperature service in the Purchase Order, component shall be marked with Low Temp behind the ASTM designation
 - If Amine service is specified, the word AMINE shall be marked on the fitting directly behind the ASTM designation.
 - If sour service is specified, the word SOUR shall be marked on the fitting directly behind the ASTM designation.
- c. Carbon steel material shall be marked by cold stamping using low stress round nosed stamps or MANUFACTURER's rolling stamp method
- d. Stainless steels (Austenitic). Duplex, SDSS, Titanium and 90/10 Cu-Ni components shall be marked by vibro-etching. The maximum depth shall be 0.5 mm (0.02 in) and the minimum height 8 mm (0.3 in)
- e. Galvanized items shall be marked by stencilling in letters not less than 20mm high with a waterproof material that is not injurious to the coating.
- f. Components that cannot be hard stamped or electro-etched shall have the required markings stamped on metal tags securely wired to each piece.
- g. Marking can be omitted for components of nominal size of NPS 1 ½ and smaller provided marking are transferred on the packing box.
- h. The marking requirements specified herein are in addition to the color coding requirements and shall be positioned so as not to interfere with colour coding. For colour coding refer to AGES-SP-07-004.

- i. Paint or ink to be used shall not contain any harmful metal, or metal salts, such as zinc, lead, sulphur, or copper which could cause corrosive attack on heating.
- j. Galvanized components shall not be electro-etched
- k. Stainless steel components shall not be electro-etched prior to solution annealing and/or pickling.
- l. Immediately following the electro-etching of any ferrous component, the markings are to be painted over with a durable, clear, hard finish varnish that will protect the markings from corrosive obliteration.
- m. All DUAL GRADE Stainless Steel Materials shall be identified as such.
- n. Where specified to be on attached metal tags, metal dies shall be used to make a permanently readable depression without cutting through the tag.
- o. Low stress or mini-stress, round nosed metal dies on all carbon steel and low temperature carbon steel piping components.
- p. Flange marking shall be stamped on the outer circumference of the flange.
- q. Line blinds shall be stamped on the handle or on the outer circumference
- r. Pipe length shall have markings stamped at both ends, between 50mm and 300mm from the ends
- s. Each length of pipe shall be marked permanently over the entire length, in accordance with ASTM A530 (for ferritic steel), ASTM A999 for austenitic steel or ASTM B775 (for nickel copper alloy), and the specific ASTM Grade specified (i.e., ASTM A106 Gr. B, A335 Gr. P5, etc.).
- t. For pipe nipples with not enough space for marking, the required certificates are mandatory and marking may be restricted to only such symbols or codes as are necessary to identify them with the certificates.
- u. Each length of TUBE shall be marked permanently over the entire length, in accordance with ASTM A450. Stencil marking shall utilize a water insoluble ink.

14.4 Shipment

- a. Material shall be released for shipment only after Company's approval of all documentation as per the VENDOR Document Requirement Schedule, attached to the requisition.
- b. Packing shall be inspected by Company (or their authorized representatives), before acceptance for shipment.
- c. All material shall be subject to Receipt Inspection at destination, comprising visual inspection and satisfactory review of Company approved certification/documents/ manuals/dossiers required by the purchase order. Incomplete documentation is not acceptable.
- d. One complete set of the installation, operation, and maintenance instructions, if applicable, packed in the boxes or crates with equipment and/or pipes & piping components. This is in addition to the number called for in the Purchase Order
- e. Shipping documentation shall be as specified in the purchase documentation and as a minimum, shall include:
 - 1 copy of the Packing Lists.
 - MANUFACTURERs Release Note (MRN).
 - Material Test Certificate.

- f. A list of any rust preventative showing the brand name, type number and MANUFACTURER's name. A copy of the MANUFACTURER's instructions for the renewal and/or removal of any rust preventatives.
- g. For packages containing desiccant, a list showing the brand name, type number, MANUFACTURER's name, the date the package was sealed and the recommended renewal frequency.
- h. Requisite copies of Certificates/Manuals/Dossiers as per the Purchase Documentation

15 DOCUMENTATION / MANUFACTURER DATA RECORDS

15.1 Documentation and Manuals

- 15.1.1 VENDOR shall provide the minimum documentation as stated in the VENDOR Document Requirement Schedule, attached to the requisition.
- 15.1.2 Below is the minimum documentation required from the VENDOR.
 - a. Purchase Requisitions
 - b. List of VENDOR's Documents and Drawings.
 - c. Manufacturing, testing and inspection procedures (Inspection & Test Plan).
 - d. SUB-VENDORS and Main VENDORS List.
 - e. Cross Sectional Assembly Drawings (For fabricated, fittings, API flanges, Spectacle blinds, clad flanges, components that are designed based on the pressure vessel design code/FEA calculation etc.).
 - f. Calculation reports.
 - g. Welding Procedures (WPS, PQR, Weld Map of key).
 - h. NDE Procedure, PMI Procedure, Testing Procedures.
 - i. PWHT Procedure.
 - j. Nonconformance records.
 - k. Listing of applicable and authorized concessions, waivers and/or material substitutions.
 - l. Galvanizing certificates were applicable.
 - m. NDE, PMI including overlay NDE, thickness check, Ferrite check, etc.
 - n. HIC test certificates for material in sour service.
 - o. Visual and Dimension check.
 - p. Hardness testing.
 - q. Impact test result.
 - r. Marking, Tagging, IDENT Code, Colour Coding and Preservation method statement.
 - s. Material Test Certificates along with MCS and Test Records.
 - t. MANUFACTURER Data Book as per Approved MRB Index.
- 15.1.3 VENDOR shall ensure that requisite set of compiled Manual(s)/Dossier(s)/Drawing(s) required by the purchase order, are furnished to the Company along with the shipping documents.
- 15.1.4 Mutual agreement on scheduled submittal of drawings and engineering data shall be an integral part of any formal Purchase Order.

- 15.1.5 Comments made by CONTRACTOR on drawing submittals shall not relieve VENDOR or SUB-VENDORS of any responsibility in meeting the requirements of the specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.
- 15.1.6 Each drawing shall be provided with a title block in the bottom right-hand corner incorporating the following information:
- Official trade name of the VENDOR.
 - VENDOR'S drawing number.
 - VENDOR logo and Project number.
 - Drawing title, giving the description of contents whereby the drawing can be identified.
 - A symbol or letter indicating the latest issue or revision.
 - PO number and item tag numbers.
 - Name of the Contractor
- 15.1.7 Revisions to drawing shall be identified with symbols adjacent to the alterations, a brief description in tabular form of each revision shall be given, and if applicable, the authority and date of the revision shall be listed. The term Latest Revision shall not be used.
- 15.1.8 After order placement, VENDOR shall submit for approval, all listed drawings/ documents, strictly in accordance with the agreed schedule and program.

15.2 Information Required with Bid

- 15.2.1 Any proposed deviations from this document.
- 15.2.2 The proposed manufacturing procedure and quality plan, including steel maker, steel making and casting practice, forging method and reduction, heat treatment (times and temperatures), machining techniques, welding procedures, the appropriate qualification test results, non-destructive testing equipment and techniques and final dimensions of the products.
- 15.2.3 The proposed range of chemical composition and the guaranteed minimum mechanical properties, including where modified in this document.
- 15.2.4 Any items/services which are to be sub-contracted, and the name of the Sub-contractor proposed for each item.
- 15.2.5 Proposals for warranty in the event of component failure during field hydrostatic test.

16 GUARANTEES AND WARRANTY

The VENDOR shall guarantee and be totally responsible for the material supplied under this specification, shall proceed based on the relevant documents.

The VENDOR shall be responsible for the correct function and operation of all the components supplied. This responsibility includes guarantees and warranties.

APPENDIX-1 ADDITIONAL REQUIREMENTS

17 ADDITIONAL REQUIREMENT OVER THE APPLICABLE INTERNATIONAL STANDARDS (ASTM, ASME, ETC.)

17.1 PIPE, CARBON STEEL, API SPEC 5L

- a. SAW pipe, thicker than 19 mm (0.75 in), shall be normalised or post weld heat treated after welding..
- b. Galvanized carbon steel pipe, PSL -1 is specified. If galvanised is specified, galvanising shall be in accordance with AGES-SP-07-009.
- c. PSL-2 is specified for non-galvanized carbon steel pipe. For non-galvanised pipe, the minimum silicon content shall be 0.10 %.

17.2 PIPE, STEEL, ASTM A672

- a. Plate material conforming to ASTM A516 shall be furnished in the normalised condition.
- b. Hardness testing, if post-weld heat-treatment is performed, supplementary requirement S3 shall apply on one finished pipe representing each lot. Hardness tests shall be executed after post-weld heat-treatment. The hardness of the weld, heat affected zone or base metal shall not exceed 248 HV 10.

17.3 PIPE, CARBON STEEL, ASTM A106

- a. If sour service is specified, the following requirements for heat treatment shall apply:
 - Normalising shall consist of heating to a uniform temperature not less than 815 °C (1500 °F), followed by cooling in still air or in the cooling chamber of an atmosphere-controlled furnace.
 - In case the pipe is hot finished, certification shall be provided that hot finishing was carried out in the temperature range of 845 °C (1550 °F) to 945 °C (1730 °F), followed by cooling in an atmosphere-controlled furnace or cooling in still air.

17.4 PIPE, STEEL, ASTM A671, LOW TEMP

- a. If post-weld heat-treatment is performed, supplementary requirement S3 shall apply on one finished pipe representing each lot. Hardness tests shall be executed after post-weld heat-treatment. The hardness of the weld, heat affected zone or base metal shall not exceed 248 HV 10.
- b. Plate material conforming to ASTM A516 shall be furnished in the normalised condition.

17.5 PIPE, STEEL, ASTM A335

- a. Pipe (except grade P1) shall conform to either of the following two options:
 - The pipe shall be supplied in the normalised and tempered condition. The tempering temperature shall be 740°C ±8°C (1365°F±13°F). The tensile properties shall be in accordance with Class 1 of ASTM A387.
 - The pipe shall be supplied in the normalised and tempered condition. The minimum tempering temperature shall be 720°C (1330°F). After all processing, one sample from each heat shall undergo three simulated PWHT cycles at 730°C ±8°C (1345°F ± 14°F) with a holding time in accordance with ASME B31.3 Table 331.1.1 for each cycle. Tensile tests according to ASTM A335 shall be performed after each cycle. If the results of all the tests comply with ASTM A335, all pipes from that heat shall be considered acceptable.
- b. Pipes, grade P1, shall conform to the following:

- The pipe shall be supplied in the normalised and tempered condition.
 - For pipe with wall thickness 13 mm (0.5 inch) and below, the tempering temperature shall be minimum 650°C (1200 °F);
 - For pipe with wall thickness above 13 mm (0.5 inch), the tempering temperature shall be minimum 675°C (1250 °F);
 - The tensile properties shall be in accordance with ASTM A335.
 - The aluminium content shall be 0.012% maximum.
- c. Unless specified otherwise, the restrictions in the chemical composition of pipe furnished to Grade P11 shall be as follows: The material shall meet the following additional chemical requirements by heat analysis:

Element	C	P	S	Cu	Ni	X-bar
Max allowed	0.15 %	0.012 wt%	0.007 wt%	0.20 %	0.30%	15

X-bar shall be calculated with the following formula:

$$X - bar = \frac{10P + 5Sb + 4Sn + As}{100}$$

in which the values of P, Sb, Sn and As are in ppm.

- d. Except where steam service is designated, pipe furnished to Grade P22, the following restrictions shall apply:
- The phosphorous content shall not exceed 0.010 %.
 - The sulphur content shall not exceed 0.010 %.
 - J-factor = (Si+Mn) x (P+Sn) x 10000 < 120. In which the values of P, Sn, Mn and Si are in wt%.
- e. For pipe furnished to Grade P22 in steam service, the following shall apply:
- J-factor = (Si+Mn) x (P+Sn) x 10000 < 180. in which the values of P, Sn, Mn and Si are in wt%.
 - Each length of pipe with outside diameter greater than NPS 4 shall be subjected to both the hydrostatic test and the ultrasonic test
 - Where steam service is designated, pipe produced from Grade P22 shall be Charpy impact tested. Charpy impact tests shall be carried out in accordance with ASTM A370 at a temperature of +20 °C (+68 °F) on longitudinal samples. 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.

17.6 PIPE, STEEL, ASTM A691

- a. For pipe furnished to Grade 1¼ Cr, the restrictions in the chemical composition of pipe furnished to Grade P11 shall be as follows: The material shall meet the following additional chemical requirements by heat analysis:

Element	C	P	S	Cu	Ni	X-bar
Max allowed	0.15 %	0.012 wt%	0.007 wt%	0.20 %	0.30%	15

X-bar shall be calculated with the following formula:

$$X - bar = \frac{10P + 5Sb + 4Sn + As}{100}$$

in which the values of P, Sb, Sn and As are in ppm.

- b. For pipe furnished to Grade 2¼ Cr, the following restrictions shall apply to the pipe and the weld:
- The carbon content shall not exceed 0.14 %. Weld metal shall have a carbon content <0.05%
 - The phosphorous content shall not exceed 0.010 %.
 - The sulphur content shall not exceed 0.010 %.
 - Base metal: J-factor = (Si+Mn) x (P+Sn) x 10000 < 120. In which the values of P, Sn, Mn and Si are in wt%.
 - Welds: X-bar (as per above mentioned formula) ≤ 15
- c. Class 22 pipe ordered to Grades 1¼ Cr, 2¼ Cr, 5 Cr and 9Cr shall conform to one of the following two options:
- The plate to ASTM A387 shall be supplied in the normalised and tempered condition. The tempering temperature shall be 740°C±8°C (1365°F±13°F). The tensile properties shall be in accordance with Class 1 of ASTM A387. The pipe shall be furnished in the post weld heat treated condition. The post weld heat treatment temperature shall be 715 °C ±10°C (1318 °F±18°F).
 - The plate to ASTM A387 shall be supplied in the normalised and tempered condition. The minimum tempering temperature shall be 720°C (1330°F). The tensile properties shall be in accordance with Class 1 of ASTM A387. The pipe shall be furnished in the post weld heat treated condition. The post weld heat treatment temperature shall be 715 °C ±10°C (1318°F±18°F). After all processing, one sample from each heat shall undergo three simulated PWHT cycles at 730°C ±8°C (1345°F ±14°F) with a holding time as per ASME B31.3 Table 331.1.1 for each cycle. Mechanical tests according to ASTM A691 paragraph 8.1 shall be performed after each cycle. If the results of all the tests comply with ASTM A335, all pipes from that heat shall be considered acceptable.
- d. Hydrostatic testing shall be performed after heat treatment.
- e. For hardness testing, supplementary requirement S3 shall apply
- f. For Magnetic Particle examination, supplementary requirement S7 shall apply. The acceptance criteria shall be in accordance with ASME B31.3, Table 341.3.2 for "Severe Cyclic Service", Criteria A. For butt-welding ends no linear indications longer than 1.6 mm (0.06 in) are allowed
- g. Supplementary requirement S10 shall apply for Ultrasonic testing
- h. Radiographic examination shall be performed after heat treatment

17.7 PIPE, STAINLESS STEEL, ASTM A312

- a. Pipe ordered to Grade TP316, the carbon content shall not exceed 0.035 %.
- b. Longitudinally welded pipe ordered in sizes \geq NPS 6, both hydrostatic testing and non destructive electric testing shall be performed.
- c. Welded pipe is may be used up to and including 5.5 mm thickness. (Instead ASTM A358 shall be used for welded SS pipe)
- d. Hydrostatic testing shall be performed after heat treatment.
- e. Hydrotesting shall be performed with water containing no more than 30 ppm chloride. The pipe shall be dry before any end closures are installed.
- f. The entire length of welds of pipe furnished by the electric fusion welding process as specified in clause 6.1.3 shall be 100 % examined by radiography in accordance with supplementary requirement S5.

17.8 PIPE, STAINLESS STEEL, ASTM A358

- a. Pipe ordered to Grade 304 or 304L shall be made using welding procedures qualified with impact testing at -196°C (-321°F) in accordance with the requirements of ASME B31.3, Section 323.2.2. The material certificates of these welded pipes shall refer to the associated WPQs.
- b. Pipe ordered to Grade 316 or 316L or dual, where low temperature service is indicated in the pipe class, welds shall be made using welding procedures qualified by impact testing at -196°C (-321°F) in accordance with the requirements of ASME B31.3, Section 323.2.2. The material certificates of these welded pipes shall refer to the associated WPQs.
- c. Any cold working shall be done before the final heat treatment.
- d. Heat treatment procedures shall be subject to statistical process control to ensure that the final material properties comply with the material specification. The process control data and related periodic quality control checks shall be documented.
- e. For pipe ordered to Grade 316, the carbon content shall not exceed 0.030 %.
- f. All welds of austenitic stainless steel pipe shall have a ferrite number between 3FN and 8FN. Ferrite number testing shall be in accordance with ISO 8249, other test methods are subject of approval by the COMPANY
- g. Hydrostatic testing shall be performed after heat treatment.
- h. Hydrotesting shall be performed with water containing no more than 30ppm chloride. The pipe shall be dry before any end closures are installed

17.9 PIPE, DUPLEX AND SUPERDUPLEX STAINLESS STEEL, ASTM A790

- a. Only high frequency welding (HFW) and laser beam welding (LBW) are acceptable automatic welding processes. Welded pipes shall be produced with only a single longitudinal weld seam.
- b. Welded pipe shall be limited to 6.4mm thickness. Pipes with a wall thickness > 6.4 mm (0.25 in) shall be furnished seamless. Additionally, for pipes of sizes $<$ NPS 8 with a wall thickness exceeding Schedule 10S as per ASME B36.19 shall be furnished as seamless as well.
- c. Mechanical tests shall be performed on material after final heat treatment.
- d. Tensile tests shall be performed in accordance with ASTM A370. Room temperature testing shall be carried out in the transverse direction on flattened plate type specimens or in longitudinal direction on plate type specimens without flattening. The test frequency shall be one duplicate test on one pipe

representing each lot. For welded pipe, additional cross weld tensile tests shall be carried out on full wall thickness specimens.

- e. Flattening test shall be executed in accordance with the requirements and acceptance criteria of ASTM A999.
- f. Hardness test: A full circumferential section shall be taken as a sample from one pipe representing each lot. Series of Rockwell C hardness measurements shall be performed in accordance with ASTM E18. Acceptance criteria are 28 HRC max for 22Cr duplex (ferritic /austenitic) stainless steels, and as per ASTM A790 Table 3 for 25Cr Super duplex (ferritic / austenitic) stainless steels.
- g. Each pipe shall be subjected to both the non-destructive electric test and to the hydrostatic test.
- h. Additionally, for all straight-seam welded pipes with a size \geq NPS 8 the entire length of the weld shall be 100 % radiographically inspected in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 (latest revision), Paragraph UW-51.
- i. Additional NDE :
 - i. Seamless pipe shall undergo Ultrasonic test for Longitudinal & Transverse imperfection for 100% of the lot in accordance to ISO 10893-10 and wall thickness for 20% of the lot in accordance to ISO 10893-12. In addition Liquid penetrant test of bevel faces in accordance to ISO 10893-4
 - ii. Welded pipes: All welds shall be inspected. For seam welds with a wall thickness > 10 mm (0.39 in), (automatic) ultrasonic examination shall be performed same as that for seamless pipe i.e. (i) above. To cover for the full through-thickness direction of the weld, the number of probes shall be in accordingly selected.
 - iii. Welded pipes: For seam welds with a wall thickness ≤ 10 mm (0.39 in), ultrasonic testing as per (i) above may be substituted by film radiography. Testing and acceptance criteria shall be in accordance with ISO 10893-6 while the image quality class shall be B, using a wire type image quality indicator.
- j. Weld repair is not permitted.

17.10 PIPE, NICKEL ALLOY , ASTM B 423

- a. Heat treatment procedures shall be subject to statistical process control to ensure that the final material properties comply with the material standard and this specification. The process control data and related periodic quality control checks shall be documented.
- b. The pipe shall undergo a hydrotest at a pressure equivalent to 1.5 times the allowable fibre stress given in ASTM B 423 clause 9.1.

17.11 PIPE, TITANIUM , ASTM B 861

- a. Pipe ordered to Grade 2 shall be bright annealed

17.12 PIPE, DUPLEX AND SUPERDUPLEX STAINLESS STEEL, ASTM A 928

- a. Welded pipes shall be produced with only a single longitudinal weld seam. Weld repairs of the weld seam shall not exceed 5 % of the seam length
- b. The filler material shall have a chemical composition that confirms to ASTM A 928 Section 7.1 and a PREN value that conforms to ASTM A 928Section 7.1 and is equal to or higher than the PREN of the plate.
- c. An analysis of one length of flat-rolled stock from each heat, or from base metal and weld deposit from two pipes from each lot, shall be made by the manufacturer in line with ASTM A 928 Section 9.1

- d. Repair of Plate defects by welding: For defects that violate the minimum wall thickness repair welding is not allowed.
- e. Mechanical tests shall be performed on material after final heat treatment
- f. Tensile tests shall be performed in accordance with ASTM A370. Room temperature testing at the base material shall be carried out in the transverse direction on flattened plate type specimens or in longitudinal direction on plate type specimens without flattening.
 - Cross-weld tensile tests shall be carried out on the seam weld on full wall thickness specimens.
 - Test frequency shall be one test on one pipe representing each lot
- g. Each length of pipe shall be subjected to a hydrostatic test. Nondestructive electric test is not acceptable.
 - The hydro test shall be carried out with higher system pressure than the ASTM A999 specification test pressure
- h. Hardness test: A full circumferential section shall be taken as a sample from one pipe representing each lot. Series of Rockwell C hardness measurements shall be performed in accordance with ASTM E18. Acceptance criteria are 28 HRC max for 22Cr duplex (ferritic/austenitic) stainless steels, and as per ASTM A790 Table 3 for 25Cr Superduplex (ferritic/austenitic) stainless steels.
- i. Additional NDE for welded pipe :
 - i. All welds shall be inspected. For manual welds with a wall thickness > 25 mm (0.98 in) and automatic welds with a wall thickness > 15 mm (0.59 in), (automatic) ultrasonic examination shall be performed for Longitudinal & Transverse imperfection in weld seam for 100% of the lot in accordance to ISO 10893-11.
 - ii. Testing of the weld seam at pie ends not covered by automatic testing, manual ultrasonic testing based on the same principle as above (i) in accordance to ISO 10893-11 or ISO 108893-6 for 100% of the lot.
 - iii. Liquid penetrant test of bevel faces in accordance to ISO 10893-4
 - iv. To cover for the full through-thickness direction of the weld, the number of probes shall be accordingly selected
 - v. For manual welds with a wall thickness ≤ 25 mm (0.98 in) and automatic welds with a wall thickness ≥ 15 mm (0.59 in), ultrasonic testing per (i) above may be substituted by film radiography. Testing and acceptance criteria shall be in accordance with ISO 10893-6, while the image quality class shall be B, using a wire type image quality indicator.

17.13 PIPE, NICKLE ALLOY, ASTM B 705

- a. Welded pipe is limited by the nominal thickness of maximum 6.4 mm (due to reported manufacturing/NDE difficulty without filler material in thickness above 6.4 mm). If specifically agreed by COMPANY, higher thickness (>6.4 mm) may be accepted by employing filler metal for the longitudinal welding. In such case pipe shall be subject to Eddy current test in addition to 100% radiography
- b. Pipe shall be furnished to Class 2.
- c. Pipe ordered to Grade UNS N06625 pipe shall only be furnished to Grade 1
- d. Repair welding and retreatment are not allowed
- e. All testing shall be performed on specimens taken from the pipe after final heat treatment.
- f. Tensile tests shall be performed in duplicate and shall be carried out on the base material in longitudinal direction (preferably on full wall thickness specimens) and in transverse direction (flattened plate type specimens is only allowed if non flattened plate type specimen is physically impossible). Transverse

tensile testing is not required for pipes smaller than NPS 2 and pipes thinner than 5 mm (0.2 in). In addition, cross-weld tensile tests shall be carried out. All individual tests shall meet the requirements.

- g. Hydrostatic testing shall be carried out in accordance with ASTM B775.
- h. Electric test shall be carried out after hydrotesting and shall be executed in accordance with ASTM B775, Section 5.4, unless specified otherwise
 - For wall thickness ≤ 6.4 mm (0.25 in), in addition to ASTM B775, Section 5.4.1, a reflector of the N-type shall be present having a depth of 5 % of the nominal wall thickness (N5 notch) for both the longitudinal and transverse notches. The width of the notch shall not exceed 0.2 mm (0.008 in). This applies to inside and outside surface. The acceptance shall be based on the N5 notch and Section 5.4.4 of ASTM B775
 - Irrespective of wall thickness, the use of ultrasonic testing (UT) in accordance with ASTM B775, Section 5.4.2 is allowed as an alternative. UT shall examine in the longitudinal and circumferential direction. The width of the longitudinal and transverse notches shall not exceed 1.0 mm (0.039 in). Notches shall be present inside and outside and shall be located at the weld centre line. If UT is used, the requirements specified in ASME V, Article 4, Clause T-451 (coarse grained materials) shall apply

17.14 PIPE, NICKLE ALLOY, ASTM B 444

- a. UNS N06625 products shall be furnished in Grade 1 (annealed)
- b. Heat treatment procedures shall be subject to statistical process control to ensure that the final material properties comply with the material standard and this specification. The process control data and related periodic quality control checks shall be documented.
- c. Repair welding and retreatment are not allowed.
- d. Tensile tests shall be carried out in longitudinal direction (preferably on full wall thickness specimens) or in transverse direction (flattened plate type specimens is only allowed if non flattened plate type specimen is physically impossible). All individual tests shall meet the requirements
- e. Each pipe shall be subjected to the hydrostatic test and to the non-destructive electric test
- f. All testing shall be performed on specimens taken from the pipe after final heat treatment.
- g. Non-destructive electric tests shall be carried out after hydrotesting and shall be executed in accordance with ASTM B829, Section 5, unless specified otherwise.
 - For wall thickness > 12.7 mm (0.50 in), eddy current testing shall be carried out.
 - Irrespective of wall thickness, in addition to ASTM B829, a reflector of the N-type shall be present having a depth of 5 % of the nominal wall thickness (N5 notch) for both the longitudinal and transverse notches. The width of the notch shall not exceed 0.2 mm (0.008 in). This applies to inside and outside surface. Acceptance shall be based on the N5 notch as specified in ASTM B829.
 - Irrespective of wall thickness, the use of ultrasonic testing (UT) in accordance with ASTM B829, Section 5.3.2 is allowed as an alternative. UT shall examine in the longitudinal and circumferential direction. The width of the longitudinal and transverse notches shall not exceed 1.0 mm (0.039 in). Acceptance shall be based on the N5 notch as specified in ASTM B829
- h. Marking shall be in accordance with ASTM B829 and shall also include the pipe schedule number or specified wall thickness (mm). Marking shall also include the charge number and, where applicable, the heat number

17.15 PIPE, TITANIUM, ASTM B 862

- a. Pipe ordered to Grade 2 shall be bright annealed

- b. Welded pipes shall be produced with only a single longitudinal weld seam
- c. The entire length of pipe furnished by the welding process as specified in ASTM B862 clause 5 shall be 100 % examined by radiography in accordance with supplementary requirement S1.2.1.
- d. Assessment of pipe weld quality shall be performed by the flattening test only.

17.16 PIPE COPPER-NICKLE , EEUMA 234

- a. The wrought finished product shall be traceable to the respective casting.
- b. If the results of the test on one of the specimens fail to meet the specified requirements, two additional specimens shall be taken from different sample pieces and tested. The results of the test on both of these specimens shall meet the specified requirements. Failure of any or both specimens to meet the specified requirements for a particular property shall be the cause for rejection of the entire lot. This is applicable to all properties, including, but not limited to, chemical composition, tensile strength, yield strength, hardness and ductility.

17.17 FITTINGS, BUTT-WELD, ASTM A234M

- a. Ultrasonic examination in lieu of radiographic examination is not allowed for welded fittings.
- b. Fittings furnished to Grades WPB or WPBW, when forged or extruded from welded pipe, shall be supplied in the normalised or hot finished condition.
- c. Fittings furnished to Grades WPBW, furnished from plate, shall be supplied in the stress relieved or normalised condition. The plate material shall be supplied in the normalised condition.
- d. If sour service is specified, normalising shall consist of heating to a uniform temperature not less than 815 °C (1500 °F), followed by cooling in still air or in the cooling chamber of an atmosphere-controlled furnace. Fittings furnished to Grade WPB, supplied in the hot finished condition, shall be provided with a certificate that hot finishing was executed within a temperature range of 845 °C to 945 °C (1550 °F to 1735 °F), followed by cooling in an atmosphere-controlled furnace or cooling in still air.
- e. Alternative heat treatments as specified in NACE MR0103 or ISO 15156-2, are allowed, provided the pipe fully complies with all the requirements of NACE MR0103 and ISO 15156-2 and has a 22 HRC maximum hardness.
- f. If Amine service is specified for fittings furnished to Grade WPBW, PWHT shall be performed at 635 ± 15 °C (1,175 ± 25 °F) for a hold time of one hour for each 25 mm (1.0 in) of metal thickness, with a minimum hold time of one hour.
- g. Fittings furnished to Grades WP1, WP5, WP9, WP11 or WP22, and fittings forged or extruded from welded pipe to Grades WP1W, WP5W, WP9W, WP11W or WP22W shall conform to one of the following two options:
 - The fittings shall be supplied in the normalised and tempered condition. The tempering temperature shall be 740°C±8°C (1365°F±14°F). The tensile properties shall be in accordance with Class 1 of ASTM A387.
 - The fittings shall be supplied in the normalised and tempered condition. The minimum tempering temperature shall be 720°C (1330°F). After all processing, one sample from each heat shall undergo three simulated PWHT cycles at 730°C ±5°C (1345°F ± 10°F) with a holding time as per ASME B31.3 Table 331.1.1 for each cycle. Tensile tests according to ASTM A335 shall be performed after each cycle. If results from all tests are conform ASTM A335, all fittings from that heat are accepted.
- h. Fittings manufactured from plate to Grades WP5W, WP9W, WP11W or WP22W shall conform to one of the following two options:

- The plate to ASTM A387 shall be supplied in the normalised and tempered condition. The tempering temperature shall be 740°C±8°C (1365°F±14°F). The fittings shall be furnished in the post weld heat treated condition. The post weld heat treatment temperature shall be 715 °C ±10°C (1318 °F±18°F). The tensile properties shall be in accordance with Class 2 of ASTM A387.
 - The plate to ASTM A387 shall be supplied in the normalised and tempered condition. The minimum tempering temperature shall be 720°C (1330°F). The tensile properties shall be in accordance with Class 2 of ASTM A387. The fittings shall be furnished in the post weld heat treated condition. The post weld heat treatment temperature shall be 715 °C ±10°C (1318 °F±18°F). After all processing, one sample from each heat shall undergo three simulated PWHT cycles at 730°C ±5°C (1345°F ± 10°F) with a holding time as per ASME B31.3 Table 331.1.1 for each cycle. Mechanical tests according to ASTM A691 paragraph 8.1 shall be performed after each cycle. If all results meet ASTM A691 requirements, all pipes from that heat are accepted
- i. If sour service is specified for fittings furnished to Grade WPBW the following shall be required
 - The material shall conform to the requirements of ISO 15156 & AGES-SP-07-003
 - The micro-alloying elements Boron (B), Titanium (Ti), Niobium (Nb) and Vanadium (V) shall not be intentionally added to the steel, unless approved by the Principal
 - Microstructure shall be free of ferrite/perlite banding
 - The weld metal deposit shall not contain more than 1.00 % Nickel.
 - j. The following requirements for inspection shall apply, if sour service is specified and the fitting is furnished to Grade WPBW and manufactured from plate material:
 - The plate shall be checked for laminations by ultrasonic examination in accordance with EN 10160 with acceptance levels S1 and E4.
 - The plate material shall be HIC tested in accordance AGES-SP-07-003 and NACE TM0284 after a simulation of the final heat treatment of the pipe
 - k. Hardness testing shall be carried out on welded fittings at a frequency of one fitting out of every ten per heat. Testing shall be carried out after post-weld heat treatment The hardness of the weld, heat affected zone or base metal shall not exceed 248HV10.
 - l. Where steam service is designated in the specification, fittings furnished from Grade WP22 shall be Magnetic particle examined as per supplementary requirement S55 of ASTM A961. Acceptance criteria shall be in accordance with ASME VIII, Division 1, Appendix 6.
 - m. Where steam service is designated in the specification, fittings furnished from Grade WP22 shall be Charpy impact tested as follows. Charpy impact tests shall be carried out in accordance with ASTM A370 at a temperature of +20 °C (+68 °F) on longitudinal samples. 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.
 - n. For fittings furnished to Grade WP11 or WP11W, the following shall apply: The material shall meet the following additional chemical requirements by heat analysis:

Element	C	P	S	Cu	Ni	X-bar
Max allowed	0.15%	0.012 wt%	0.007 wt%	0.20%	0.30%	15 ppm

X-bar shall be calculated with the following formula:

$$X - bar = \frac{10P + 5Sb + 4Sn + As}{100}, \text{ with P, Sb, Sn and As values in ppm.}$$

- o. Except where steam service is designated, for fittings furnished to Grades WP22 or WP22W, the following shall apply:
 - The phosphorous content shall not exceed 0.010 %.
 - Base metal: $J\text{-factor} = (Si + Mn) \times (P + Sn) \times 10000 < 120$ in which the values of P, Sn, Mn and Si are in wt%.
 - Welds: $X\text{-bar}$ (as per above mentioned formula) ≤ 15 .
- p. For fittings furnished to Grade WP22 in steam service, the following shall apply:
 - $J\text{-factor} = (Si + Mn) \times (P + Sn) \times 10000 < 180$ in which the values of P, Sn, Mn and Si are in wt%.
- q. For grade WP22W, weld metal shall have a carbon content $> 0.05\%$.

17.18 FITTINGS, BUTT-WELD, ASTM A420M

- a. Fittings shall be furnished in the normalised or normalised and tempered condition.
- b. Where plate material is used for welded fittings, it shall be supplied in the normalised condition.
- c. If sour service is specified for fittings furnished to Grade WPL6W the following shall apply
 - The material shall conform to the requirements of ISO 15156 & AGES-SP-07-003
 - The micro-alloying elements Boron (B), Titanium (Ti), Niobium (Nb) and Vanadium (V) shall not be intentionally added to the steel, unless approved by the Principal
 - Microstructure shall be free of ferrite/perlite banding
 - The weld metal deposit shall not contain more than 1.00 % Nickel.
- d. The following requirements for inspection shall apply, if sour service is specified and the fitting is furnished to Grade WPL6W and manufactured from plate material:
 - The plate shall be checked for laminations by ultrasonic examination in accordance with EN 10160 with acceptance levels S1 and E4.
 - The plate material shall be HIC tested in accordance with AGES-SP-07-003 and NACE TM0284 after a simulation of the final heat treatment of the pipe.
- e. If Hydrofluoric acid service is specified, supplementary requirement S78.1, S78.2, S78.3, S78.4, S782.5 and S78.6 of ASTM A960 shall apply. For supplementary requirement S78.2 CE shall not exceed 0.43 irrespective of the specified wall thickness
- f. If Amine service is specified for fittings furnished to Grade WPL6W, PWHT shall be performed at $635 \pm 15^\circ\text{C}$ ($1,175 \pm 25^\circ\text{F}$) for a hold time of one hour for each 25 mm (1.0 in) of metal thickness, with a minimum hold time of one hour.
- g. Fittings furnished to Grades WPL6W, shall be furnished from same grade of plate or welded pipe as shown in the buying description.
- h. Low temperature carbon steel fittings shall be impact tested at a temperature of minus 46°C . Impact testing shall be performed as an average of three tests and shall be at least 27 J for standard size specimen of 10 mm x 10 mm (0.39 in x 0.39 in). Only one result may be lower than 27 J, but shall have a minimum of 21 J. For sub-size specimens, the impact values required by ASTM A420 Table 4 shall be multiplied by 1.5.
- i. Hardness testing shall be carried out on welded fittings at a frequency of one fitting out of every ten per heat. The method shall be Vickers or Rockwell, or another method which can make measurements within the heat affected zone. Testing shall be carried out after post-weld heat treatment. The hardness of the weld, heat affected zone or base metal shall not exceed 248 HV 10.

- j. Ultrasonically examination in lieu of radiographic examination is not allowed.
- k. For welded fittings, magnetic particle examination shall be carried out in accordance with ASTM A960, supplementary requirement S69. The wet method shall be used. The acceptance criteria for welds shall be in accordance with ASME B31.3, Table 341.3.2 for Severe Cyclic Conditions, Criteria A. For other surfaces and for butt-welding end preparations, there shall be no linear indications longer than 1.6 mm (0.063 in).

17.19 FITTINGS, BUTT-WELD, ASTM A403

- a. Where stabilising heat treatment is specified, the fittings, with exception of H-grades, shall be manufactured with a grain size of 3.5 or finer in order to lessen the chances of reheat cracking during PWHT or during service. For H-Grades grain size requirements as per clause 5.16 of the ASTM A403 applies.
- b. All welds shall be made with the addition of filler metal.
- c. For fittings to Grade 304 or 304L welds shall be made using welding procedures qualified by impact testing at -196°C (-321°F) in accordance with the requirements of ASME B31.3, Section 323.2.2. The material certificates of these welded fittings shall refer to these WPQs.
- d. For fittings to Grade 316 and 316L where low temperature service is specified in the purchase description, welds shall be made using welding procedures qualified by impact testing at -196°C (-321°F) in accordance with the requirements of ASME B31.3, Section 323.2.2. The material certificates of these welded fittings shall refer to the associated WPQs.
- e. If a stabilised heat treatment is specified, fittings shall be given a stabilising heat treatment in accordance with supplementary requirement S2 within a temperature range of 870°C to 900°C (1600°F to 1650°F) for 4 hours subsequent to the solution heat treatment. This time/temperature combination for the stabilising heat treatment superceed that specified in supplementary requirement S2.

Alternatively, the MANUFACTURER may submit a stabilisation heat treatment procedure for approval to the COMPANY, and supplementary requirement S63 (Intergranular corrosion test) shall apply. The test shall be in accordance with ASTM A262, Practice E.

- f. Induction heating is not allowed.
- g. Cold working shall be done before final heat treatment.
- h. Heat treatment procedures shall be subject to statistical process control to ensure that the final material properties comply with the material standard and this specification. The process control data and related periodic quality control checks shall be documented.
- i. All welds of austenitic stainless steel welded fittings shall have a ferrite number between 3FN and 8FN. Ferrite number testing shall be in accordance with ISO 8249, other test methods are subject of approval by the COMPANY
- j. Fittings furnished to ASTM A403, Grades 304, 304L, 304H, 316, 317L, 321, 321H, 347 and UNS S31254 of Class WP-WX, shall be furnished from same grade of plate or welded pipe as shown in the buying description.
- k. Fittings furnished to Grade 316 shall have a carbon content not exceeding 0.030 %.
- l. Fittings with a butt-welding end wall thickness > 20 mm (0.79 in) shall have the bevel and weld-end preparation examined by the liquid penetrant method over a width of 25mm (1 in). Liquid Penetrant method shall be in accordance with ASTM E165. Acceptance standards shall be in accordance with ASME VIII, Division 1, Appendix 8.

17.20 FITTINGS, DUPLEX AND SUPERDUPLEX STAINLESS STEEL, ASTM A815

- a. The radiography of welds of this class of fittings shall be done after forming. All welds shall be made with the addition of filler metal
- b. Fittings ordered as class WP-WU are not allowed.
- c. Final heat treatment shall be performed after forming, welding and before machining
- d. Manufacturer shall be qualified according to NORSOK M-650 or through the TAMAP audit process. NORSOK certification (if applicable) shall be submitted as part of documentation
- e. Tees shall be manufactured by forging or forming in one piece. If seam welded pipe is used as the parent material the longitudinal weld shall be located in the body opposite the tee branch.
- f. Induction heating is not allowed
- g. Product analysis shall be performed on the parent metal for each heat. Also product analysis shall be performed on the weld metal of a representative sample from one fitting, for each ten fittings from each lot. A 'lot' is defined as a group of fittings with the same dimensions, from the same production and heat treatment batch. The chemical composition and PREN requirements shall be met
- h. In fittings of welded construction, the chemical composition of the weld metal and the related PREN shall confirm this specification. The PREN shall match or be higher than that of the base metal.
- i. Mechanical tests shall be performed on material after final heat treatment.
- j. Tensile tests shall be performed in accordance with ASTM A370. Room temperature testing at the base material shall be carried out either in the transverse direction or in longitudinal direction. For welded fittings, additional cross-weld tensile tests shall be carried out, if practical on full wall thickness specimens
- k. For welded fittings, the hardness of the heat affected zone shall be within the hardness limits of the base material.
- l. Hardness test: A sample representing maximum wall thickness of the fitting shall be tested for each lot (lot defined in ASTM A815 Section 7.1). Hardness measurements shall be performed in accordance with ASTM E18 between 1 mm (0.04 in) from the inner surface and the outer surface. (Alternative Brinell hardness testing HBW as per ASTM E10, or Vickers HV10 as per EN 9015-1 is allowed provided conversion table 1 as per ASTM E140 is applied).

If welds are present, additional rows of Vickers HV10 hardness indentations test shall be made in accordance with ISO 9015-1 on one full transverse thickness sample from the weldments on one fitting from each lot. Rows of hardness indentations shall be made in accordance with Figure 1 of ISO 9015-1, and at mid wall thickness in case the wall thickness is ≥ 6.5 mm (0.26 in). Individual hardness values shall not exceed the equivalent HV10 value of the criterion. Acceptance criteria are 28 HRC max for 22Cr duplex (ferritic/austenitic) stainless steels and 32 HRC max for 25Cr Superduplex (ferritic/austenitic) stainless steels.

All hardness measurements shall be carried out after final heat treatment

17.21 FITTINGS, NICKLE ALLOY, ASTM B366

- a. For WPNCMC fittings (UNS designation N06625), only seamless pipes as per ASTM B444 or welded pipe as per ASTM B705 shall be used as base material
- b. All welds shall be made with the addition of filler metal. The weld metal shall be equivalent to the base material of the fitting
- c. All joints of welded fittings shall be radiographically examined in accordance with UW-51 of ASME VIII, Division 1. A weld joint factor of 1.00 shall be guaranteed

- d. Except for WPNCMC fittings (UNS designation N06625), all fittings shall be furnished in the solution heat-treated condition. WPNCMC fittings (UNS designation N06625) shall be furnished in the annealed condition (grade 1).
- e. Cold working shall be done before final heat treatment.
- f. Repair welding is not allowed.
- g. Supplementary requirement S2 shall apply. Tensile testing shall be carried out in accordance with ASTM E8.
- h. The finished fittings shall conform to the minimum mechanical properties as specified for the respective base material grades ASTM B444 UNS N06625 Grade 1 (seamless pipe) or ASTM B705 UNS N06625 Grade 1 (welded pipe).
- i. Liquid penetrant test: Supplementary requirement S3 shall apply to 10 % of the fittings above DN 50 (NPS 2). Acceptance criteria shall be in accordance with ASME VIII, Division 1, Appendix 8.
- j. Fittings furnished to Grades WPNCMC (Alloy 625), WPNICMC (Alloy 825), and WP20CB (Alloy 20) shall be pickled and free from any scale or oxides. Pickling shall be in accordance with ASTM A380. In case bright annealing is applied, pickling is not obligatory.

17.22 FITTING, TITANIUM, ASTM B 363

- a. Fittings shall not be made from bar.
- b. Supplementary requirement S2 shall apply

17.23 FORGING, CARBON STEEL, ASTM A105

- a. If galvanising is specified, galvanising shall be in accordance with to with COMPANY specification for Galvanizing ,AGES-SP-07-009.
- b. Supplementary requirement S2.1 shall apply.
- c. Forgings shall be normalised.

17.24 FORGING LOW TEMP. CARBON STEEL, ASTM A350

- a. Forgings shall be normalised.
- b. If Hydrofluoric acid service is specified, supplementary requirement S62 of ASTM A961 shall apply.
- c. Magnetic Particle examination: For forgings furnished to Grade LF3, supplementary requirement S55 of ASTM A961 shall apply. Acceptance shall be in accordance with ASME VIII, Division 1, Appendix 6.
- d. If Hydrofluoric acid service is specified and the carbon content is lower than 0.18 wt%, then the sum of Copper, Nickel and Chromium shall not be higher than 0.15 wt%.

17.25 FORGING, STAINLESS STEEL, ASTM A182

- a. For grades F44, F51, F53, F55, F60, F61 and F62, the manufacturer shall be qualified according to NORSOK M-650 or through the TAMAP audit process. NORSOK certification (if applicable) shall be submitted as part of documentation.
- b. Heat treatment procedures shall be subject to statistical process control to ensure that the final material properties comply with the material standard and this specification. The process control data and related periodic quality control checks shall be documented.
- c. Forgings with the exception of blind flanges and lapped joint flanges, in Grades F5, F9, F11 and F22 shall conform to either of the following two options:

- The forging shall be supplied in the normalised and tempered condition. The tempering temperature shall be 740°C±8°C (1365°F±13°F). The tensile properties shall be in accordance with ASTM A182 (Class 1 where applicable).
 - The forging shall be supplied in the normalised and tempered condition. The minimum tempering temperature shall be 720°C (1330°F). After all processing, one sample from each heat shall undergo three simulated PWHT cycles at 730°C ±8°C (1345°F ± 14°F) with a holding time as per ASME B31.3 Table 331.1.1 for each cycle. Tensile tests according to ASTM A182 shall be performed after each cycle. If results from all tests are conform ASTM A182, all forgings from that heat are accepted.
- d. For forgings furnished to Grades F5, F9, F11 or F22, supplementary requirement S2 shall apply.
- e. For forgings furnished to Grades F44, F62, F304, F304H, F304L, F316, F321, F321H or F347, F347H shall be solution heat-treated.
- If a stabilised heat treatment is specified, forgings shall be given a stabilising heat treatment in accordance with supplementary requirement S10 within a temperature range of 870 °C to 900 °C (1600 °F to 1650 °F) for 4 hours subsequent to the solution heat treatment. This temperature range and time shall supersede that specified in supplementary requirement S10.
 - Alternatively, the MANUFACTURER may submit a stabilisation heat treatment procedure for approval to the COMPANY, and supplementary requirement S4 (corrosion test) shall apply
- f. Final heat treatment shall be performed after forging and before machining.
- g. For forgings furnished to Grade F316, the carbon content shall not exceed 0.03 %.
- h. For forgings furnished to Grade F11, the following shall apply: The chemical composition shall meet the following additional chemical requirements by heat analysis:

Element	C	P	S	Cu	Ni	X-bar
Max allowed	0.15 %	0.012 wt%	0.007 wt%	0.20 %	0.30%	15

X-bar shall be calculated with the following formula:

$$X - bar = \frac{10P + 5Sb + 4Sn + As}{100}$$

in which the values of P, Sb, Sn and As are in ppm.

- i. Except where steam service is designated, forgings furnished to Grade F22, the following restrictions shall apply:
- The carbon content shall not exceed 0.15%.
 - The phosphorous content shall not exceed 0.010 %.
 - The sulphur content shall not exceed 0.010 %.
 - J-factor = (Si+Mn) x (P+Sn) x 10000 < 120. in which the values of P, Sn, Mn and Si are in wt%.
- j. For forgings furnished to Grade P22 in steam service, the following shall apply:
- J-factor = (Si+Mn) x (P+Sn) x 10000 < 180. in which the values of P, Sn, Mn and Si are in wt%.
- k. Final heat treatment shall be performed after forging and before machining.
- l. Mechanical test :
- Mechanical tests shall be performed on material after final heat treatment
 - For all grades except ferritic/austenitic stainless steels the test specimens shall be taken from mid-wall thickness at a section representing the thickest part of the forging.

- If the forgings are made using closed die which does not allow the inclusion of prolongations, testing may be carried out on part-finished sacrificial forgings.
- The prolongations shall not be removed from the forgings until the heat treatment has been completed.

m. Hardness testing:

- For all ferritic-austenitic stainless steels maximum hardness requirements: Acceptance criteria are 28 HRC for 22Cr duplex (ferritic/austenitic) stainless steels and 32 HRC for 25Cr Superduplex (ferritic/austenitic) stainless steels. For austenitic –ferritic stainless steels -Supplementary Requirement S2 shall apply
 - For ferritic-austenitic stainless-steel forgings, a sample representing maximum wall thickness of the fitting shall be tested for each lot (as defined in ASTM A312 Section 8.5). Triplicate hardness measurements shall be performed in accordance with ASTM E18 between 1 mm (0.04 in) from the inner surface and the outer surface. (Alternative Brinell hardness testing HBW as per ASTM E10 is allowed provided conversion table 1 as per ASTM E140 is used). The hardness requirements of the applicable materials standard shall be met. All hardness measurements shall be carried out after final heat treatment.
- n. Where steam service is designated in the purchase description, forgings produced from Grade F22 shall be Charpy impact tested in accordance with ASTM A370 at a temperature of +20 °C (+68 °F) on longitudinal samples.
- o. Repair welding is not allowed for forgings furnished to austenitic grades. Repair welding is not allowed for forgings furnished to austenitic/ferritic grades unless specifically approved by the COMPANY.
- p. Repair welding is not allowed for forgings furnished to austenitic grades and ferritic-austenitic grades.
- q. For forgings furnished to Grades F5, F9, F11 or F22, supplementary requirement S55 (magnetic particle) of ASTM A961 shall apply. Acceptance criteria shall be in accordance with ASME VIII, Division 1, Appendix 6.
- r. For austenitic stainless steel forgings in ASME rating Class 600 or higher, supplementary requirement S56 (liquid penetrant) of ASTM A961 shall apply. Acceptance criteria shall be in accordance with ASME VIII, Division 1, Appendix 8.
- s. For forgings furnished to Grade F44, F62 or F50-F55, F57-F61 and F65-F67, supplementary requirement S56 (liquid penetrant) of ASTM A961 shall apply. Acceptance criteria shall be in accordance with ASME VIII, Division 1, Appendix 8.

17.26 FORGING, NICKLE ALLOY, ASTM B564

- Forgings furnished to Grades UNS N04400, UNS N06600, UNS N06625 or UNS N08825 shall be annealed.
- Forgings furnished to Grades UNS N06625 or UNS N08825 shall be pickled in accordance with ASTM A380 and free from any scale or oxides. For machined surfaces pickling is not required. If bright annealing is applied, pickling is not obligatory.
- Repair welding is not allowed for forgings furnished to Grades UNS N06625 or UNS N08825.
- Tensile tests for forgings to Grades UNS N06625 or UNS N08825 shall be performed in duplicate. The individual tests shall meet the requirements.
- Supplementary requirement S5.2 & S5.3 shall apply to forgings furnished to Grades UNS N06625 or UNS N08825.

17.27 PLATE, CARBON STEEL, ASTM A516

- a. The carbon content shall not exceed 0.23%
- b. Impact testing: Supplementary requirement S5 is required for plate specified as for low temperature service. Test results shall be at least 27 J for standard 10 mm x 10 mm (0.39 in x 0.39 in) specimen, as an average of three tests. One result may be lower than 27 J, but shall have a minimum of 21 J.

17.28 PLATE, ALLOY STEEL, ASTM A387

- a. The base material shall be normalised and tempered.
- b. After plasma-cutting and welding, the product shall be annealed (stress relieved).

17.29 PLATE, STAINLESS STEEL, ASTM A240

- a. For duplex and super duplex grades, mechanical testing shall be carried out as defined in ASTM A240 Section 5.4.1 to 5.4.3 at one plate per lot. One lot is defined as a set of plates with the same wall thickness, produced from one heat of material in the same production and heat treatment batch. All testing shall be carried out on the final product after heat treatment
- b. Tensile testing: On duplex and super duplex grades tensile tests shall be performed in accordance with ASTM A370. Room temperature testing shall be carried out in the rolling direction and perpendicular to the rolling direction on full thickness plate type specimens. Test frequency shall be one duplicate test for both test directions on one plate representing each lot
- c. Hardness testing ; In duplex and super duplex grades, series of Rockwell C hardness measurements shall be performed in accordance with ASTM E18 or Vickers HV10 as per EN 9015-1 is allowed provided conversion table 1 as per ASTM E140 is applied) at two locations. At each location, hardness readings shall be taken at 1 mm (0.04 in) from both surfaces surface and at mid-section. The requirements of the applicable material standards shall be met. Acceptance criteria is 28 HRC max for 22Cr duplex (ferritic/austenitic) stainless steels.
- d. Plates shall be in solution annealed condition.
- e. For grade TP347H the minimum annealing heat-treatment temperature shall be 1093 °C (2000°F).
- f. The finished items furnished to Grades UNS S31254 or UNS N08367 shall be annealed and water-cooled.
- g. Heat treatment procedures shall be subject to statistical process control to ensure that the final material properties comply with the material standard and this specification. The process control data and related periodic quality control checks shall be documented.
- h. Weld repair of the plate is not allowed.

17.30 PLATE, NICKEL ALLOY, ASTM B443

- a. The finished product shall be free from any scale or oxides.
- b. Repair welding of the plate material is not allowed.

17.31 PLATE, NICKEL ALLOY, ASTM B424

- a. The finished product shall be free from any scale or oxides.
- b. Repair welding of the plate material is not allowed.