



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 142

Valves

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1. Scope

This specification completes the definition of the material described in the requisitions issued by the Engineering Company and specifies the particular conditions for the fabrication, inspection and shipment of conventional types of valves: gate valves, butterfly valves, globe valves, plug valves, ball valves, check valves, needle valves, etc., as well as integral manifold valves comprising a combination of several valves in one integral bolted manifold in order to obtain systems such as single or double block and bleed.

This specification shall apply only to conventional valves made of ductile cast iron, carbon steel, alloy steel, corrosion resistant alloys, bronze and other copper alloys, including actuated or motorised versions of such valves, i.e. ESDVs, MOVs, BDVs, HIPS etc.

This specification shall apply to process piping and pipeline valves whatever the line design code.

As a supplement to the present specification, valves in cryogenic service (i.e. for use at operating temperatures lower than -46°C) must also comply with the Company specification [GS EP PVV 150](#), and valves for use under sour wet service conditions (i.e. according to the NACE definition of such conditions) shall meet the additional requirements of the Company specification [GS EP PVV 613](#).

Subsea valves are subject to additional requirement by specification [GS EP SPS 004](#) and [GS EP SPS 005](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Any conflicting requirements between this specification and any other relevant document shall be reported to the Company for decision. In any case, and notwithstanding the final decision of the Company, the most stringent requirement is always first meant to govern.

Standards

Reference	Title
ASME B1.1	Unified Inch Screw Threads
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B16.24	Cast Copper Alloy Pipe Flanges and Flanged Fittings
ASME B16.25	Buttwelding Ends
ASME B16.34	Valves-Flanged, Threaded, and Welding End
ASME B16.47	Large Diameter Steel Flanges (NPS 26 through NPS 60)
ASME B18.2.1	Square and Hex Bolts and Screws



Reference	Title
ASME B18.2.2	Square and Hex Nuts
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B36.19M	Stainless Steel Pipe
ASTM A 105	Forgings, Carbon Steel, for Piping Components
ASTM A 182	Forged or Rolled Alloy - Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service
ASTM A 193	Alloy-Steel and Stainless Steel Bolting Materials for High-temperature Service
ASTM A 194	Carbon and Alloy-Steel Nuts for Bolts for High-pressure and High-temperature Service
ASTM A 216	Carbon Steel Castings Suitable for Fusion Welding for High-Temperature Service
ASTM A 217	Martensitic Stainless Steel and Alloy Steel Castings for Pressure Containing Parts Suitable for High Temperature Service
ASTM A 320	Alloy-Steel Bolting Materials for Low-temperature Service
ASTM A 350	Forgings, Carbon and Low-Alloy Steel, requiring Notch Toughness Testing for Piping Components
ASTM A 351	Austenitic Steel Castings for High Temperature Service
ASTM A 352	Ferritic Steel Castings for Pressure Containing Parts Suitable for Low Temperature Service
ASTM A 370	Mechanical Testing of Steel Products
ASTM A 395	Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures
ASTM A 453	Bolting Materials, High-Temperature, 50 to 120 ksi Yield Strength, with Expansion Coefficients Comparable to Austenitic Steels
ASTM A 488	Qualifications of Procedures and Personnel for the Welding of Steel Castings
ASTM A 694	Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves, and Parts for High Pressure Transmission Service
ASTM A 703	Steel Castings, General Requirements, for Pressure Containing Parts
ASTM B 62	Composition Bronze or Ounce Metal Castings
ASTM B 148	Aluminium-Bronze Sand Castings
ASTM B 150	Aluminium Bronze Rod, Bar, and Shapes
ASTM B 287	Method of Acetic Acid - Salt Spray (Fog)
ASTM B 584	Copper Alloy Sand Castings for General Application

Reference	Title
ASTM B 633	Specification for Electrodeposited Coatings of Zinc on Iron and Steel 156
ASTM B 656	Standard Guide for Autocatalytic (Electroless) Nickel-Phosphorous Deposition on Metals for Engineering Use
ASTM B 733	Standard Specification for Autocatalytic (Electroless) Nickel-Phosphorous Coatings on Metals
ASTM D 297	Standard Test Methods for Rubber Products - Chemical Analysis
ASTM D 412	Standard Test Methods for Vulcanised Rubber and Thermoplastic Elastomers – Tension
ASTM D 1414	Standard Test Methods for Rubber O-Rings
ASTM D 1415	Standard Test Methods for Rubber Property - International Hardness
ASTM D 1418	Standard Practice for Rubber and Rubber Latices – Nomenclature
ASTM D 2240	Standard Test Methods for Rubber Property - Durometer Hardness
ASTM E 446	Steel Castings up to 2 in. (51 mm) in Thickness
ASTM E 709	Standard Guide for Magnetic Particle Examination
EN 10204	Metallic products - Type of inspection documents
ISO 286-2	ISO system of limits and fits - Part 2: Tables of standard tolerance grades and limit deviation for holes and shafts
ISO 4042	Fasteners - Electroplated Coating
ISO 5208	Industrial valves - Pressure testing of metallic valves
ISO 10497	Testing of valves - Fire type-testing requirements
ISO 15614-7	Welding procedure test - Part 7: Overlay welding
ISO H7-G6	Sliding Holes and Shaft tolerances to ISO 286-2
MSS SP 6	Standard Finishes for Contact Faces of Pipe Flanges and connecting ends 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 42	Class 150 Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends
MSS SP 44	Steel Pipeline Flanges
MSS SP 45	By-pass and Drain Connections
MSS SP 53	Quality Standards for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Magnetic particle Examination Method



Reference	Title
MSS SP 54	Quality Standards for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Radiographic Examination Method
MSS SP 55	Quality Standards for Steel Castings for Valves, Flanges, and Fittings and Other Piping Components - Visual Inspection
MSS SP 61	Pressure Testing of Steel Valves
MSS SP 72	Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP 80	Bronze Gate, Globe, Angle and Check Valves

Professional Documents

Reference	Title
API 5L	Specification for Line Pipe
API Spec 6A / ISO 10423	Specification for Wellhead and Christmas Tree Equipment
API Spec 6D / ISO 14313	Specification for Pipeline Valves (Gate, Plug, Ball, and Check Valves)
API Spec 6FA	Specification for Fire Test for Valves
API 594	Wafer and Wafer-Lug Check Valves
API 598	Valve Inspection and Testing
API 600	Steel Gate Valves Flanged and Butt welding Ends
API 602	Compact Steel Gate Valves - Flanged, Threaded, Welding and Extended-Body Ends
API 604	Ductile Iron Gates Valves Flanged Ends
API 607	Fire Test for Soft-Seated Quarter-Turn Valves
API 609	Lug- and Wafer-Type Butterfly Valves

Regulations

Reference	Title
European Directive 97/23/EC	Pressure Equipment Directive
European Directive 94/9/EC	Equipment for use in potentially explosive atmospheres

**Codes**

Reference	Title
ASME B31.3	Process Piping
ASME B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids
ASME B31.8	Gas Transmission and Distribution Piping Systems
ASME V	Non-destructive Examination
ASME VIII division 1-2	Rules for Construction of Pressure Vessels
ASME IX	Welding and brazing qualifications

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 170	Materials for Sour Service (Upstream applications) Specification for design
GS EP COR 350	External protection of offshore and costal structures and equipment by painting
GS EP COR 354	External protection of onshore structures and equipment by painting
GS EP COR 356	Corrosion Protection of Fasteners for Subsea and Topsides applications
GS EP INS 137	On/off valve control panels and actuators functional and construction requirement
GS EP PVV 150	Valves in cryogenic service
GS EP PVV 611	Welding of pressure containing piping and equipment
GS EP PVV 613	Valves materials requirements for use in sour service
GS EP PVV 614	Welding of duplex and superduplex stainless steel
GS EP SPS 004	Subsea Manifold System Gate Valves
GS EP SPS 005	Subsea ball valves

3. Terms and definitions

Technical terms and definitions are listed in [API Spec 6D / ISO 14313](#).

Additionally:

ASME B16.34: reference to the standard [ASME B16.34](#) means reference to the last edition of the standard except for the paragraph 6.1.2.c that shall remain as stated in the edition 2004 of the standard.

AED elastomeric o-ring: elastomeric o-ring that resists to explosion decompression phenomenon and passes the test describes in Appendix 8 of the specification.

Coupling: driven component (drive adapter, drive tube, drive shaft) that allows transmission of torque and/or thrust from an actuator driving component to the valve shaft/stem.

CRA: Corrosion Resistant Alloy.

HVOF coating process: High Velocity Oxygen Fuel coating process.

Inspection Agency: the body in charge of the inspection of the products on behalf of the purchaser at the manufacturer premises and at any subcontractor's premises as far as necessary.

Intermediate support: mechanical component (bracket, spool, adapter flange) that allows the attachment between a valve and actuator.

H2S service: intermediate or severe sour service according to [GS EP COR 170](#).

Mounting kit: components which may comprise combinations of the following: intermediate support, coupling, drive key(s).

4. Requisition and valve data sheets

Mechanical valves data sheets shall be issued by the contractor or Company for each type of valve, or each itemised valve, specifying the main features as derived from the relevant piping material classes and the present specification.

For pipeline valves, the data sheets shall also specify the all through internal bore dimension to match the adjacent pipe requirements.

Valve data sheets shall be elaborated from the format shown in Appendix 9. All information shall be filled-in as to get description of the product for purchase.

For the purpose of the valve service class selection, the temperature range to be taken into account shall be the planned operating temperature range (both higher and lower temperatures) at which the valve is expected to be operated.

The valve data sheet shall be complemented by the itemised instrument valve data sheet for each actuated valve.

5. Definition of service classes for valves

Valves shall be classified as per table below depending on their service conditions.

Table 1 - Definition of service classes for valves

Valve Service Class	A	B	C	D	E
Fluids	Water - Air - Nitrogen Hydraulic oils	Hydrocarbons (liquid and gas)	Hydrocarbons (gas)	Hydrocarbons (liquid and gas)	Hydrocarbons (liquid and gas)
Service	Utility or water injection	General Process Production Process Transport	General Process (Cryogenic)	General Process	(Note 1)
Operating Temperature Range	$T \leq 75^{\circ}\text{C}$ $T \geq \text{Ambient}$	$T \leq 200^{\circ}\text{C}$ $T \geq -46^{\circ}\text{C}$	$T < -46^{\circ}\text{C}$	$T > 200^{\circ}\text{C}$	$T \leq 200^{\circ}\text{C}$ $T \geq -46^{\circ}\text{C}$

Note 1: Extent of service class E for actuated valves on hydrocarbon services.

All ESDV and BDV valves, these two types in size NPS 8 and above, all HIPS valves, shall be service class E valves unless otherwise specified. MOV valves on pipelines or on risers shall be service class E valves, as well as all in-line valves adjacent to pig launchers or pig receivers.

Other valves may also be specified "service class E" on P&ID's, such as valves on production and test manifolds, depending on their criticality.

"Dormant" valves on buried pipelines which are only used to potentially isolate a section of possibly damaged pipe are service class B valves unless otherwise specified by the valve data sheets.

6. Subcontracting

All Valves are deemed to be fabricated and tested at the Manufacturer's premises. Any deviation to this requires a prior approval from the Company, which must be obtained prior to the Purchase Order issue. In such an event, the Manufacturer shall maintain full QA/QC control over any Sub-Contractor or sub-contracted activity.

First level suppliers for pressure containing parts and pressure controlling parts shall be approved by the Company. The requirement also applies to sub-manufacturers for special process, e.g. weld-overlay ENP, tungsten carbide coating, etc.

Whatever the extent of the sub-contracted activities, the Manufacturer is reputed to have the full control of the individual valve part design, manufacturing flow process, (heat treatment) delivery conditions manufacturing tolerances, together with the quality control activities related to those parts all along the delivery process.

This also applies to the supply of the actuators and associated local panel when the valve Manufacturer is in charge of that supply.

7. Materials

Materials used in the valves manufacture shall be in accordance with the relevant Valve Data Sheets issued by the Engineering Company. Any material substitution is subject to the approval by the Company.



The following requirements shall apply:

7.1 General requirements and limitation for casting material

Cast material cannot be proposed as substitute to forged material unless specifically agreed by the Company.

Cast manufacturing process shall be assessed and approved by the Company for its all extent from steel making to cast product release. It includes assessment of patterns, sand quality and sand treatment, pouring modelling and techniques, heat treatment sequence and means, etc.

Unless otherwise specified steel casting for pressure containing parts shall comply with general requirements of [ASTM A 703](#) with all its supplementary requirements as far as these are applicable. Use of scraps is not allowed for cryogenic stainless steel, duplex stainless steel and any Nickel alloy if the steel or alloy process system does not include some adequate argon-oxygen-decarburization (AOD) refining treatment unit.

Major weld repairs are not allowed for low temperature carbon steel and for any steel or nickel alloy.

Pressure containing casting and pressure controlling part shall be traceable to the foundry by unique identification marking independently of the pattern owner marking. This identification mark shall be embossed with the foundry logo for sand cast supply, stamped or laser printed marking for other casting types. Painted identification marks are not accepted instead.

The part identification mark shall also identify the material grade, heat, ladle charge and the sequential number in the ladle as per [ASTM A 703](#). Any time of the manufacturing sequence, products of the same heat furnace charge are deemed to be of a single heat. A single product shall not be made from two or several heats poured together in the same mold.

Cast material is not allowed for valve stem whatever the pressure class and valve size.

Seat and obturators may be allowed by casting for valve manufacturers that run their own foundries for their own valve supply. This allowance is given to valve manufacturers that have supplied the Company for a minimum of five years without any supply disruption over the period and without any negative feed-back on such a manufacturing.

Cast material may be used for obturators and seats except for:

- Obturators of valves in pressure class 1500 and above whatever the valve size
- Seats in pressure class 600 and above whatever the valve size.

Weld repairs are not allowed on seats and obturators.

Approval by the Company of centrifugally cast process for seats and obturators is moreover depending on proven experience by the valve manufacturer with the same source of supply and same manufacturing process for the valve size, component geometry and thickness, and valve pressure class.

Approval by the Company of cast material for pressure containing parts in pressure class 600 and above may be subject to some specific additional testing not addressed by the present document. Such requirements will be detailed in the project specification that will address:

- Test block definition: it can be a test block as defined by [ASTM A 703](#) or a valve component pertaining to the requisition.

- Verification of the mechanical tests and impact tests performed on the test blocks related to the supply or on specific additional valve bodies identical to items of the actual supply. Minimum requirements for impact test values are shown in Table 2 below.
- Verification of the microstructure and chemical analysis on test block and valves components.
- The test blocks or valve bodies used for the chemical and mechanical tests shall have passed the same full heat treatment sequence in the same heat furnaces as and along with items of the actual supply.
- As a minimum each individual furnace charge shall include two test blocks or one sacrificial valve body, valve end closure, valve bonnet. One of the two test blocks will be kept for testing by the Company.

For quench and tempering steel or solution annealed grades the heat treatment facilities shall be such that the transfer time from the furnace to the quenching bath is less 50 seconds.

Table 2 - Minimum impact requirements on casting material in delivery conditions

Material	Minimum Design Temp.	Wall thickness. Valve component	Impact Test Temperature	Minimum Impact Test Value Unless otherwise specified
Carbon Steel	T ≥ -29°C	< ½ inch	n.a.	Impact testing not required
Low alloy steel		≥ ½ inch	-29°C	min. 20 J average for 3 specimen min. 16 J for individual specimen
Low Temperature Carbon Steel	T ≥ -46°C	All thickness	-46°C	as per ASTM A 352 or: min. 20 J average for 3 specimen min. 16 J for individual specimen, whichever is greater
Low alloy steel				
Duplex St. Steel	T ≥ -46°C	All thickness	-46°C	min. 40 J average for 3 specimen min. 28 J for individual specimen
For all materials: the minimum impact test values are related to tests performed on full-section impact test specimen (10x10mm). Values for sub-sized specimen (when required) shall be agreed on by Company. Impact testing shall be performed per ladle (furnace) charge .				
These impact test specimen shall be taken at one fourth of the thickness of the block or component or of the valve body. The corresponding wall thickness of the test block or valve component shall not be less than the thickness of the valve component in its critical area as defined by the ASME B16.34				

7.2 Carbon steel valves

The carbon steel used for the fabrication of the valves shall be produced in an electric furnace, or by the basic oxygen process.

Carbon steel valves with welded ends (either butt-weld or socket-weld ends), or for which welding is used as part of the fabrication method (e.g. end flanges welded to the body, or welded body, etc.) shall comply with the following chemistry requirements, based on ladle analysis of the carbon steel materials used for the construction of the valves (this does not apply to weld overlays):

- a) Carbon Content: The carbon content shall be less than 0.23%

b) Carbon Equivalent: The Carbon Equivalent, calculated using the formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \text{ shall be less than } 0.42\%.$$

If the content of alloying elements other than C or Mn is unknown, and with the prior approval of the Company, the formula to be used shall be:

$$CE = C + \frac{Mn}{6}$$

and, in this case, the carbon equivalent shall be less than 0.40%.

CE value on product may be enlarged to 0.44% maximum for forged components made of [ASTM A 694](#) F60 or F65 grades in quenched and tempered delivery conditions exclusively and whose thickness does exceed 2 in. (50 mm) in any section as used in valve manufacturing. Such an allowance shall be based on appropriate welding qualification tests performed on the material of the same source and in same thickness. The short formula is discarded in that case.

7.3 Austenitic stainless steel valves

The types 321 stainless steel shall have a carbon content greater than or equal to 0.02%. The valve bodies and bonnets shall undergo a heat treatment ("Annealing") in accordance with the corresponding ASTM standards.

When type 316 stainless flanged valves in material to [ASTM A 351](#) Gr. CF8C are specified, forged materials to [ASTM A 182](#) Gr. F316 or Gr. F321 can be acceptable substitutes ("L" grades are not acceptable in that case).

7.4 Ductile cast iron valves

Where cast iron valves are authorised in the relevant piping material classes, only ductile cast iron is allowed. In this case, the valve bodies and bonnets shall be made of spheroidal graphite ductile cast iron in accordance with [ASTM A 395](#). They shall undergo the various treatments, including the supplemental tests required by this standard.

7.5 Copper alloy valves

Except as otherwise indicated in the requisition or in the valve data sheets, the composition of the bodies and bonnets of bronze valves shall be in accordance with UNS reference no. C 83 600 of [ASTM B 62](#). The UNS reference for other copper alloys, in accordance with [ASTM B 584](#), shall be stipulated in the data sheets or in the requisition.

7.6 Seal materials for ball valves

This paragraph applies to ball valves of all sizes and ratings, including those being part of integrated manifold valves comprising a combination of several valves in one integrated bolted manifold.

The selection of seal materials for ball valves shall be based on actual maximum and minimum operating temperatures of the valves, pressure fluid composition and chemical product used on a temporary basis. The selection shall comply with the following rules, in the following order:

- a) Reference to a valve service class, according to Table 1. This service class shall be taken from the relevant valve data sheet and/or requisition.
- b) Selection of a seal category, according to Table 2.
- c) Selection of seal materials, according to Table 3.
- d) Selection of a seal arrangement design according to Appendix 2.

Table 3 - Seals category selection for ball valves

Valve Service class	Seat inserts (1)	Dynamic seals	Static seals	Fire safe graphite Back-up seals
A	Thermoplastic	Elastomer	Metallic or Elastomer	Not required
B (5)	Thermoplastic (4)	Elastomer AED	Metallic or Elastomer AED	Required (2)
C	Thermoplastic	Thermoplastic	Metallic or Thermoplastic	Required (2)
D	Metallic	Metallic or Bellow seats + Graphite	Metallic or Graphite	Not required
E (5)	Metallic (3) (+ Tungsten Carbide Coating)	Elastomer AED	Metallic or Elastomer AED	Required (2)

Notes to Table 3:

- (1) Elastomer materials are strictly forbidden as seat to ball sealing barrier whatever the valve pressure class and service class.
- (2) Graphite back-up seals are not required in case of metallic primary seals (static seals only) and are not required for valves in subsea application.

Metallic seals are either metallic ring joints or spiral wound gaskets exclusively. Spiral wound gaskets are only acceptable for pressure class 150, 300, and 600. Filler material used for spiral wound gaskets shall be made of high purity graphite ($\geq 99.8\%$). In this case, it is emphasised that design calculation notes shall take into account the gasket reaction forces.

- (3) Metal to metal contact means tungsten carbide coating on both seat and obturator in conformity with section 7.7 and Appendix 4.
- (4) Tungsten carbide coating is required instead when section 7.7.3 applies.
- (5) An additional NBR o-ring is required on all the stem, bonnet and body leakage paths to the atmosphere when the valve is installed in the splash zone of the platform or in loading / offloading systems, as to protect the graphite secondary sealing barrier from sea water ingress. This requirement relates also to the valves installed inside the buoys.

Table 4 - Seal materials selection

	Nature of seal material (or trade mark)	Designation	Maximum Operating temperature range (°C)
ELASTOMERIC		(designation as per ASTM D 1418)	
	NITRIL RUBBER (service class A only)	N B R	0 to + 80
	HYDROGENATED NITRIL	H N B R	-40 to +150
	VITON ® GLT	F K M	-40 to +180
	CHEMRAZ ® 526	F F K M	-20 to +220
	SILICON (70 shore A)	V M Q	-60 to +220
	FLUORINATED SILICON (70 shore A)	F V M Q	-60 to +220
THERMOPLASTIC	TEFLON ® (Virgin or filled)	P T F E	-80 to +200
	KELF ®	P C T F E	-150 to +100
	TEFLON ® FEP	F E P	- 80 to +140
	TEFLON ® PFA	P F A	-80 to +200
	NYLON ® 12	POLYAMIDE	-20 to +100
	DEVLON V API		-20 to +100
	PEEK ®	POLYETHER KETONE	- 80 to +160
	TURCITE ® 243	POLYETHER KETONE	-200 to +250
	VESPEL ® SP 21	POLYAMIDE	-200 to +260
OTHER	GRAPHITE	HIGH PURITY GRAPHITE	-240 to +550
	METALLIC	SPIRAL WOUND	
		RING JOINT	

Notes to Table 4:

- 1) Graphite seals are not acceptable as primary pressure containment seals; they are only used as back-up seals for fire resistance properties. Graphite back-up seals on ball valves shall be made of single piece, solid graphite compound (braided material is not acceptable).
- 2) "O"-rings cross section diameter shall be a maximum of 6.99 mm if AED property is required. VITON ® is not acceptable on methanol fluid services, wherever the methanol content exceeds 5% in volume, and even if methanol is only used for drying of pipelines. (Some HNBR grades, or FFKM like CHEMRAZ ® 526 may be used in this case, subject to appropriate testing).

- 3) Nitril rubber, silicon or fluorinated silicon material shall not be selected when resistance to explosive decompression is required by the valve data sheet.
- 4) Stem seals may only be made from "O"-rings (lip seals may be used only when permitted by the valve service class). "Gland packing" design involving graphite materials is not acceptable for primary pressure containment stem seals (Gland packing with chevrons type seals are acceptable for stem seals).
- 5) Seals materials as shown on **Table 3** shall not be used beyond the temperature limits shown on this table. Temperature ranges here above are maximum ranges, they are not the same for all materials of the same nature. Individual material temperature range shall be obtained from and confirmed by the seal material Manufacturer.
- 6) In case of solid particles in the fluid, the following design is required:
 - a) No lip seals are permitted except if the valve design is specifically qualified for the application
 - b) No soft seals are permitted for the seat-to-ball seals: valves must be metal-to-metal seating.
- 7) In special cases, particular seal materials other than those listed in Table 2 may be required by the Company. In such a case, such requirements would be spelled-out in the related valve requisition.
- 8) Seal materials other than those listed on Table 3 may be proposed for approval to the Company as alternate materials. Such proposal must be substantiated by appropriate documentation on material properties and testing in similar range of fluid, pressure, and temperature.
- 9) All "O"-rings used for valves in service class other than class A shall be certified having successfully passed the anti-explosion decompression test according to Appendix 8 of this specification. Testing results shall be submitted by the valve Manufacturer to the Company for approval.
- 10) All "O"-rings used for valves in service class other than class A shall be certified compatible with the service fluids of the related valves within the operating temperature range to be considered. In case no such indication is given on the valves requisition, the service fluid shall be assumed to contain methane with about 5% CO₂ at temperatures up to 120°C.

7.7 Metallic coating requirements for ball valves

7.7.1 General

The trim and seats, except if made of stainless steel material having at least 17% chromium (nominal value), shall receive an Electroless Nickel Plating treatment (ENP) of 0.003 inch (75 μ) minimum thickness, according to the procedure shown in Appendix 3. This requirement is not applicable to [ASTM A 705](#) type 630 (UNS S17400) unless otherwise specified by the valve data sheet.

7.7.2 Ball valves in corrosive service

Carbon steel ball valves (other than service class E) used in corrosive gas service, carbon steel piping material classes having a minimum corrosion allowance of 3 mm, shall receive a 3 mm thick weld overlay in stainless steel grade 316L on all seal pockets and related contact faces. This requirement only applies to dynamic seals (i.e. seat-to-body and also upper stem seals); it

does not apply to static seals such as body seals, or to parts already made of stainless steels having a minimum nominal chromium content of 17%. SS TP 316L weld overlay procedure must conform to Appendix 5.

In the case of floating ball valves, this requirement does not apply to seat-to-body sealing areas for which the seat ring is made of an integral, solid thermoplastic material (i.e., valves having a fixed seat), but it applies to stem sealing areas in all cases (For floating ball valves having also a floating seat design, the seat-to-body sealing area must consequently be overlaid). In the case of small size carbon steel valves (typically in sizes less than 2 inches), where it might be difficult or impossible to do the stainless steel overlay on valve bodies or bonnets, this requirement may be waived provided that the related piece is replaced with solid corrosion resistant alloy according to the Table 5 hereafter. In such a case, the end nipples must still be in carbon steel according to the relevant piping material class, and shall be welded by the valve Manufacturer to the corrosion resistant alloy of the body with Inconel 625 filler material exclusively.

Table 5

Valve pressure class	800			1500		2500
Piping pressure class	150	300	600	900	1500	2500
General corrosive service	316L or 321		321	316L or 321	Duplex stainless steel F51	
H ₂ S corrosive service					Incoloy 825 or Inconel 625	

7.7.3 Particular case of solid particles in the fluid

Seats and ball contact faces must be Tungsten Carbide coated in order to achieve a minimum surface hardness of 1050 Vickers. The thickness of the Tungsten Carbide coating must be a minimum of 400 µm (thickness of the finished, machined surface).

This coating is required in addition to the 75 µm ENP coating requirement which has to be applied on the remaining parts of the trim (i.e., ball, stems and seats). Tungsten Carbide Coating procedure must conform to Appendix 4.

7.7.4 Particular case of service class E ball valves

Service class E valves (which must be metal-to-metal contact) shall have the following additional features:

- Seats and ball contact faces must be Tungsten Carbide coated in order to achieve a minimum surface hardness of 1050 Vickers. The thickness of the Tungsten Carbide coating must be a minimum of 400 µm (thickness of the finished, machined surface). This coating is required in addition to the 75 µm ENP coating requirement which has to be applied on the remaining parts of the trim (i.e., ball, stems and seats). Tungsten Carbide Coating procedure must conform to Appendix 4. Tungsten carbide coating and ENP coating shall not be superimposed.
- Tungsten carbide coating shall be supported by an intermediate 3 mm Inconel 625 weld overlay coating for carbon steel, low alloy trim component exposed to sour service condition or when the line can be exposed to any aggressive chemical treatment.

- 3 mm thick weld overlay in Inconel 625 of all seal pockets and related contact faces (whatever the corrosion allowance of the relevant piping material class). This requirement only applies to dynamic seals (i.e. seat-to-body and upper stem-to-bonnet seals); it does not apply to static seals such as body seals. Inconel 625 weld overlay procedure must conform to Appendix 5. Materials in solid Inconel 625 or Inconel X718 grades need not be overlaid. Exception to the weld overlay will also apply to Duplex stainless steel material unless if otherwise specified.
 - Alternatively to the Inconel 625 weld overlay process, an Inconel 625 HVOF coating process may be considered, subject to the Company prior approval and under the following conditions. The HVOF coating process is not allowed for stem sealing application
 - The HVOF coating is not allowed for sour service
 - A minimum 300 µm coating thickness is required on dynamic sealing contact faces wherever allowed
 - Coating procedures as well as porosity tests method shall be submitted to the Company for prior approval
 - Porosity test results on coupons representative of the same substrate material in the same delivery condition and thickness, same HVOF process and equipment and same final machining or surfacing shall be submitted to the Company for approval.

7.8 Substitution of equivalent materials

No substitution of materials shall be authorised without the prior approval of the Company.

7.8.1 Valves fabricated by welding

The replacement of valves specified as being made of cast or forged steel by welded fabrication also requires the prior acceptance of the Company, which must be obtained prior to the purchase order award.

7.8.2 Internals

Where the valve data sheet calls for seats and plugs in "F6" (13% chromium) the material may be replaced by stellite-coated seats and/or plugs provided the services conditions permit.

7.8.3 Weld overlaid pressure containing parts

Use of carbon steel weld overlaid pressure parts instead of solid corrosion resistant material may be considered as an acceptable substitute by the Company for some specific supply.

When permitted by the Company such a substitution will be limited to valves of NPS 16 and above in pressure class 900 and above. The conditions for such substitution are:

- Proven experience of the valve manufacturer with that kind of manufacturing for the range of valve size.
- The valve manufacturing plant is equipped with all the welding and non destructive examination facilities and these production means are under the responsibility of the in-house welding department.



- Exhaustive list of requirements will be established by the Company including in terms of mock-up requirement as to ascertain the manufacturing capabilities prior to starting the production of such a supply.

8. Design

8.1 Design appraisal

For each type of valve, the Manufacturer shall submit a fully detailed calculation note to the Engineering Company in order to demonstrate that body and internal component stresses are within acceptable levels. Calculations must be based on the applicable code(s) requirements or criteria (VON MISES criteria, for instance). For this purpose, all external loads, tension and bending moments shall be taken into account, including the maximum torque developed by the actuator (if any) under the design pressure.

Calculation note must comply with Appendix 6 of the present specification.

Under extreme conditions (i.e. test, maximum torque, etc.) the maximum allowable stresses used for the stem calculation shall be:

- Combination of tension, bending and shear stresses: $\sigma \leq 0.9 \text{ YS}$
- Torsional stresses: $\sigma \leq 0.52 \text{ YS}$

(YS being the nominal yield strength of the material under consideration)

The Manufacturer shall also submit detailed drawings (sketches are not acceptable) and material take-off for each type of valve of the supply. The submission for review of drawings and calculation notes to the Engineering Company does not relieve the Manufacturer from any of his responsibilities and liabilities regarding the design of these valves.

8.2 Valves designed to API Spec 6A

The valve manufacturer must have a valid license certificate to **API Spec 6A** for the proposed range of products.

All the valves are designed and tested to the full rating unless otherwise specified.

Bolt allowable stresses shall not exceed those of **ASME VIII division 2** for both the hydrostatic test pressure and the rated working pressure.

Bolt allowable stresses govern all applicable valve loadings and combinations of loading including gasket pre-stressing load, end thrust load etc.

One fourth of the minimum calculated wall thickness of pressure containing parts shall be at the inner side of the body or bonnet bolt holes.

Only valves which have been qualified in accordance to **API Spec 6A** Appendix F verification test procedure shall be considered.

In addition to the mechanical calculation notes, finite element analyses are mandatory for each valve model and size.

The analyses shall be established with all details related to the meshing and elements characteristics and selection of these. Modelling will address composite material as far as necessary. The scope shall address stress and deformation of pressure containing parts and pressure controlling parts.



The study shall be run for all the major loading cases including hydrostatic test, high pressure closure test at 110% valve design pressure at coincident temperature and operating conditions.

In case line loads are not properly defined by the Engineering Company, the line load shall be established considering the thickness and the mechanical characteristics of the connecting pipe.

The finite element analyses shall be used to verify the effectiveness of individual sealing barrier and to evaluate the seat to obturator pressure contact range.

Material requirements shall satisfy PSL3 and quality control requirement PSL3, or PSL3G for valves in gas service, unless otherwise specified.

8.3 Bonnets and stems

8.3.1 Actuated valves

For actuated valves, bonnets, stems, stem extensions, etc., shall be designed and calculated to withstand the maximum torque delivered by the actuator at the maximum allowable actuator power (i.e. pressure or otherwise). Operation shall be smooth at all times. The maximum valve torque and its most demanding situation along the valve stroke shall be verified during valve testing as to confirm the actuator sizing for the given pressure differential in all situations.

8.3.2 Hand-operated valves

For hand-operated valves, bonnets, stems, stem extensions, etc., shall be designed to withstand the maximum anticipated torque that might be applied during the operation of the valve.

8.4 Internals

In order to prevent the seizing of parts in contact with one another, there must be differences in hardness between seats, obturators, stems, etc. However, this does not apply to parts that are coated (ENP, tungsten carbide, etc.).

The type of plug (solid, flexible, etc.) shall be stipulated in the valve data sheet. If a stellite-coated plug is specified, it must be made of the same material as the valve body.

The seats of globe valves less than or equal to 1"½ in diameter shall be removable.

8.5 Packing box

The stem packing must be suitable for service conditions specified and must contain a corrosion inhibitor to prevent oxidation of the stem, especially in case of prolonged storage. All valves stem shall be adjusted ready for service.

At the request of the Engineering Company, the Manufacturer shall indicate the nature, dimensions and number of disks making up the packing of the packing box, as well as the force required to press the packer and provide any endurance/cyclic test data performed with the same material arrangement.

8.6 Accessories, drains, and by-pass connections on valves

- a) In the particular case of swing check valves, a boss shall be provided downstream of each check valve (swing type only) to allow for the drilling of a drain in accordance with [ASME B16.34](#).
- b) In the particular case of ball valves, the requirement for accessories is shown on the Table 6 hereafter:

Table 6- Vents, drains and other connections on ball valves

Type of accessory	Above ground valves	Under ground valves	Service class E valves
Vent plugs (1) All service classes	Yes (2)	Yes (2)	Yes (2)
Drain plugs (1) All service classes	Yes (2)	Yes (2)	Yes (2)
Sealant injection facilities of upper stem (service classes B & E, $\Phi \geq 6"$)	Yes (3)	Yes, raised to gearbox (3)	Yes (3)
Sealant injection facilities of seat seals (Service classes B & E)	Yes (5)	Yes	No (4)

Notes to Table 6:

Whatever their design or function all plugs and sealant accessories shall be tested for their tightness at the service conditions when installed on the valves.

- (1) Vent and drain NPT threaded plugs are meant necessary for the valve testing.

They are solid plugs unless otherwise specified by the valve data sheet. Solid plugs are seal welded after valve **testing**. Seal weld shall be designed for the full thrust effect on the plug section at 150 % the valve rating pressure.

- (2) Seal weld are not allowed on carbon steel valves when used **in sour service**. NPT threaded anti blow-out plugs equipped with a bleed, as defined in note c) below, shall be used instead. The anti blow-out plugs shall also be considered as substitutes to solid plugs for valves whose actuators have to be installed on site. In that case the requirement shall be defined by the valve data sheet.
- (3) Sealant injection points shall incorporate a check valve and a secondary means of isolation. All connections shall be butt-welded to the valve body, or alternatively, shall be seal welded if screwed **for valves in all services other than** sour service In the particular case of sour service, welds on carbon steel valves are not authorised and screwed connections with 2 "O"-rings must be used instead, similarly to the anti blow-out plug.
- (4) Except for buried valves.
- (5) For actuated soft seated valves in diameter 16" and above.
- c) All anti blow-out plugs shall be equipped with a bleed and shall be NPT threaded. Two elastomeric o-rings are preferably located at top and bottom of the thread or both of them at

the bottom of the threaded section of the plug. These o-rings shall be of the same material as for the other valve sealing barriers. The bleed screw and the mandatory upper protective screw shall be both embedded in the plug head. The two screws shall be operated using the same specific tool. The size of plugs will depends on the valve size.

- d) In the particular case of integral manifold valves, vent connection at the bleed valve outlet shall be plugged with a metallic screwed bleed plug fitted with a **captive** bleed screw (Swagelok, Parker, or equivalent).

The bleed plug must be tested with the valve for its tightness.

Any other particular requirement regarding drains and by-pass connections to be provided on valves shall be specified in the valve data sheets and shall be in compliance with [MSS SP 45](#). This information shall be shown on a separate sketch or shall be marked as an annotation on the Manufacturer's drawing of the valve.

- e) PTFE or any kind of plastic material tape shall not be used for sealing threaded connections. This requirement also applies to valve ports during valve testing.

8.7 Bolting and gaskets

8.7.1 Bolting calculations

All bolting calculations must satisfy [ASME B16.34](#) requirements. In particular, the maximum allowable bolt stress used in the body or bonnet joints shall not exceed the maximum value of either 7000 or 9000 psi, respectively, whichever bolt-material grade is used. As a minimum these stress value limitations address both the loadings due to internal pressure and gasket setting pressure wherever it applies.

8.7.2 Bonnet gaskets

The gaskets of bolted bonnet or cover flange joints shall be suitable for the pressure class of the valves and the maximum and/or minimum temperatures specified on the valve data sheets and requisitions, as well as for any additional requirement such as "Firesafe", etc. The type of facings for the bonnet or cap joints shall correspond to those specified in paragraph 10.1.1 for a flange rating at least equal to the valve pressure class. CAF bonnet gaskets are not acceptable on steel valves.

Except as otherwise indicated in the requisitions, bonnet gaskets for gate and globe valves of 900 pressure classes or higher shall be of the metallic ring joint type and gaskets for the 600 pressure classes shall be of the spiral wound or metallic type.

All bonnet gaskets for valves specified in accordance with [API 602](#) shall comply with that standard.

Other types of gaskets may be submitted to the Company for approval.

8.7.3 Bolting for bonnet, packing-box, etc.

Bolting shall comply with [ASME B16.34](#). The threading of the bolting shall be in accordance with the "Coarse" series, class 2B, of [ASME B1.1](#). However, bolting to ISO standards, including metric threading, is allowed as an alternate.

Coating of all carbon steel or low alloy steel bolting shall conform to [GS EP COR 356](#) requirements.

Valve bonnet, packing-box, cover or body bolting material shall be equal or superior (for mechanical properties and corrosion resistance) to that listed in the following table. Compatibility of selected material with service conditions shall be checked.

Table 7 - Valve bolting materials

Valve body material	Design temperature Range (1)	Bolting material
Carbon steels (2)	-29 to +250°C	ASTM A 193 Gr. B7 and ASTM A 194 Gr. 2H
Low temperature Carbon Steels (2)	-46 to +250°C	ASTM A 193 Gr. B7M and ASTM A 194 Gr. 2HM or ASTM A 320 Gr. L7 or L7M and ASTM A 194 Gr. 4 or Gr. 7
Low Alloy Steel 3.5% Ni	-101 to +265°C	ASTM A 320 Gr. L7 and ASTM A 194 Gr. 4 or Gr. 7
Austenitic Stainless Steels	-196 to +300°C	ASTM A 193 or ASTM A 320 Gr. B8 or B8M cl.2 (see note 3) and ASTM A 194 Gr. 8MA or 8TA
Aluminium Bronze	-196 to +200°C	ASTM B 150 Gr. C63000 HR50
Duplex Stainless Steel to UNS 31803 or Inconel 625	-46 to +200°C	ASTM A 453 Gr. 660. F51 bolting will be preferred for small sizes screws if allowed by the design code
Other Non-ferrous		Per applicable valve standard

Notes to Table 7:

- (1) "Design temperature" means temperature @ design pressure for bolting.
- (2) Grades B7M for studs and 2HM for nuts must be selected if valves are in H₂S service and confined under heat insulation.
- (3) Stainless steel bolting to [ASTM A 193](#) Gr. B8 or B8M may conform to class 1 instead of class 2 for bolt diameters larger than 1 ½ inch. [ASTM A 453](#) Gr. 660 may also be used down to minus 100°C if satisfactorily tested at that temperature.

8.8 Operation of the valves

8.8.1 Manual operators

As a general rule, all valves shall be operated by a hand-wheel or by a wrench. Manually operated valves shall be furnished complete with either wrench or hand-wheel.

Unless otherwise agreed wrench for valves made of corrosion resistant alloy shall be in AISI 316 stainless steel material.

The maximum dimensions of hand-wheel and levers shall be according to requirement of [API Spec 6D / ISO 14313](#) except the maximum handwheel diameter is limited to 800 mm and the maximum lever length is limited to 450 mm.