



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, etc.

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 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
ASME B18.2.2	Square and Hex Nuts
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B36.19M	Stainless Steel Pipe

Reference	Title
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
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



Reference	Title
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
ASTM F 871	Specification for Electrodeposited Coatings on Threaded Components
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 H7-G6	Sliding Holes and Shaft tolerances to ISO 286-2
NACE MR0175 / ISO 15156	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production
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 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 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 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 005	Subsea ball valves

3. Requisitions and valves data sheets

Valves data sheets shall be issued by the Engineering 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 internal bore dimension and tolerances, which must match the adjacent pipe requirements. Valve data sheets shall conform to the format shown on Appendix 9 on which all information shall be filled-in by the Engineering Company.

Valves data sheets shall indicate both the relevant piping material class and a valve service class that is to be selected from the table 3.1 here after. For the purpose of the valve service

class selection, the temperature range to be taken into account shall be the actual operating temperature range (both highest and lowest temperatures) at which the valve is expected to be operated (i.e., opened or closed) and remain tight. In case of depressurisation leading to auto-refrigeration temperatures lower than minus 46°C, and provided that the valves are not required to ensure tightness in the closed position, a "cryogenic" design (i.e., valve service class "C") shall not be selected.

Valve data sheet shall also indicate the fluid composition (including fluid which may be passing through the valve on a temporary basis). This valve data sheet is complemented by the itemised instrument valve data sheet for each actuated valve.

4. Definition of service classes for valves

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

Table 3.1 - 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.

5. 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.



6. 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:

6.1 Cast material limitation and general requirements for casting

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. 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.

- 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 those products, i.e. 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:

- 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.
- 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. Unless otherwise agreed impact tests on steel grades LCC shall exhibit values not less 27J average / 21J minimum individual at the minimum design temperature of the applicable piping material class the valve is pertaining to. 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](#)

6.2 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%.

6.3 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 are acceptable substitutes ("L" grades are not acceptable).

6.4 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.

6.5 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.

6.6 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 3.1. This service class shall be taken from the relevant valve data sheet and/or requisition.
- b) Selection of a seal category, according to table 6.5.a.
- c) Selection of seal materials, according to table 6.5.b.
- d) Selection of a seal arrangement design according to Appendix 2.

Table 6.6.a - 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	Thermoplastic (5)	Elastomer AED (2)	Metallic or Elastomer AED (2)	Required (3)
C	Thermoplastic	Thermoplastic	Metallic or Thermoplastic	Required (3)
D	Metallic	Metallic or Bellow seats + Graphite	Metallic or Graphite	Not required
E	Metallic (4) (+ Tungsten Carbide Coating)	Elastomer AED (2)	Metallic or Elastomer AED (2)	Required (3)

Notes to Table 6.6.a:

- (1) Elastomer materials are strictly forbidden as seat to ball sealing barrier whatever the valve pressure class and service class.
- (2) AED means "Anti-Explosive Decompression", and elastomer materials must be certified according to the testing procedure of Appendix 8.
- (3) 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.

- (4) Metal to metal contact means tungsten carbide coating on both seat and obturator in conformity with section 6.7 and Appendix 4.
- (5) Tungsten carbide coating is required instead when section 6.7.3 applies.

Table 6.6.b - 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
THERMOPLASTIC	FLUORINATED SILICON (70 shore A)	F V M Q	-60 to +220
	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
OTHER	VESPEL ® SP 21	POLYAMIDE	-200 to +260
	GRAPHITE	HIGH PURITY GRAPHITE	-240 to +550
	METALLIC	SPIRAL WOUND	
		RING JOINT	

Notes to Table 6.6.b:

- 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 6.6.b 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 6.6.a 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 6.6.b 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.

6.7 Metallic coating requirements for ball valves

6.7.1 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.

6.7.2 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 6.7.2 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 6.7.2

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	

6.7.3 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 μ (thickness of the finished, machined surface).

This coating is required in addition to the 75 μ 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.

6.7.4 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 μ (thickness of the finished, machined surface). This coating is required in addition to the 75 μ 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 intermediate or severe sour service condition, regions 2 and 3 as defined by [NACE MR0175 / ISO 15156](#), 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 is limited to sweet or mild service application, regions 0 and 1 as defined by [NACE MR0175 / ISO 15156](#)
- A 300 μ coating thickness only (finished surface) would be required on both dynamic seals contact faces
- 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.

6.8 Substitution of equivalent materials

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

6.8.1 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.

6.8.2 Internals

Seats and plugs specified as "F6" (13% chromium) may be replaced by stellite-coated seats and/or plugs with the prior approval of the Engineering Company.

6.8.3 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.

7. Design

7.1 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.

7.2 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 ball pressure contact range.

Material requirements shall satisfy PSL 3 and quality control requirement PSL3, or PSL3G for valves in gas service, unless otherwise specified.

7.3 Bonnets and stems

7.3.1 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.

7.3.2 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.

7.4 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.

7.5 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.

7.6 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 7.5 hereafter:

Table 7.5 - Vents, drains and other connections on ball valves

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

Notes:

- (1) Only if required for pressure tests; in this case, vents and drains plugs must be seal welded after test for valves in all services other than H₂S. In the particular case of H₂S service, seal welds on carbon steel valves are not authorised and anti blow-out plugs with 2 "O"-rings must be used instead.
 - (2) All connections shall preferably be butt-welded to the body, or alternatively, shall be seal welded if screwed for valves in all services other than H₂S. In the particular case of H₂S service, welds on carbon steel valves are not authorised and screwed connections with 2 "O"-rings must be used instead.
 - (3) Except for buried valves
 - (4) For soft seated, actuated valves diameter 16" and above
- c) 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.
- d) All anti blow-out plugs shall be equipped with a bleed and be NPT threaded. Two o-rings are located at top and bottom of the thread respectively. 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. Size of plugs to be agreed depending on the valve size.
- 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.



7.7 Bolting and gaskets

7.7.1 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.

7.7.2 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 9.1.1 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.

7.7.3 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.

All carbon steel or low alloy steel bolting shall be Zinc bichromated treated ([ISO 4042](#) - 12 C Fe or [ASTM F 871](#) and [ASTM B 633](#) - Fe Zn 12 Sc3).

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 7.6.3 - 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 shall be preferred for small sizes screws or bolts depending on the environment.
Other Non-ferrous		Per applicable valve standard

Notes to table 7.6.3:

- (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. A 453 Gr. 660 may also be used down to minus 100°C if satisfactorily tested at that temperature.

7.8 Operation of the valves
7.8.1 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.

For valves operated manually, the maximum force required under design and test conditions, when applied at the rim of the hand-wheel or lever, shall not exceed 300 N during valve opening

or closing, and 400 N when unseating the valve. This applies to seating, unseating, and operating at maximum pressure differential for both minimum, and ambient temperatures.

Gear operator requirements for valves shall be in accordance with the following minimum requirements, as shown in Table 7.7.1. However, gear operators may have to be provided beyond these requirements in order to meet the maximum allowable force applied to hand-wheels or levers as stated here above.

Table 7.7.1 - Gear operator requirements

Valve type	Valve pressure class	Nominal diameter
Gate	150	14" and larger
	300	10" and larger
	600	8" and larger
	900	6" and larger
	1500	4" and larger
	≥ 2500	4" and larger
Globe and Plug	150	8" and larger
	300	8" and larger
	600	6" and larger
	900	4" and larger
	1500	3" and larger
	≥ 2500	3" and larger
Butterfly	150	8" and larger
	300	8" and larger
	600	6" and larger
Ball (floating or trunnion mounted type)	150	8" and larger
	300	8" and larger
	600	6" and larger
	900	6" and larger
	1500	4" and larger
	≥ 2500	4" and larger

Gear operators shall be heavy-duty type and shall be weatherproof by total enclosure suitable for a marine environment. Gearboxes shall be sealed, and lubricated for life, and suitable for operating at an ambient temperature of +38°C. Any lubricants shall be suitable for the Minimum Winter Design Temperature in the location where they are to be installed.

Gear operators for gate and globe valves shall be bevel types unless spur type is specifically stated in the requisition. Both bevel and spur gear operators shall be the type with 4 or 8 bolt mountings which allows them to be orientated on site any of 0° to 90° positions.

Gear operated ball and butterfly valves shall be provided with worm gear operators, or with scotch yoke operators.



Grey cast iron materials shall not be used for gearboxes or hand-wheel; only steel or ductile iron shall be used. Wrench and hand-wheel are made of solid material. Material shall be suitable for ambient temperature of -30°C unless otherwise specified.

Chain wrenches shall be to Manufacturer's Standard.

Chain wheels shall be of the adjustable sprocket rim type, with chain guides included. Chain wheel attached to valve handle by bolting shall use "U" bolts and not "J" bolts.

Extension stems, when specified on the requisition, shall be to proven Manufacturer's Standards. All materials and connection details shall be justified for the application.

For all valves fitted with manual gear operators, the Manufacturer shall submit with his quotation suitable drawings showing the principal dimensions and assembled weight of the valve and of the gear operator, clearly indicating the size(s) and Tag No's of the valve(s) to which the drawings are applicable.

7.8.2 Actuators

Valves operated by actuators shall also comply with the relevant instrumentation general and/or particular specifications.

For each actuated valve (i.e. each item), the detailed torque table in Appendix 10 must be completely filled in by the valve Manufacturer and under its responsibility, based on information collected from the actuator Manufacturer. This must be done at both the bid stage (i.e. these tables must be attached to the technical bid documents) and after the purchase order is awarded (i.e. these tables become part of the design documents which are required to receive COMPANY's approval together with drawings, bill of materials, calculation notes, etc.). All torque values shown on these tables must be checked during the valves and the actuators tests.

The pressure differential shall be addressed by the valve data sheet established by the Engineering Company and shall correspond to the most demanding situation the valve might face during installation start-up or in operation.

The maximum actuator output torque at the maximum supply pressure on the actuator shall not exceed the maximum allowable torque on both the valve and actuator stems. The output torque shall be understood at the connection of the gearbox with the valve stem (or stem extension) wherever such equipment exists in-between. The actuator shall also be capable to operate the valve at the minimum supply pressure on the actuator, and with the maximum pressure differential on the valve. In this case, the safety factor of the actuator output torque over the valve torque requirement must be a minimum of 1.3 in all operating cases of the valve (see Appendix 9).

7.8.3 Locking device

All manual valves (whether operated with a lever or a gear operator) shall be provided with adequate pads and holes for enabling locking at both the open and closed positions preventing any possible movement by involuntary external action, vibration, etc. Design and efficiency of the locking device shall be independent of the installation position of the valves.

7.8.4 Accessories

Accessories such as operating extensions, limit switches, emergency manual operation devices for actuated valves, etc., shall be submitted to the Engineering Company for approval and shall require a specific description.



7.9 Lifting lugs

Lifting lugs shall be provided for valves of nominal size 8 inches and above. Design of these lugs shall include additional weight of the actuator and the gear box as far as applicable. Design and calculation of these lifting lugs shall be submitted for approval together with all other documents and calculation notes.

Specific additional lugs may also be required for valves to be installed in the vertical position.

Lifting points on the gear box or actuator shall never be used for lifting the actuated valve.

7.10 Valves supports

Valves supports (legs or saddles) shall be supplied and installed by the valve Manufacturer on valves of nominal mass of 500 kg and above which are to be installed in the horizontal position. Design and calculation of these supports shall be submitted for approval together with all other documents and calculation notes. Such supports are not intended to be line support unless otherwise specified.

7.11 Miscellaneous requirements

- a) Valves shall be designed to operate freely after the stem has remained in one position for an extended period of service, of up to one year from the date of installation, or since the last periodic maintenance.
- b) Valves shall be designed to contain or limit pressure above normal working pressure that may build up in trapped cavities due to thermal expansion or evaporation of liquid.

7.12 General characteristics specific to each type of valve

All valves shall comply with the definition given by the Data Sheets issued by the Engineering Company for each type of valve as well as with the requirements of standard [ASME B16.34](#), completed by the following appropriate API or MSS Standards specific to each particular type of valve.

Ball, gate, globe and check valves are required to be of "firesafe" design and meet the requirements of [ISO 10497](#), [API 607](#), [API Spec 6FA](#). To demonstrate that valves offered comply with these requirements, the Manufacturer shall supply with his quotation copies of Certification issued by a recognised Inspection Authority confirming that this requirement has been met for all items offered, and that appropriate testing has been carried out to demonstrate the "firesafe" design per one of the relevant standards listed here-above. The fire test certificate shall be submitted with the general arrangement drawing and complete part list of the valve that was qualified as to validate the "firesafe" design of the supply. The validation of the qualification will be limited to valve of the same design, showing the same sealing material and sealing arrangement as the qualification valve.

7.12.1 Gate, globe and check valves

The following standards: [API 600](#), [API 602](#), [ASME B16.10](#) and [MSS SP 42](#) shall be the main complementary standards for steel gate, globe and check valves. When allowable leakage rates in these codes (e.g. [ISO 5208](#) rates) differ from those stated in this document, COMPANY shall be informed for approval.

In addition to a description of the internals of the valves, the data sheets shall stipulate the type of boring (full or reduced bore) and whether the stems are moving or fixed, externally or internally threaded, and whether with yokes.

Gate and globe valves shall be suitable for re-packing under pressure in the fully open position. Globe valve stem design shall also allow for tightness at intermediate obturator position when the valve is intended for flow control.

Seats of globe valves NPS 2 and above shall be renewable. Welded seats are not accepted.

Soft seal valves shall be clearly marked by the Manufacturer with the soft seal material and maximum working temperature.

For carbon steel and ferritic alloy swing type check valves, disc retaining components e.g. studs, nuts, washers and pins shall be of the same material as specified for the "trim" of the valve.

"Wafer" type check valves shall comply with [API 594](#).

If required, for fire safe resistance, graphite seals shall be installed to protect from leaks to the atmosphere (on bonnet and stem seals where applicable).

7.12.2 Ball valves

a) General

All requirements of this specification which are related to a ball valve size are meant to be related to the valve port size. All ball valves shall be bi-directional. Ball valves (manual and actuated) shall normally be reduced bore, unless otherwise specified on the requisition; however, valves of diameters $\leq 1\frac{1}{2}$ shall have a port size at least equal to the internal bore of the matching pipe. Actuated valves shall be 2 inches minimum in diameter (port size).

b) Design code

Ball valves shall comply with [ASME B16.34](#) or [API Spec 6A](#) when addressed by related piping material class. Other codes (in particular, [ASME VIII division 1](#)) shall only be used as a supplement to [ASME B16.34](#) for additional calculations not already covered in [ASME B16.34](#).

c) Body

The body shall be able to be fully dismantled, with a bolted design (i.e., side entry or top entry exclusively). All-welded or screwed-body design is not acceptable ("screwed body" means bodies made with a screwed-in insert). The pressure-containment top cover of top entry valves must be bolted to the body. However, all-welded body design is acceptable for valves of diameters not exceeding $1\frac{1}{2}$ inches, or for buried valves on buried pipelines, except for valves which are subject to the NACE requirements for wet sour service (H₂S).

d) Trim

Ball valves shall be of the "trunnion" type. However, "floating" type ball valves, if manually operated, are acceptable in the following cases only (actuated valves must be trunnion mounted exclusively, whichever their size or pressure class):

- Pressure class 150: Diameters up to 6 inches (included)
- Pressure class 300: Diameters up to 4 inches (included)
- Pressure classes 600, 900, and 1500: Diameters up to $1\frac{1}{2}$ inches (included)
- Pressure class 2500 up to $1\frac{1}{2}$ inches (included) if operating forces are demonstrated by testing to be within paragraph 7.7.1 limits.

**e) Anti-static features**

Ball valves shall also be of "anti-static" design, i.e. incorporate suitable devices in their design to ensure electrical continuity between the ball, stem and body of the valve. For this purpose, graphite seals are not considered to offer satisfactory electrical continuity. When additionally test to **API Spec 6D / ISO 14313** is required, the valve shall be fully dry and all graphite seals removed from the valve.

f) Bearings

All bearings shall be of a self-lubricating design (anti-friction material is acceptable).

g) Upper stem

Sealant injection facility of the upper stem must be provided for all valves of service classes B and E in diameter 6 inches and over. The injection point on the stem must be located between primary and back-up seals or between two primary seals.

Ball valve stem retention shall not depend on the packing gland: a bottom entry shouldered stem is required. To achieve this, the upper stem shall be shouldered to the body of the valve and not to the bonnet nor to an intermediate piece bolted on the valve body. However, this is not required on integral trim, i.e., if stems are made in one piece with the ball. (In the case of top entry design, the bolted top cover that is required for pressure containment is considered part of the body for that purpose).

Primary stem sealing barrier efficiency shall not depend upon a compressive action from the packing gland for ball valves in pressure class 300 and above. When allowed cycling test shall be organised on valves of the supply to demonstrate the efficiency and reliability of the compressive action exerted on the primary sealing barrier in the long term. Extent of testing shall be agreed depending upon the valve MTO and packing gland arrangement. It shall be successfully completed prior to the release of the supply.

Extended spindle/stem assembly, when specified, shall have the stem within a tube and shall be to proven Manufacturer's Standard design. Design shall enable any necessary stem seal adjustment to be carried out at the top of the stem extension without removing any insulation. Any requirement for such valves will be indicated in the requisition. For flanged valves, the extended spindle length is measured from the top of an end-flange; for threaded or socket weld valves, it is measured from the top of the valve body. Stem/spindle extension lengths shall be as follows:

- For valves 2" in size and smaller: 100 mm, plus or minus 10 mm
- For valves larger than 2": 150 mm, plus or minus 10 mm.

Stem made of precipitation hardening material, typically 17.4PH, Inconel X718 etc., and whose finished section is more than 150 mm in its largest part shall be checked for tensile properties and microstructure on some appropriate extension of a stem of the supply. This extension shall go through the complete stem manufacturing process before testing. Extent of testing will be determined based on the service conditions. It shall consist of two cylindrical tensile specimen and three macrographs as a minimum.

h) Seats

The construction of the body seat rings or ring assemblies for trunnion mounted valves shall be such that body cavity relief is possible. A pressure relief hole in the ball is not allowed, whether on floating ball or on trunnion mounted valves.



On top entry valves, the seat design shall be such as to allow for easy trim removal; this shall be based on the use of split seats. Specific designs such as "seat push-back" devices are subject to the COMPANY prior approval.

i) Ball position indicator

Positive means of indicating ball position shall be supplied by the Manufacturer for each valve, in accordance with the following:

- Manually operated ball valves
 - Wrench operated valves: ball position indicator shall not be capable of incorrect fitting
 - Gear operated valves: when in place on valve, the gearbox valve position indicator shall be directly associated with actual stem/port position and shall be visible at all time under normal operation. When gear-operator is removed (i.e. for maintenance, etc.), the valve stem end shall incorporate positive indication of actual ball position. The refitting of the gearbox shall be capable of retaining the position so indicated.
- Actuated ball valves
 - These valves shall have similar positive indication as required for gear-operated valves as stated here above, and must incorporate one-way fitting of couplings, etc., to maintain external evidence of the actual ball position at all time, including under normal operation conditions.

For both types of ball valves (either manual or actuated), "pointer" type attachments alone will not satisfy these requirements.

For both types of ball valves (either manual or actuated) of NPS 36 and above in pressure class 900 and above the positive means shall give the indication of the ball position by adequate marking on the stem or on the stem extension for the two open and close positions. This marking shall be visible through the adapter flange when the valve is fully assembled with its actuator or gear box.

7.12.3 Plug valves and needle valves

These valve types are limited to specific applications and shall not be used in high pressure gas service without first approval by the COMPANY.

7.12.4 Butterfly valves

Butterfly valves shall comply with **API 609**.

Requisitions for butterfly valves shall state the outside diameter and wall thickness of the mating pipework. The Manufacturer shall confirm in his quotation that mating pipework bore will give adequate disc swing clearance.

All gear-operated butterfly valves are to be fitted with a disc position indicator.

On wrench operated butterfly valves, the wrench must be capable of being positively locked in the fully open and the fully closed positions.



8. Dimensions

8.1 Face-to-face or end-to-end dimensions

8.1.1 Flanged and butt-welding valves

Except as otherwise stated in the valve data sheets, the dimensions between the flanges or the welding ends of valves shall comply with [API Spec 6D / ISO 14313](#). However, [ASME B16.10](#) is applicable for all valves or sizes not listed in [API Spec 6D / ISO 14313](#).

The dimensions between the flanges or the welding ends of ball valves shall be in accordance with "Long Pattern" dimensions. The "short pattern" may only be used by the Engineering Company in order to solve layout clearance problems. (If selected, the short pattern shall be specified on the corresponding valve data sheet).

8.1.2 Threaded or socket-welding valves

The end-to-end dimension of threaded or socket-welding valves shall be indicated by equivalence to a Manufacturer's catalogue.

8.1.3 Valves installed between flanges (wafer type valves)

The end-to-end dimensions of butterfly valves shall be in accordance with [API 609](#).

The outside dimensions of "wafer" type check valves shall be determined by [API 594](#).

8.2 Ends

8.2.1 Flanged valves

The flanges shall be of the type required for the piping class to which the valve belongs.

They shall be in conformity with [ASME B16.5](#) for diameters up to 24" and with [ASME B16.47](#) (series A) for diameters of 26" and over.

The tapping of threaded flanges shall comply with [ASME B1.20.1](#).

Screwed flanges added on to bronze valve bodies shall comply with [ASME B16.24](#).

The body end flanges of all double flanged valves shall be drilled for through bolting. Except where otherwise specified, flanges that are drilled and tapped for studs are not acceptable unless approved by the Engineering Company. Where tapped holes are permitted, the depth of thread engagement shall conform to [ASME B16.34](#).

8.2.2 Butt-welding valves

Butt-welding ends of valves shall comply with [ASME B16.25](#), and their bores shall match those of the pipes to which they are connected.

All butt-welding end valves must be supplied with pup pieces and/or transition pieces to allow for transition between the valve body (material grade and thickness) and the adjacent pipe (material grade and thickness) to which the valve is intended to be connected. The total length (pup piece + transition piece, or pup piece alone if no transition piece is found necessary) must be, on each side, equal to a minimum of twice the valve port diameter, with a maximum of 1 meter.

The pup pieces and/or transition pieces shall be supplied and welded by the valve Manufacturer and under its responsibility prior to valve testing. Subject to special agreement prior to the Purchase Order award, pup pieces may be supplied free issue to the valve Manufacturer.

The wall thickness, length and material of the transition pieces will be also determined as to minimise the stress concentration at the two butt welds. Local stress evaluation may require development of finite element analysis, so as to run the verification under the various loading conditions.

The transition piece will be made preferably from a forging. Any fabrication made from a piece of pipe shall be performed with SAW process in compliance with the specification **GS EP PVV 611**.

Longitudinal weld seams of transition piece and pup piece must be located in the top quadrant and staggered by 200 mm from each other except if otherwise specified.

The longitudinal weld of the transition piece and pup piece and also the connecting butt welds to these components are subject to 100% radiographic examination and 100% ultrasonic examination. The applicable criteria are those of the specification **GS EP PVV 611** except if otherwise specified.

The pup pieces will be ordered with the necessary extra length as to adapt the end cap or other means required for testing the valve with the full end thrust effect.

The sketch hereafter shows the principle of what is required.

Detail of transition and/or pup pieces requirements

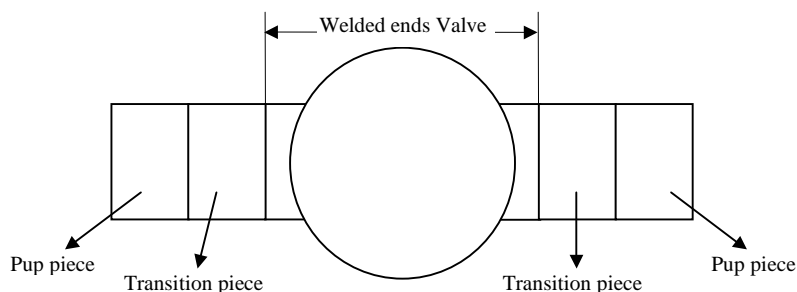


Figure 8.2.2.a - Butt Welding ends valves

Both pup pieces and transition pieces shall meet the internal bore requirement of the valve.

The thickness and material grade of the pup pieces must be the same as the adjacent pipe. The thickness and material grade of the transition pieces must be selected to meet the criteria of [ASME B16.5](#) (Figure 14 "Bevel for combined thickness") or [ASME B31.8](#) or [ASME B31.4](#), depending on whether valves are to be connected on piping or on gas or liquid pipelines. Transition pieces may not be necessary, depending on adjacent pipe and valve end respective thickness and material grade. A typical assembly detail is shown on the sketch hereafter:

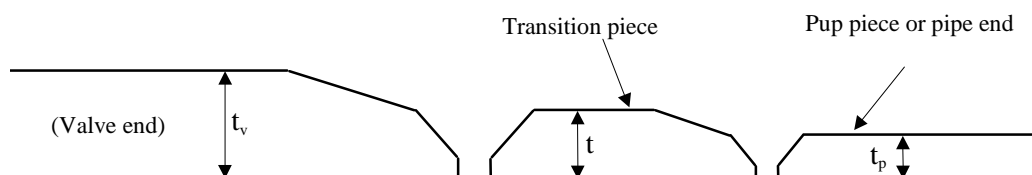


Figure 8.2.2.b - Typical assembly detail (Valve termination shall have a minimum thickness in accordance with [ASME B16.34](#))

According to the codes, the following must be met: $t_v \leq 1.5 t$, and $t \leq 1.5 t_p$ (t_v , t , and t_p are determined by wall thickness calculations based on both the applicable codes and the respective material grades).

In case $t_v \leq 1.5 t_p$, transition pieces are not necessary, but a pup piece shall nevertheless be supplied and welded to the valve end by the valve Manufacturer.

A practical example is given hereafter:

Table 8.2.2 - Practical example

	Valve	Transition piece	Pipe
Design code	ASME B16.34	ASME B31.8	ASME B31.8
Material grade	ASTM A 350 LF2	ASTM A 694 F52	API 5L X65
Wall thickness	$t_v = 42.9 \text{ mm}$	$t = 31 \text{ mm}$	$t_p = 21.4 \text{ mm}$

The weld filler metal of two dissimilar material grades must always match the highest grade material composition and characteristics. The complete assembly details must be submitted to the COMPANY for prior approval, together with the related welding procedures and qualification records (WPS/PQR).

8.2.3 Valves ended with hub connectors

The design of the hub connector will satisfy the rule of the minimum thickness required by the valve design code.

The vendor of the hub connector shall have clarified the maximum loading that can be accepted by the hub connectors in terms of normal load and moment, all information to be given in SI units.

The testing of these valves shall be performed using mating blind hub connectors and same sealing gaskets as the ones of the production supply.

8.2.4 Threaded or socket-welding valves

Threaded valve ends shall be tapped in accordance with [ASME B1.20.1](#) and [ASME B16.11](#).

Socket-welding valve ends shall be bored in accordance with [ASME B16.11](#).

Socket weld ball valves (soft seated valves only) shall be provided with 100 mm long plain end nipples (each side) made of an integral forged nipple schedule XXS (Carbon steel) or 80S (Stainless steel) or greater if specified in the relevant piping class. Nipple diameter shall be equal to the diameter of the connecting pipe. Materials shall comply with the relevant Piping Material Classes requirements, unless otherwise specified on the Valve Data Sheets.

Nipples shall be of integral forged type. Socket welded nipples are not allowed anymore.

8.2.5 Valves installed between flanges

The ends of "Wafer" type check valves shall comply with [API 594](#) and the ends of butterfly valves shall comply with [API 609](#).

The contact faces of check valves and the contact faces of butterfly valves for which separate gaskets are specified shall receive the same finish machining as the contact faces of the flanges between which these valves will be installed. This flange finish facing is specified in the relevant piping material class.

8.3 Valve bore

Full opening valves (full bore valves) shall comply with [API Spec 6D / ISO 14313](#). Beyond the limits of the table 1 of [API Spec 6D / ISO 14313](#) the minimum valve bore is defined by agreement with the COMPANY.

Reduced opening valves NPS 24 and less shall not be less than one size below nominal size of valve bore according to the table 1 of [API Spec 6D / ISO 14313](#)

Reduced opening valves above NPS 24 shall not be less than two sizes below nominal size of valve bore according to the table 1 of [API Spec 6D / ISO 14313](#)

Reduced opening of valves designed to [API Spec 6A / ISO 10423](#) shall not be less than nominal size of valve according to [API Spec 6A / ISO 10423](#).

8.4 Other dimensions

All other dimensions, such as: thickness of bodies and bonnets, attachment bolting, stem diameters, etc., shall be in accordance with standards specific to each type or group of valves.

9. Details of fabrication

9.1 Flanges of flanged valves

The main machining operations performed on the flanges shall be the following:

9.1.1 Contact face finishing

Contact faces shall undergo finish machining in accordance with [MSS SP 6](#). The table 9.1.a hereafter summarises the main recommendations of this standard:

Table 9.1.a - Flange facing requirements

Flange facing	Finish	Average roughness (maximum value)
Flat Face or Raised Face 1/16" (with flat gasket)	"Stock finish"	(See note 1)
Raised Face 1/16" (with spiral wound gasket) or Raised Face 1/4"	Smooth finish	250 AARH (6.3 μ)
RTJ (2)	Groove: very smooth	63 AARH (1.6 μ)

Note 1: The "Stock Finish" facing is not defined in [MSS SP 6](#). For Flat Face or Raised Face (stock finish) facing, the roughness average range is 6.3 to 12.5 μ (AARH = 250 to 500 micro inches). Pitch and depth of machining groove shall be per [MSS SP 6](#), table 1. However, roughness in excess of 12.5 μ (AARH greater than 500 micro inches) is acceptable to a maximum of 50 μ , provided groove parameters per [MSS SP 6](#) table 1 are maintained.

Note 2: The **minimum** BRINELL hardness of grooves of RTJ flanges shall be:

- 110 for carbon steel flanges
- 150 for alloy steel flanges
- 150 for stainless steel flanges
- 230 for Inconel 625 flanges.

The **maximum** BRINELL hardness of ring joints shall be:

- 90 for ARMCO mild steel
- 130 for Alloy Steel (4.6% Cr - 0.5% Mo)
- 135 for Stainless Steel (TP 304/TP 316/TP 317)
- 210 for Inconel 625.

9.1.2 Drilling

Bolt holes shall be made by multiple-spindle drill presses, or with a CNC drilling machine. The relationship between the drilling parameters and the flange diameters shall comply with [ASME B16.5](#) or [ASME B16.47](#) (Series A). The flanges shall be spot-faced at the bolt holes in accordance with [MSS SP 9](#). The holes shall not be centred on the vertical or horizontal axis of the flanges.

9.2 Welding and weld repairs

Tack welds or non-continuous welds intended to be temporary or permanent features between internal components are strictly forbidden.



Welding and weld repairs are not authorised on valves in H₂S service.

Any welding must comply with the COMPANY Specification [GS EP PVV 611](#).

Where the material specification requires impact tests, a spare test coupon shall be cast with each heat of castings whatever the valve pressure class. This shall be used if requested by the Engineering Company, to establish impact values for weld metal and heat affected zone, for a weld repair procedure.

When allowed, major weld repairs of castings shall only be undertaken with the written approval of the COMPANY. Major repairs are as defined in [ASTM A 703](#).

Repairs by welding or by impregnation with a metallic or non-metallic substance shall not be authorised on cast-iron valve bodies and bonnets.

Defective steel valve bodies and bonnets may be repaired by welding in accordance with the provisions of their respective standards. The welding procedures and qualification of the welders for these repairs must be in accordance with [ASTM A 488](#) for steel and Nickel alloys castings. The weld repair qualification procedures for castings shall cover all weld repair work irrespective of the stage in production at which weld repairing is carried out. Austenitic stainless steel and other valve castings alloys that have been subjected to weld repairs shall be solution heat-treated.

For valves of welded or fabricated construction, including valves with welded-on flanges or welded-in nipples, etc., all welding shall be performed using weld procedures and welders/welding operators qualified according to [GS EP PVV 611](#) and [ASME IX](#). Where such valves are offered, this shall be highlighted in the quotation and, where such valves are of impact tested materials, all weld procedures, including repair procedures, shall be submitted for review and comments to the Engineering Company.

9.3 Cleaning

Seats, wedges, disc and seat ring threads shall be cleaned just prior to assembly, to ensure they are free from any dirt, grease or oil film; however, light grease or oil is permitted to allow for the installation of "O"-ring seals. (This requirement supersedes the requirement for light machine oil allowed by [API 600](#)).

However such products shall not drive to any misinterpretation of the valve test result. Finding of any adverse product shall lead to the rejection of the whole lot of valves presented for inspection and possibly to the rejection of the complete supply.

Contact surface of seat to obturator shall be dry before starting the valve test.

10. Inspection and tests

10.1 Quality control

The inspection and tests necessary to confirm that the products meet the requirements of the standards, specifications and of the Purchase Order shall be carried out in the Manufacturer's plant by personnel of the plant. These specially qualified personnel shall be independent of the production department of the plant.

Products that are to specifications shall be guaranteed by an adequate inspection certificate, conformity certificate, material certificate, test certificate, etc.



If the Manufacturer does not have the necessary means of examination, these tests shall be carried out by an agency and at a place approved by the COMPANY or by the Engineering Company.

The Inspection Agency shall conduct inspections in the Manufacturer's plant so as to make sure of the proper execution of the order and of the quality examination. It shall also witness final shop acceptance.

All inspection activities shall be listed in a quality plan per the forms attached in Appendix 1. This quality plan shall be submitted to the COMPANY for approval.

For each valve purchase order and in each related valve assembly plant, COMPANY has right to get one valve out of fifty completely dismantled for verification of the valve conformity in terms of valve design, valve component material, sealing arrangement, etc. This requirement shall be extended to more valves if obvious changes or non conformities are identified. The verification can be required and performed at time of valve testing or even at time of valve final inspection.

10.2 Visual examination

All valves must be 100% visually inspected as per [API 598](#) and [MSS SP 55](#).

10.3 Pressure tests

10.3.1 General

All valves (i.e., 100% of the supply) shall undergo pressure tests in accordance with the requirements of [API Spec 6D](#) and [API 598](#). ("Spot Testing" is not acceptable). Valves not covered by these standards shall be tested in accordance with [MSS SP 61](#).

The Manufacturer shall submit for the COMPANY's approval its detailed testing procedure for each type of valves, including each pressure class and size. This procedure must be in full accordance with the present specification requirements and the applicable codes.

High pressure gas closure test of gate, globe, plug and check valves are performed if specifically required by the valve data sheets. This test shall be identified by specific valve marking. Optional tests that are described in table 1-A or table 1-B of [API 598](#) become mandatory irrespective of valve size and valve pressure class.

Back seat test of gate and globe valves used in gas service shall be performed with nitrogen at 110% the pressure rating of the valve.

All valves in hydrocarbon service require gas testing. Test of actuated valves shall include the test of valves fully equipped with their own actuator and control panels. Testing with some template is not accepted.

All small valves designed to class 800 shall be considered as equivalent to valves of the same size in pressure class 600 for extent of testing and acceptance criteria.

PTFE or any other kind of plastic tape shall not be used for sealing threaded connections including vent or drain plug threaded connections.

Test certificates must be supplied for each valve of the supply, which must accordingly be identified by an appropriate fabrication numbering system. A test certificate addresses one valve or one integral bolted manifold only.

10.3.2 Test medium

a) Water tests

Testing medium shall be clean, inhibited, fresh water. Stainless steel valves shall be tested using inhibited fresh water having a maximum chloride content of 15 ppm. This also applies to valves fabricated with some parts made of stainless steel. The temperature of the test must be a minimum of +10°C. In case of non-impact tested body materials, the minimum temperature of the test medium shall be +16°C.

After testing with water, all valves shall be thoroughly dried to prevent possible corrosion from the water.

b) Gas tests

Gas tests shall be monitored using soap bubble method where zero leaks are either expected or requested. Where leak rates other than zero are specified, the leakage rate shall be measured using a flow meter calibrated with the gas used for testing.

10.3.3 Acceptance criteria

High-pressure hydrostatic seat test leakage rates shall comply with [API Spec 6D](#).

The following criteria apply to gas tests only (including air, nitrogen, etc.):

- **External leakage** (maximum allowable leak rate from each source): 5 SCF/annum (0.27 SCC/min.)
- **Seat leakage**: according to the table 10.3.3 hereafter.

Table 10.3.3 - Leakage rates acceptance criteria for closure tests with gas
(all values are in SCC/cm dia/min.)

Testing at ambient temperature			
		Low pressure tests (all sizes)	High pressure tests (all sizes)
Soft seals	Valve pressure class ≤ 600	0 leakage	0.5
	Valve pressure class ≥ 900		1
Metallic seals	Valve pressure class ≤ 600		2
	Valve pressure class ≥ 900		4

Low temperature: cryogenic tests (per GS EP PVV 150)			
		Low pressure tests (all sizes)	High pressure tests (all sizes)
Soft Seals	Valve pressure class ≤ 600	60	60
	Valve pressure class ≥ 900	120	120
Metallic seals	Valve pressure class ≤ 600	120	180
	Valve pressure class ≥ 900	180	360

10.3.4 Specific requirements for ball valves

- a) All tests must comply with the procedure shown on Appendix 7. The testing certificate form to be used shall conform to the sample attached to Appendix 7.
- b) Trunnion mounted ball valve tests shall include testing of the seat relief design effectiveness. This test shall be made on at least one or 20% of manual valves of each size and pressure class, selected at random by the Inspector. In case of failure 50% of other valves of the same lot shall be tested. The extent of testing shall then be increased to 100% in case of two other failures.

The seat relief test shall be made on 100% of the actuated valves.

For the purpose of this test, nitrogen gas pressure shall be introduced in the valve body cavity, whilst both valve ends are to the atmospheric pressure. It must be verified that seat release occurs at a maximum pressure of 10% of the valve rating pressure (except for 150#: 8 bar, 300#: 10 bar and 600#: 15 bar).

- c) Valves of sizes and pressure class according to the table 10.3.4 hereafter, shall be pressure-tested with full end thrust effect. For this purpose, flanged-end valves shall be tested using end flanges (i.e., with blind flanges), and welded-ends valves shall be tested using temporary caps.

Table 10.3.4 - Size and pressure class relationship for test requirements of ball valves with full end thrust

Pressure class	Minimum size (inches)
150	Not required
300	24 (1)
600	16 (1)
900	16 (1)
1500	12
2500	12
API 10000 and above	All sizes

Notes to table 10.3.4:

- (1) Up to 900# rating and for NPS up to 28", thrust effect may be evaluated on only one valve of each type (a type shall be understood as same valve design, same NPS, same rating and same part list - metallic and non metallic - for each purchase order).
- (2) All valves ended with hub connectors shall be tested with full end thrust effect by means of mating blind hub connectors whatever the pressure class.
- (3) All ball valves shall pass an additional high pressure closure test according to the procedure described in [API 598](#):
 - For valves of service classes B, C, D and E, this high-pressure closure test must be done with nitrogen gas
 - For valves of service class A is done with water. Exceptionally and subject to acceptance by COMPANY, high pressure closure test of manually operated service class B ball



valves used in liquid service, excluding any multiphase service, may be done with water provided identification and marking of those valves are organised as to prevent from any further use in gas service.

10.4 Toughness tests

The toughness tests to be carried-out on the valves (if required) are normally shown on the Purchase Order documents.

When these tests are required, they shall be carried out in conformity with the requirements of [ASTM A 370](#) and at the temperature required for the grade of material.

10.5 Hardness tests

If specified in the Purchase Order documents, hardness tests shall be carried out on each valve body (e.g. for compliance with the NACE standards in case of H₂S service).

10.6 Special examinations

All non destructive examination on casting is deemed performed on finished casting after all repair works and the complete heat treatment sequence.

For all valves 6" and larger in pressure class 300 and higher, castings shall be examined in accordance with section 8 of [ASME B16.34](#) (Requirements for special class valves, examination of steel castings) and [MSS SP 55](#).

For these valves, the extent of radiographic examination of cast components shall also include location of abrupt change in geometry or thickness, location of risers, gates and feeders.

For those specific locations ultrasonic examination can be used as substitute provided the surface finish permits the full examination of the part from all necessary examination surfaces.

In addition the following shall apply to components of lower pressure ratings,

- 10% of all valves of size 6" to 18" class 150# and 300#
- 20% of all valves 20" and larger 150# and 300#.

In case of failure the rule of below section 11.3 applies.

For ferrous materials, Magnetic Particle examination shall be used in preference to Dye Penetrant.

A full radiographic inspection shall be carried out on 100% of the bevelled areas of all weld-end valves of sizes 2" and above, and on all butt-welded joints, to prove that these areas are free from any defects. Bevelled area of valve ends made of forgings may be inspected by ultrasonic testing instead of radiography.

Additionally, any weld (including fillet welds) on valve bodies, regardless of size or pressure class, shall be 100% examined by dye penetrant testing.

Radiographic defect acceptance levels on welds shall be in accordance with the following:

- Welds in forged or other wrought materials: [ASME B31.3](#) Table 341.3.2A, for normal fluid service (although the inspection level must be 100%, and not "spot or random"); however, acceptance criteria for inspection of welds in valves specified for "severe cyclic services" shall be those for "severe cyclic conditions" of the Table 341.3.2A
- Welds in castings - [ASTM E 446](#) up to 25 mm wall: level 1; above 25 mm wall: level 2



- Butt-welds for pipeline valves must also comply with the applicable pipeline code. This refers in particular to transition and/or pup-piece welds in case of welded-ends valves.

Cracks or crack-like defects, such as shrinkage, are not acceptable whatever their size.

11. Acceptance

All valves shall be 100% tested by the Manufacturer in his shop and under his responsibility.

The functional test of the each actuated valve shall be performed after complete testing of its actuator and control panel. All test record of the actuator and the control panel shall be available prior to starting the valve functional test, including the values of the actuator output torques.

The Inspection Agency shall not release the valves unless all related certificates have been submitted and approved. In addition to checking the certificates, the Inspection Agency shall check the quantities presented and shall have checked the following:

- Destructive tests called for in the codes and standards
- Pressure tests
- Tightness tests
- Special examinations
- Shapes and nominal dimensions
- Dimensional tolerances
- Treatment and surface finish conditions
- Marking and finishing conditions.

The valve release inspection shall address, as a minimum:

- Coating quality and cleanliness
- Port sealing effectiveness.

Internal cleaning: Any evidence of grit or sand blasting particles found inside the valve at that stage will require the valve to be stripped down, inspected and re-tested.

Trim alignment and gear box or actuator end stop positions.

End protection and valve preservation.

11.1 Extent of the Inspection Agency inspection and witnessing

Each actuated valve shall be individually fully tested for mechanical, leakage and functional tests.

The Inspection Agency inspection and witnessing rate for the manual valves shall be as follows:

Table 11.1 - Extent of the Inspection Agency inspection and testing for manual valves

Valve size (port size for ball valves)	Valve type					
	All valve types and all valve service classes in Pressure class ≥ API 10000	Gate, Globe, and Check valves	Ball valves			
			Valves service class E	Valves service class A, B, C, D		
		Valve pressure class as per ASME B16.34 or to API 5000				
		All pressure classes	All pressure classes	Pressure classes ≤ 600	Pressure classes > 600	
≤ 1 ½"	100%	10%	100%	10%	10%	
2" to 10"	100%	25%	100%	25%	50%	
≥ 12"	100%	100%	100%	100%	100%	

Notes to table 11.1:

- 1) All small valves designed to class 800 are considered as equivalent to pressure class 600 for the extent of testing.
- 2) The selection of valves to be tested shall be made by the inspector of the Inspection Agency and not by the Manufacturer. Higher inspection/witnessing rates may be requested for specific cases.

11.2 Test failure, re-work, re-test

In case a test fails, the Manufacturer is permitted to re-submit the same valve only once, and only after it has been properly re-worked and the reasons for failure thoroughly examined and explained by the Manufacturer to the Inspection Agency (who must report them). Should a given valve fail to pass a test for the second time, it shall be rejected and replaced by a new one.

11.3 Test failure on spot checks

For valve sizes for which spot checks from the Inspection Agency are carried out, the extent of sampling shall be increased by steps of at least 10% of the total valves number subject to spot checks, up to 100%, for each test failure. This increased sampling area shall first be related to valves of the same type and size as those having failed, and then, to larger sizes of the same type from the same manufacture.

12. Documentation
12.1 Certificates of conformity

The Manufacturer shall submit a certificate of conformity with the standards specified in the Purchase Order documents.

12.2 Materials certificates

The Manufacturer shall submit material certificates giving the results of the chemical analysis and of the mechanical tests carried out in accordance with the requirements of the reference

codes and standards, for all main metallic materials. The following type of certificates are required, with reference to [EN 10204](#):

Table 12.2 - Type of material certificate required for each valve part

Nature of valve part	Type of certificate (based on valve service class)	
	Valve service class A	Valve service class B, C, D, E
BODY	3.1	3.1
FLANGES	3.1	3.1
BONNET	3.1	3.1
BALL	2.2	3.1
OBTURATORS (1)	2.2	2.2
STEMS	2.2	3.1
BOLTING	2.2	2.2
SEATS	2.2	2.2
SEALS (2)	2.1	2.1

(1) On valves other than ball valves

(2) AED testing certification according to Appendix 8 shall be 3.1 type. Specific ED test may be required when the valve manufacturer cannot show evidence of its direct supply from the seal manufacturer or when lot identification cannot be established.

12.3 Pressure tests certificates

The Manufacturer shall submit a certificate of the pressure tests carried out on the valves in accordance with the codes and standards. For ball valves, the form to be used is shown on Appendix 7.

12.4 Other tests certificates

The Manufacturer shall submit all other test certificates showing results of tests as required in the present specification and annexes, for each valve.

12.5 Technical manual

The Manufacturer shall submit a detailed and dimensioned drawing of each valve, with a list specifying the technical characteristics, the references of the parts, and the materials used (including material grades for all parts). He shall also submit a detailed manual giving all information needed for:

- Understanding the functioning of the valve
- Operating the valve
- Maintenance and other work.



13. Preparation for shipment

13.1 Marking

13.1.1 Valve tagging

All valves shall be tagged by the Manufacturer with the Tag Number as stated on the requisition prefixed by the valve nominal size. This shall be clearly stamped on corrosion resistant metal tag permanently attached to the valve.

13.1.2 Identification of materials and main characteristics

In addition to the markings required by [MSS SP 25](#), the following information shall be marked by cold stamping on each valve:

- Purchase Order Number
- The type of valve (gate, globe, check, etc.)
- The valve service class letter (i.e., A, B, C, D, or E)
- The specification and grade of body and trim materials
- The casting number
- The batch number
- Serial number
- The valve pressure class
- The diameter
- The ring joint number, in the case of flanges having this type of contact face
- The nature of fluid service (in case of specific requirements like H₂S service)
- The high pressure gas closure test.

Soft seal valves shall be clearly marked by the Manufacturer with the soft seal material and maximum working temperature.

13.1.3 Colour coding

If required, all valves shall be identified by an appropriate colour coding system specified in the order.

13.2 Protection of ends

All valve ends must be blanked off by wooden, metal or plastic plugs.

The threads of threaded valves shall be oiled or protected by a non-peel varnish.

The bevelled ends of valves with butt-welding ends and the contact faces of end flanges shall be protected by a peel-off varnish.

13.3 Painting

When paint is required for protection of the valve, it shall be applied only after all tests and examinations have been carried out by the Inspection Agency.



The interior surfaces, the threaded parts, the bevelled or socket-welding ends, the flange contact faces, and the various valve-identifying markings shall not be painted.

13.3.1 Carbon steel valves

The coating applied shall be as per **GS EP COR 350** or **GS EP COR 354**.

13.3.2 Austenitic stainless steel valves

All stainless steel valves shall be protected against the risks of saline corrosion during cleaning, transport, fabrication, testing and/or storage. It is not a requirement that the Manufacturer shall paint such valves if they are otherwise suitably protected as required above.

However, if these valves are required protected by paint, the coating applied shall be as per **GS EP COR 350** or **GS EP COR 354**.

13.3.3 Non-ferrous valves

Non-ferrous (i.e. bronze and gunmetal) valves shall not be painted.

13.4 Preparation

The valves shall be closed for shipment, except for ball valves that shall be shipped in the fully open position. (However, failed closed ball valves may be shipped in the closed position). Gate and globe valves with soft seals shall have the wedge/disc backed off to relieve the pressure on the seals.

13.5 Packing

The valves must be packed in sea packing, waterproof. Packing must be suitable for all stages of transport (rail, road, air, etc.).

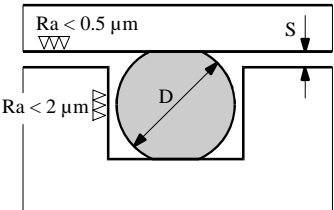
Appendix 1 Minimum requirements for quality plan

Activity	Relevant procedures and specifications	R.W.H. points			Documents	
		Manufacturer Inspection	Inspection authority	Third Party	Required	Notes
1) Material properties Mechanical and chemical properties of body, closures, ball, seats, stem, trunnion, bolting and seals	ASTM Materials standards (as applicable)		R		Material certificates	
2) Visual and dimensional inspection 100% Rough Material 100% Machined components (including flange facings)	API Spec 6D ASME B16.5 ASME B16.10 ASME B16.34		R R		Fabrication drawings	
3) N.D.E. Radiographic inspection (where applicable) Wet M.P.I. or DPI on 10% of machined bodies and closures	ASME B16.34 ASME B16.34 ASTM E 709		R R		Inspection reports Inspection reports	
4) Hardness test 100% on RTJ Groove flanges facing and gaskets			R		Test reports	
5) Electrodes nickel plating Thickness measurement Hardness checking Adhesion checking	ASTM B 656 ≥ 0.003" (75 μ) 700 HV on ball, seats, and stems		R R R		Test reports Test reports Test reports	
6) Weld overlays	GS EP PVV 142		R		Test reports	
7) Tungsten carbide coatings	GS EP PVV 142		R		Test reports	
8) AED tests on "O-rings"	GS EP PVV 142		H		Test reports	
9) Tests on assembled valves Pressure tests (including Torque tests on actuated valves) Cryogenic tests	GS EP PVV 142 GS EP PVV 150		H (1) H		Test reports	
10) Painting Thickness measurement adhesion checking	Project requirements		R W W		Inspection reports	
11) Tagging, marking and final checking	API Spec 6D plus Project requirements and GS EP PVV 142		R			
12) Fire safe certification	ISO 10497 or API Spec 6FA or API 607		R		Fire safe certificates	
R: review of documentation W: witness - to be notified H: hold - production stop	Signatures:				Date:	

(1) Depending on specification requirements

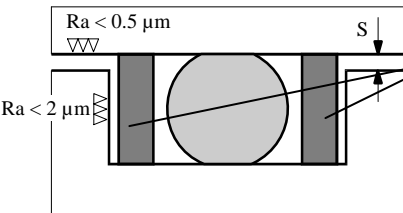
Appendix 2 Non metallic seals

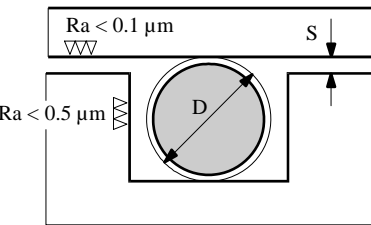
1 - Elastomer seals

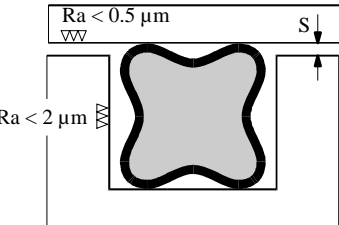
Material	θ range (°C)	"O"-rings	Pressure range (barg)	Hardness (Shore A)	Gap S (mm) D \geq 5 mm
Nitril Rubber	0 to +80		P < 150	≥ 70	≤ 0.1
Hydrogenated Nitril	-40 to +150		150 \leq P \leq 200	≥ 75	≤ 0.07
VITON® GLT	-30 to +180		P > 200	≥ 85	≤ 0.05
CHEMRAZ® 526	-20 to +220				
Silicone (70 Shore)	-60 to +220				

General Tolerance ISO H7-G6

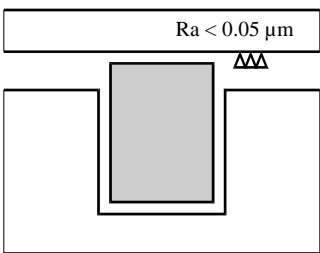
For gas hydrocarbons, "O"-Rings must be certified resistant to explosive decomposition

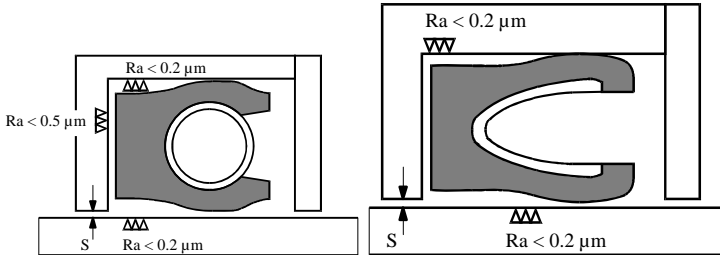
Material	Anti extrusion rings
PTFE + graphite (10 to 25%) Thickness 2.5 mm Assembly standard US AS568 A Extrusion gap S < 0.1 mm	 <p>For pressure classes 900 and over, 2 anti-extrusion rings must be installed, one each side of the elastomer "O"-rings. These anti-extrusion rings may be split or not, depending on diameter and supplier</p>

Sheath Material	Body Material	θ range (°C)	Encapsulated "O"-rings
FEP	Viton®	-40 to +140	 <p>Sheath thickness ≥ 0.5 mm and < 1.5 mm</p> <p>Extrusion gap S < 0.1 mm</p> <p>When "O"-Ring diameter is less than 25 D, groove shall be made in two parts for assembly</p>
	Silicon	-60 to +140	
PFA	Viton®	-40 to +200	
	Silicon	-60 to +200	

Quad rings	
<ul style="list-style-type: none"> Material and temperature range as for "O"-Rings Pressure/Hardness as for "O"-Rings 	 <p>Extrusion gap S < 0.07</p> <p>For high pressures (P > 200 barg) or high temperatures ($\theta > 100^\circ\text{C}$), anti-extrusion rings shall be used</p>

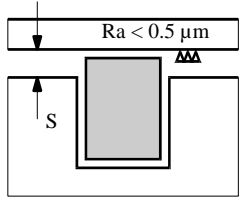


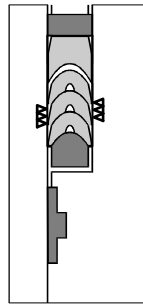
2 - Thermoplastic seals

Material	θ range (°C)	Insert seals
PTFE + graphite (10 to 25%) KEL F ® TURCITE ® 243 NYLON 12 ® PEEK ® VESPEL ® SP 21	-80 to +200 -150 to +100 -200 to +250 -20 to +100 -80 to +160 -200 to +260	 <p>Material compressive strength at 23°C: $\sigma_c \geq 30 \text{ N/mm}^2$</p>

Material	θ range (°C)	Lip seals
PTFE (virgin) PTFE + 25% graphite PTFE +15% fibreglass +5% M _o S ₂ TURCITE ® 243 VESPEL ® SP 21 PFA ®	-80 to +200 -150 to +200 -150 to +250 -200 to +250 -200 to +260 -80 to +200	

Material flexural yield strength at 23°C: $\sigma_f \geq 100 \text{ N/mm}^2$

Extrusion gap S < 0.1 - Springs made of stainless steel or Incoloy 825

Material	θ range (°C)	Fire safe back-up seals	Maximum pressure (barg)	Density (g/cm ³)
Graphite + ash (small content) + corrosion inhibitor	-240 to +550	 <p>S < 0.1 mm</p>	150 200 350 > 350	> 1.6 > 1.7 > 1.8 > 2 to 2.2
Material	θ range (°C)	U or V shaped packing:  Bearing guide and anti extrusion ring: 		
Packing material: PTFE + graphite 10% PEEK ® PFA ® Bearing guide and anti extrusion ring: PTFE + fiberglass 15% +10% M _o S ₂ PEEK ® +graph. fiber 10% VESPEL ® SP 21	-200 to +200 -80 to +160 -80 to +200 -200 to +240 -80 to +160 -200 to +260		Packing: Ra < 0.5 µm Material flexural strength at 23°C: $\sigma_f > 100 \text{ N/mm}^2$ Bearing guide/ anti-extrusion ring: Ra < 0.5 µm Material compressive strength at 23°C: $\sigma_c > 30 \text{ N/mm}^2$ After reinforcement fiberglass $\sigma_c > 250 \text{ N/mm}^2$ Friction factor < 0.1	

Appendix 3 Electroless nickel plating procedure

1. Coating process

The ENP coatings shall be obtained by chemical reactions leading to a plating composed of 90% Nickel and 10% Phosphorus. This type of coating must comply with [ASTM B 733](#), with the following classification of this standard: **SC4, Type III, Class 2, NiP 10 75** and with the following particular or additional requirements:

a) Surface preparation

The support surface shall be correctly prepared by abrasive blasting to SA 3. The roughness shall be:

- For round shape surfaces: $R_t \leq 2 \mu\text{m}$ and $R_a \leq 0.4 \mu\text{m}$
- For other surfaces: $R_t \leq 60 \mu\text{m}$ and $R_a \leq 12.5 \mu\text{m}$.

b) Diffusion heat treatment

The diffusion heat treatment specified in [ASTM B 733](#) after the ENP coating for class 2 shall be applied under a neutral atmosphere.

c) Additional testing

The coating hardness must be tested.

2. Testing

The following properties shall be tested in order to verify the quality of the deposits, and test certificates must be submitted to the COMPANY for approval:

2.1. Testing on samples (coupons)

The following testing shall be carried-out on one coupon for every batch or heat treatment:

a) Hardness

The ENP hardness shall be checked according to [ASTM B 733](#), paragraph 7.5. A minimum value of 700 HV₃₀₀ shall be obtained.

b) Thickness

The ENP thickness shall be checked according to [ASTM B 733](#), paragraph 10.3.4 (micrometer method). No value below the specified thickness shall be found.

c) Alloy composition

The ENP alloy composition shall be checked as specified in [ASTM B 733](#), paragraph 8.1. The Phosphorus content shall be within 9 and 11% in weight.

d) Porosity

The ENP porosity shall be checked as specified in [ASTM B 733](#), paragraph 9.6.1 (Ferroxyl test method).

e) Corrosion resistance

The ENP corrosion resistance shall be checked according to [ASTM B 733](#), paragraph 9.7 (using method per [ASTM B 287](#), acetic salt spray test).

2.2. Testing on components

The following testing shall be carried-out on components:

a) Appearance

The ENP appearance shall be checked as specified in [ASTM B 733](#), paragraph 7.2. Coating shall be smooth, adherent and free from visible blisters, pits, nodules, porosity and other defects. Slight discoloration resulting from heat treatment shall not be cause for rejection. 100% of the components shall be examined.

b) Adhesion

The ENP adhesion shall be checked according to [ASTM B 733](#), paragraph 9.4.2. The method used is based on impact test using a spring-loaded centre punch. No flaking or blistering shall be visible at a 10x magnification. Testing shall be made at random on components for each batch or heat treatment.

Appendix 4 Tungsten carbide coating procedure

1. Coating process

Coating process shall be HVOF (High Velocity Oxygen Fuel process).

2. Coating thickness

The thickness of the coating shall be minimum 400 μ after grinding and polishing.

3. Cleaning

The components shall be machined to achieve a surface roughness of 0.8 μ m Ra.

All edges shall be chamfered or radiused. Balls shall be spherical within 0.05 mm.

The components shall be cleaned for removal of oil by a cleaning agent (acetone or similar) before grit blasting.

The components may not be preheated before grit blasting or directly afterwards since clean dry air shall be used for the grit blasting operation.

4. Coating period

Small components shall be coated within four hours after grit blasting.

5. Sealing

All coated surfaces, excluding parts used on pure oxygen service, shall be sealed after the spraying. The type of sealing shall be specified in the Manufacturer procedure. The sealing product will be selected considering the valve operating temperature range.

6. After-coating treatment

All coated surfaces shall be ground and sealing area shall be polished or lapped.

The two seats shall be lapped with the corresponding ball surface to assure full tightness.

Surface roughness shall be $\leq 0.10 \mu$ m Ra.

Surface Porosity Test: 100% of sealing area to be dye penetrant examined. No visible defects are acceptable.

7. Coating testing

The following testing shall be performed for qualifying the coating process (the base material used for testing shall be the same material as the one to be coated, i.e. a qualification run on carbon steel is not accepted for the application on stainless steel or any other corrosion resistant alloy).

For a same application plant, validity of qualification test records is limited to five years, provided also it can be demonstrated the manufacturing process has remained unchanged over that period.

A specific qualification shall also be required in case of application of the tungsten carbide coating over a weld overlay made of stainless steel or Inconel 625 or Incoloy 825.

The details of the here below tests refers to the application on a carbon steel or stainless steel base material. The application over other material will require specific testing.

These tests shall be repeated for each 24 hours period, for each type of material and for each batch of powder: These tests shall be identified and traceable to the components produced at the same time

a) Bend test

A plate sample (approximate dimensions of 100 x 20 x 1.5 mm) shall be coated. The sample shall then be bent to 90° over a mandrel of 15 mm diameter.

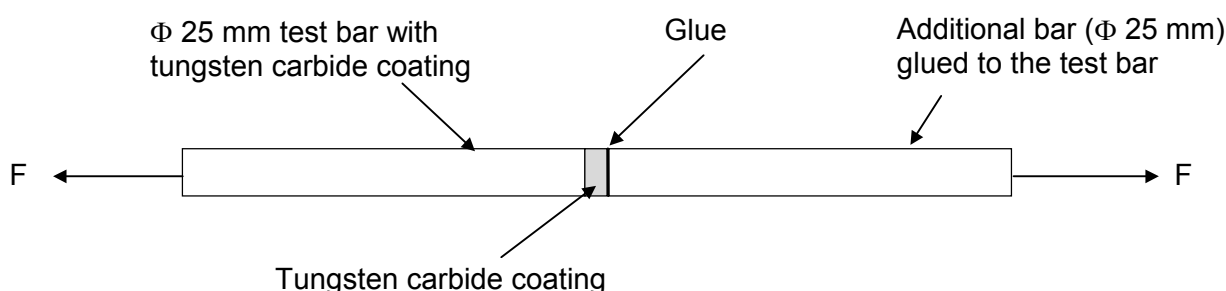
For each supply and each one production week, one set of bend test specimen will be coated with a seat and an obturator. Positions of the test coupons on the components shall be verified by the valve manufacturer and the Inspection Agency.

Acceptance Criteria

Cracking is acceptable but there shall be no peeling.

b) Bonding test

A test bar of 25 mm diameter shall be tungsten carbide coated and stuck to another bar having the same diameter as shown on the sketch hereafter. The whole sample shall then be submitted to a tensile test until complete separation of the two parts. The breaking shall occur on the glued side of the stuck bar. The applied stress shall be reported.



Bonding test assembly

($F \geq 10,000$ psi)

8. Documentation (EN 10204 type 3.1)

- Certificate of conformity
- Dimensional report
- Coating test certificate (Hardness, porosity, composition and bond test results).

9. Technical data

- Nominal Composition 86% WC - 10% Co - 4% Cr
- Minimal Hardness 1050 HV
- Tensile Bond Strength > 10,000 psi
- Density 10.4 g/cm³
- Porosity ≤ 1%

Appendix 5 Inconel 625 or SS TP 316L - Weld overlay procedure for seal pockets and seal contact surface on obturators

1. Scope

This addendum covers requirements for weld overlay of Inconel 625 or stainless steel on carbon steel substrate material of valve parts for corrosion protection purpose. It applies to sealing areas of valves exclusively.

This appendix does not apply to weld overlays of large valve surfaces such as internal surface of bodies, for which the COMPANY specification [GS EP PVV 611](#) remains however applicable.

2. Weld overlay requirements

2.1. Service conditions

- a) Weld overlay shall provide corrosion protection on specified sealing areas of valves
- b) Welded surfaces are in contact with the corrosive fluid
- c) No surface defects are allowed on sealing surfaces.

2.2. Weld overlay description

- a) Weld overlay shall be in accordance with [ASME IX](#) (Corrosion protection - Weld Metal Overlay) and the COMPANY specification [GS EP PVV 611](#).
- b) Overlay thickness shall be sufficient in order to obtain a minimum of 3 mm thick protective layer in the final machined condition.
- c) Areas to be welded and dimensional tolerances shall be shown on detailed drawings (overlay thickness included).
- d) Maximum allowable hardness at any location on welded surface after final machining operation shall be less than 22 HRC for 316L and 35 HRC for Inconel 625 ([NACE MR0175](#)).
- e) Dilution on welded surface shall not exceed 10% of base metal.
- f) Heat Affected Zone (HAZ) thickness shall be minimised.
- g) Overlay shall be performed in a minimum of two layers.
- h) Welded surfaces are sealing areas in which any defect shall not be accepted.

3. Fabrication

3.1. General requirements

Automatic process with computerised monitoring system for the equipment positioning, equipment rotation and welding parameters shall be preferred.

SMAW and ESW processes are not allowed for the weld overlay on seal pocket or any sealing contact surface (ball or other obturator).

Weld production and qualification test shall be performed in accordance with [ASME IX](#).

Welding qualification shall be performed using the same equipment as the one used for the production.

Only welders having satisfactorily passed a performance qualification test shall conduct the production of welded pieces.

3.2. Welding consumables

Welding consumables used for fabrication shall conform to the description shown in the relevant WPS. A test certificate shall be provided for each lot used.

3.3. Welders qualification

Welders without same or equivalent performance qualification shall satisfactorily pass the test using the procedure of chapter 4.

3.4. Fabrication procedures

No fabrication shall start until the welding procedures are approved. These procedures shall cover at least the following:

- Storage, drying and handling of consumables
- Cleaning of base metal surfaces to be welded
- Welding method with operating mode and parameter description. The welding sequence shall minimise 'stops and starts'.

The welding procedure qualification record (PQR) shall be documented and submitted together with the relevant WPS for approval by the COMPANY. Welding parameters, heat input, gas composition, gas flow etc shall be available for each layer.

3.5. Defect removal and repair

- a) Repairs may be local or total when non-conforming conditions are found. Defects in excess of acceptance standard shall be removed by reducing weld overlay thickness and shall be repaired by re-welding.
- b) All excavations shall be dye penetrant inspected prior to the start of repair welding in order to confirm the complete removal of defects.
- c) Repair by re-welding shall be performed in accordance with a written procedure. The following information must be given in these procedures:
 - Method of removing defects
 - Requirements related to the shape of the excavation
 - Inspection of repair prior to re-welding
 - Applicable welding procedure and qualification tests
 - Inspection after welding.

4. Qualification tests and acceptance criteria

4.1. Qualification ring

Qualification test coupon shall be of the same material and grade as the production base material.

The qualification shall be run on a NPS 6 forged or cast ring with a seal pocket machined on its inside and its outside surface. The dimensions of the ring will be not less than 150x40 mm. The size of the two seal pockets will be 5x40 mm as finished after weld overlay machining.

The following examination shall be performed after weld overlay on the coupon:

- a) **Dimensional verification:** overlay thickness and conformity of dimensional tolerances (any change in dimensions after welding).
- b) **Visual inspection:** method as per [MSS SP 55](#). No defects are allowed.
- c) **Dye penetrant inspection:** overlay shall be dye penetrant examined according to [ASME VIII division 1](#), Appendix 8. No defects are allowed.
- d) **Chemical analysis:** spectrographic analysis of the weld metal surface shall be verified at the minimum overlay thickness as specified for finished components and also 1.0 mm below this finished surface. Chemical analysis results shall be within the nominal composition of the required type of overlay (i.e., SS TP 316L or Inconel 625, as applicable).
- e) **Hardness testing:** ten indentations shall be performed at three test line locations. Testing shall include base material, Heat Affected Zone (HAZ) and weld metal. Three indentations minimum are required within each layer. The hardness survey shall be made at a maximum 0.5 mm distance between the indentations from the fusion line, through HAZ and into the unaffected base material. Hardness testing shall be the Vickers hardness test, 5 or 10 kg load.
- f) **Macrographic examination (x1.5):** three macro-sections equally spaced around the circle to [ASME IX](#). They shall be documented by colored digital pictures attached to the test report.
- g) **Micrographic examination:** The microstructure of the Heat Affected Zone (HAZ) shall be free of precipitations and intermetallic phases. The micro-examination of the etched specimens shall be performed at a magnification of x 400 and documented by photographs attached to the test report, which shall be submitted on request. The frequency of examination shall be as for mechanical testing.

4.2. Production weld overlay (100% extent of testing)

The following examination shall be performed after production weld overlay:

- a) **Dimensional verification:** overlay thickness to meet final machined condition requirement (as per drawings), and conformity of welded pieces.
- b) **Visual inspection:** method as per [MSS SP 55](#). No inclusion, porosity, crack, slag, nor any visible defects are permitted.
- c) **Dye penetrant inspection:** on last layer, this final non-destructive examination shall be carried out after any post-weld head treatment and final machining. Inspection method and procedures shall comply with the code [ASME VIII division 1](#), Appendix 8. No defects are allowed on sealing surfaces. If required additional examination will be performed as to ascertain the quality of the weld deposit underneath the machined surface. Any linear indication or rounded indication greater than 2.0 mm are not allowed. Any left embedded round defect shall be proven as not adverse to the sealing contact.

4.3. Documentation

The following shall be submitted for information:

- Welding procedures (WPS) and procedure qualification records (PQR)
- For each piece, the required test and examination certificates
- Welding consumable certificates.

Appendix 6 Stem calculation requirements

1. Scope

This addendum covers calculation requirements in order to determine the maximum allowable torque on a valve stem. Such calculation implies verification of all stem parts and attachments, whilst the following formulae only relates to stem and stem key verification. The final maximum allowable value for stem torque shall be taken as the lowest result of all the related verifications, including the two calculations detailed hereafter.

2. Stem calculation

2.1. Von Mises formula

$$\sigma_e^2 = \sigma_t^2 + 3\sigma_c^2 \quad (1)$$

Where σ_t = tension stress (for instance, due to internal pressure)

σ_c = torsional stress

σ_e = equivalent stress.

2.2. Maximum equivalent stress

The maximum equivalent stress σ_e shall not exceed 90% of the nominal yield strength of the stem material: $\sigma_e \leq 0.90 \text{ YS}$ (where YS = the nominal yield strength of the stem material).

2.3. Maximum torsional stress

From the above, and taking into account a tension stress equal to zero (normal case), the following can be derived:

$$\sigma_c \leq \sqrt{\frac{(0.9\text{YS})^2 - \sigma_t^2}{3}} \quad (2)$$

and since $\sigma_t = 0$ (normal case),

$$\sigma_c \leq \frac{0.9\text{YS}}{\sqrt{3}} \quad (3)$$

$$\sigma_c \text{ max} = 0.52\text{YS} \quad (4)$$

2.4. Maximum allowable torque for the stem

Section modulus of a round (solid) bar:

$$\frac{I_o}{v} = \frac{\pi D^3}{16} \quad (5)$$

(D = diameter of the bar, in mm)

Torsional stress of a round bar under a torsional torque:

$$\sigma_c = \frac{M_c}{\left(\frac{I_0}{v}\right)} \times 1000 \quad (6)$$

With the following:

σ_c = torsional stress (N/mm²)

M_c = torsional torque (Nm)

$\frac{I_0}{v}$ = section modulus (mm³)

From equation (6), the torsional torque is given by the following equation:

$$M_c = \frac{\sigma_c \left(\frac{I_0}{v}\right)}{1000} \quad (7)$$

or:

$$M_c = \frac{\sigma_c \pi D^3}{16000} \quad (8)$$

The maximum allowable torsional torque is derived from equations (4) and (8):

$$M_{c \max} = \frac{0.52 Y S \pi \cdot^3}{16000} \quad (9)$$

3. Stem key calculation

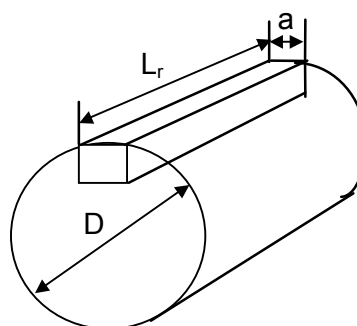
3.1. Force induced on the key by the torsional torque

$$F_{ck} = \frac{M_c}{r} \times 1000 \quad (10)$$

Where M_c = torsional torque (Nm)

r = stem radius ($= \frac{D}{2}$) (mm)

F_{ck} = force induced on the key (N)



3.2. Shear stress induced in the key by the torsional torque

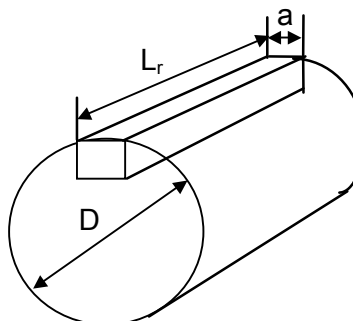
$$\sigma_{ck} = \frac{F_{ck}}{S_{ck}} \quad (11)$$

Where S_{ck} = contact area of the key (mm²)
 $(S_{ck} = a \times L_r)$

σ_{ck} = shear stress on the key (N/mm²)

From equations (10) and (11),

$$\sigma_{ck} = \frac{2M_c \times 1000}{D \times a \times L_r} \quad (12)$$



Where L_r = Length of the key (mm)

a = stem key width (mm)

3.3. Maximum shear stress value for the stem key

The shear stress in the key shall not exceed 90% of the nominal yield strength of the key material: $\sigma_{ck} \leq 0.90 \text{ YS}$ (where YS = the nominal yield strength of the key material).

3.4. Maximum allowable torque for the stem key

$$\sigma_{ck} \text{ max.} = 0.90 \text{ YS} = \frac{2M_c \times 1000}{D \times a \times L_r}$$

$$M_c \text{ max} = \frac{0.90 \text{ YS} \times D \times a \times L_r}{2000} \quad (13)$$

Appendix 7 Ball valves testing procedure

1. Scope

This procedure applies to ball valves pressure testing. It describes testing procedures regarding tightness and performance of the valves.

Functional tests of actuated valves shall be carried-out only after having successfully passed all steps of the required pressure tests of this appendix.

2. Description of the tests

Pressure tests of valves shall be carried-out in the following sequence. All equipment used to monitor tests and pressure gauges must have current calibration certificates.

2.1. Filling of the valve

- Test fluid:
 - Water + corrosion inhibitor diluted at 3%
 - Maximum chloride content: 15 ppm
- Valve ends shall be blanked
- Ball in half open position
- Filling from the drain
- Vent (at highest point) in open air
- When valve is full, blank the vent
- Pressure measurements shall be made at not less than 25% nor more than 75% of gauge span.

2.2. Shell tests (with water)

- Ball in half open position (minimum 10 degrees opening)
- Apply pressure to the values shown on one of the applicable tables 1.a, 1.b, 1.c, 1.d (shell tests)
- Isolate the valve from the pressure source
- Clean and dry the valve body
- Minimum duration of pressure test according to table 2
- Acceptance criteria: no visible leakage is acceptable.

2.3. High pressure closure tests (with water)

- Ball in half open position, valve at atmospheric pressure
- Close the valve
- Apply pressure on one seat to the values shown on one of the applicable table 1 (high pressure closure tests), the volume beyond this seat being at atmospheric pressure
- Duration of pressure test according to table 2

- Acceptance criteria: Maximum acceptable leakage rate according to table 3 (leakage to be measured in the valve body cavity)
- Torque measurement: at the maximum differential pressure if shown on the valve data sheet or, without this information, at the nominal pressure of the valve pressure class (as shown on one of the applicable tables 1), on each seat
- The torque measurement shall be carried out until complete decompression of pressurised volume.
- The same test shall be carried out on the other seat.
- Torque measurement with the valve in full open position, no pressure in the valve cavity and full pressure in the line.
- The above torque measurements shall be performed along the necessary angle of the valve stroke as to guarantee the selection of the gear box or the actuator for the required safety factor of 1.30 at minimum supply pressure.

2.4 Functional test (with water, actuated valve only)

- All connecting lines between valve and its local control panel shall be made of tubing of the same section as the one to be used on site. Flexible hose are not accepted for this purpose. In case of self standing local control panels length of these shall not be less than 5 meters unless otherwise specified.
- The valve is fully equipped with the extension stem when it exists. The report of the actuator output torques is available
- The actuator shall be preset for both the open and close position. The verification is made after three cycles as a minimum
- The valve is then put in the close position and the shutoff pressure applied successively on each seat with the opposite seat and the cavity are at atmospheric pressure
- Verification of the manoeuvrability of the valve and record of actuator and control panel performance are organised in conjunction with the instrument data sheet requirement.
- Verification of the actuator/control panel checklist, see appendix of **GS EP INS 137**.

2.5. Gas tests

Gas tests are also required for valves in liquid hydrocarbon service except otherwise agreed. Gas tests shall only be carried-out after all water pressure tests have been passed satisfactorily. For safety reasons, gas tests shall be performed in an area especially dedicated to it and specifically designed to resist a possible high-pressure gas explosion, such as a heavy wall concrete building or pit. No personnel may be allowed to approach the valve whilst it is under gas pressure.

All flexible hoses shall be secured tied.

Gas test shall start when the valve is completely dry.

2.5.1. Low pressure closure tests, with air or nitrogen

This test can be repeated after the high pressure closure test.

The procedure is as follows:

- Ball in half open position, valve at atmospheric pressure
- Close the ball
- Put one seat under pressure (5.5 bars + 10% for all valve pressure classes and diameters), the volume beyond this seat being at atmospheric pressure
- Duration of pressure test according to table 2 (this test duration is meant to be measured after venting of the body cavity for the minimum stabilisation time also shown on table 2)
- Inspection on an outlet located between the two seats in the valve body cavity, using the bubble test method
- Acceptance criteria: no leaks are acceptable.

The same test shall be carried out on the other seat.

The test is then repeated at the end of the complete valve test sequence.

2.5.2. Seat relief test

The valve is put in close position with both ends vented to the atmosphere. The pressure is increased in the cavity. When one seat releases the pressure the vent of that side is then closed and the pressure of the cavity is still increased till release by the second seat.

2.5.3. High pressure closure tests

- Ball in half open position, valve at atmospheric pressure
- Close the ball
- Apply pressure on one seat to the values shown on one of the applicable table 1 (high pressure closure tests), the volume beyond this seat being at atmospheric pressure
- Duration of pressure test according to table 2 (this test duration is meant to be measured after venting of the body cavity for the minimum stabilisation time also shown on table 2)
- Leakage rate measurement on an outlet located between the two seats in the valve body cavity, using a flow meter (the unit for leakage measures is in cm³/min)
- Acceptance criteria: the maximum acceptable leakage rate shall be according to table 3.

The same test shall be carried out on the other seat.

Table 1.a - Test pressure in relation to valve pressure class
Carbon steels to group 1.1 of ASME B16.34

Valve pressure class	Nominal pressure (bars)	Shell tests pressure (bars)	High pressure closure tests pressure (bars)
150	19.7	29.5	21.6
300	51	76.5	56.1
600	102	153.1	112.3
900	153.1	229.6	168.4
1500	255.5	383.2	281
2500	425.4	638.1	468
API 5000	345	517	345
API 10000	690	1034	690

Table 1.b - Test pressure in relation to valve pressure class
316L type stainless steels to group 2.3 of ASME B16.34

Valve pressure class	Nominal pressure (bars)	Shell tests pressure (bars)	High pressure closure tests pressure (bars)
150	15.9	23.9	17.5
300	41.4	62.1	45.5
600	82.7	124.1	91
900	124.1	186.2	136.5
1500	206.9	310.4	227.6
2500	344.8	517.2	379.3

Table 1.c - Test pressure in relation to valve pressure class
321 type stainless steels to group 2.4 of ASME B16.34

Valve pressure class	Nominal pressure (bars)	Shell tests pressure (bars)	High pressure closure tests pressure (bars)
150	19	28.4	20.9
300	49.6	74.5	54.6
600	99.3	148.9	109.2
900	148.9	223.4	163.8
1500	248.2	372.3	273
2500	413.7	620.6	455.1

Table 1.d - Test pressure in relation to valve pressure class
S 31803 (F51) type duplex stainless steel to group 2.8 of [ASME B16.34](#)
and Inconel 625 group 3.8 of [ASME B16.34](#)

Valve pressure class	Nominal pressure (bars)	Shell tests pressure (bars)	High pressure closure tests pressure (bars)
150	20	30	22
300	51.7	77.6	56.9
600	103.4	155.1	113.8
900	155.1	232.7	170.7
1500	258.6	387.8	284.4
2500	430.9	646.4	474
API 5000	345	517	345
API 10000	690	1034	690

Table 2 - Minimum duration of tests in relation to valve nominal size

The below minimum durations can be extended to COMPANY or Inspection Agency requirement as long as the stabilisation is not achieved or because of unexpected behaviour of the valve. However individual testing time is not planned to exceed 30 minutes.

Valve nominal size (inches)	Shell tests minimum duration (minutes)	Closure tests minimum duration (minutes)	
		Stabilisation time (for gas tests only)	Testing time
≤ 4	2	5	2
From 6 to 10	5	10	5
From 12 to 18	15	15	5
20 and above	30	15	5

**Table 3 - Maximum acceptable leakage rates for high pressure closure tests
(leakage rates are in cm³/min.)**

Valve nominal size (inches)	DN	Tests with water	Tests with gas (see note 2)			
		Metallic seals (according to API Spec 6D) (see note 1)	Soft seals		Metallic seals	
			Valve pressure Class ≤ 600	Valve pressure Class ≥ 900	Valve pressure class ≤ 600	Valve pressure class ≥ 900
≤ 2	50	0.31	2.5	5	10	20
2 ½	65	0.38	3.25	6.5	13	26
3	80	0.46	4	8	16	32
4	100	0.61	5	10	20	40
6	150	0.91	7.5	15	30	60
8	200	1.21	10	20	40	80
10	250	1.52	12.5	25	50	100
12	300	1.83	15	30	60	120
14	350	2.14	17.5	35	70	140
16	400	2.44	20	40	80	160
18	450	2.74	22.5	45	90	180
20	500	3.05	25	50	100	200
22	550	3.35	27.5	55	110	220
24	600	3.66	30	60	120	240
26	650	3.96	32.5	65	130	260
28	700	4.27	35	70	140	280
30	750	4.57	37.5	75	150	300
32	800	4.80	40	80	160	320
36	900	5.48	45	90	180	360
40	1000	6.00	50	100	200	400
42	1100	6.40	52.5	105	210	420
48	1200	7.30	60	120	240	480
54	1400	8.23	67.5	135	270	540
60	1500	9.14	75	150	300	600

Note 1: No leaks are acceptable for soft seals under hydrostatic closure tests.

Note 2: No leaks are acceptable for low pressure closure tests with gas whether with soft seals or with metallic seals.



2.6. Cleaning after testing

- Blind test flange removed
- Ball in half open position
- Interior of valve air-blown and dried.

After these operations, the ball must be left in fully open position, the valve ends being then sealed-off with plastic caps.

2.7. Pressure test certificate

The below pressure test certificate is only an example that does not reflect a test sequence.

A complete test certificate shall report all test performed including the seat relief test when applicable. It also shall address all tests of all valves included in one integral bolted manifolds.



Pressure tests certificate

MANUFACTURER			
PO N°		MANUFACTURER REF:	
CUSTOMER ITEM:		VALVE DESCRIPTION:	
TAG N°		SERIAL N°	
		DRAWING N°	
TESTS	ACCEPTANCE CRITERIA	TEST RESULTS	COMMENTS
HYDROSTATIC SHELL TEST			
Pressure	Table 1	P = bars	
Duration	Table 2	t = mn	
Body leak	No leakage	OK <input type="checkbox"/>	
Bonnet-cover leak	No leakage	OK <input type="checkbox"/>	
Stem leak	No leakage	OK <input type="checkbox"/>	
OPERATIONAL TORQUE TEST (to report pressure in cavity and in line, two sides)			
Valve differential pressure	$\Delta P = \dots\dots\dots$ bars	$\Delta P = \dots\dots\dots$ bars	
(Break to open case) Nm Nm	
Side A pressurised Nm Nm	
Side B pressurised Nm Nm	
Without pressure			
HIGH PRESSURE CLOSURE TEST (WATER)			
Pressure	Table 1	P = bars	
Duration	Table 2	t = mn	
Side A	Table 3	Leak rate:	
Side B	Table 3	Leak rate:	
LOW PRESSURE CLOSURE TEST (GAS)			
Pressure	5.5 bars	P = bars	
Stabilisation time	Table 2	t = mn	
Duration	≥ 2 mn	t = mn	
Side A	No leaks	Leak rate:	
Side B	No leaks	Leak rate:	
HIGH PRESSURE CLOSURE TEST (GAS)			
Pressure	Table 1	P = bars	
Stabilisation time	Table 2	T = mn	
Duration	≥ 2 mn	T = mn	
Side A	Table 3	Leak rate:	
Side B	Table 3	Leak rate:	
RESULTS:			
SATISFACTORY: YES <input type="checkbox"/>		NO <input type="checkbox"/> NON CONFORMITY REPORT N°	
	NAME	PLACE/DATE	SIGNATURE
MANUFACTURER INSPECTION			
COMPANY REPRESENTATIVE			

Appendix 8 Elastomer "O"- ring seals explosion decompression - Type testing procedure

1. Scope

This addendum covers requirements for testing the properties of resistance to explosion decompression of elastomer seals. These tests are type tests and are valid for all "O"-ring seals made of the same material, as long as their cross section size does not exceed the size of the test sample.

2. Testing principle

- a) **Purpose of the test:** This type testing includes verification of mechanical properties of "O"-rings as well as testing of their anti-explosion decompression ("AED") properties.
- b) **Size of specimens to be tested:** All specimens shall be made of "O"-rings of the maximum cross section diameter actually used in the valve supply with a minimum of 5 mm in diameter.
- c) **Nature and number of specimens:** One run of tests shall be dedicated to only one "O"-ring material. Each test run shall include five "O"-rings specimens of the same material, same compound, and same batch, which shall have been subject to the same vulcanisation treatments. These five specimens shall be used as follows:
 - All five o-rings are of either 5.33 or 6.99 mm nominal sections. Internal diameter of the two types of o-rings is fixed to 113.67 mm
 - Three samples (samples 1 to 3) shall be subject to AED tests
 - One sample (sample 4) shall be subject to tensile test
 - And one sample (sample 5) shall be kept as a spare for any possible future investigation.

3. Mechanical testing

All tests to be performed shall comply with the following [ASTM D 297](#), [ASTM D 412](#), [ASTM D 1414](#), [ASTM D 1415](#) and [ASTM D 2240](#), where applicable.

All mechanical tests shall be performed at room temperature (i.e., $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$).

The following mechanical tests shall be carried-out for each test run:

- a) **"O"-rings cross section measurement:** This measurement shall be done on all "O"-rings, including those subject to AED tests (in this case, measurements shall be made before and after the AED tests). The measurement method shall comply with [ASTM D 1414](#), section 7. The measurement points shall be a minimum of 4, equally spaced on the outer surface of each "O"-ring.
- b) **"O"-rings weight measurement:** This measurement shall be done on all "O"-rings, including those subject to AED tests (in this case, measurements shall be made before and after the AED tests). Weight shall be measured using an analytical weighing apparatus, of a precision of ± 0.1 mg maximum.
- c) **Rubber density:** These measurements shall be made before and after the AED tests, according to [ASTM D 1414](#) and [ASTM D 297](#), using an hydrostatic weighing apparatus of a precision of ± 0.1 mg maximum.

- d) **“O”-rings superficial hardness:** These measurements shall be made before and after the AED tests, according to [ASTM D 1414](#) and [ASTM D 1415](#) (IRHD testing method) or [ASTM D 2240](#) (Shore A testing method). The measurement shall be made after 15 seconds following the indenter penetration.
- e) **“O”-rings tensile test:** This test shall be made on both the sample 4 (i.e., on the “O”-ring not subject to AED tests), and on one “O”-ring which has been subject to AED tests, after these tests are completed (either sample 1, 2, or 3). Tensile and elongation tests shall be performed on an entire “O”-ring using an adequate dynamometer and load cell. The tensile modulus shall be calculated at 100% deformation. Testing method shall comply with [ASTM D 412](#).

4. Explosion decompression testing procedure

- a) **Test facilities:** The testing facilities shall be approved by the COMPANY. All testing devices used for anti-explosion decompression testing shall be located in a safe area (ideally a locked room) dedicated to this purpose only, equipped with a proper outer vent system in order to cope with any gas leakage including those produced during the gas depressurisation phases of the tests. The complete test run shall be placed under the full responsibility of only one single operator.
- b) **Test equipment:** The test equipment shall be made of a pressure vessel of a sufficient volume (3 litres minimum) with flanges of sufficient dimensions to receive the specimens to be tested. The devices used for decompression monitoring (i.e., needle valves or other type of valves) shall be calibrated prior to starting the tests. These devices shall be sized to allow for a full decompression all along the required 90 seconds in a linear mode all along the depressurisation.
- c) **Test medium:** The test medium shall be a mixture of natural gas comprising 80% methane and 20% CO₂. The gas mixture shall be obtained exclusively from bottles filled to the required nominal composition, i.e. loaded with the mixture of 80% methane and 20% CO₂. A booster pump may be necessary in order to reach the required test pressure. The capacity of the bottles shall be of a sufficient volume in order to carryout the required testing cycles, and in any case replacement of bottles shall not be permitted during a soaking phase. Gas analysis shall be done at the inlet and outlet of the testing chamber.
- d) **Installation of the specimens in the test vessel:** The specimens shall be installed on the pressure vessel as flange seals, exclusively in a groove, and shall be submitted to an axial compression and a groove filling limited to 13.5% and 73% maximum respectively. Actual groove size and compression rate shall be reported.
- e) **Procedure:** The testing shall consist in five cycles. The duration of the first cycle shall be 78 hours followed by four other ones of 48 hours each. The temperature is maintained at 75°C all along under a pressure of 190 bars minimum. After each soaking period, the pressure must be rapidly decreased to atmospheric pressure, in 90 seconds maximum. A one hour stand-by period is maintained between each cycle. The procedure shall include full monitoring and computerised record of both inlet and outlet pressures, as well as temperature of the test vessel during the five testing cycles (including decompression phases). The test temperature must be taken at the tested “O”-ring location or close to it. During the soaking periods, the variation of the inlet pressure shall be less than ± 2 bars(g) and the variation of the test vessel temperature shall be less than $\pm 2^\circ\text{C}$.

f) Test sequence: Tests shall be conducted in the following order:

- Clean the test vessel and housings
- Install test seals, clean
- Purge the test vessel with nitrogen
- Fill the test vessel by replacing the purged gas with the test gas
- Heat the test vessel to the specified temperature
- Increase the pressure to the test pressure value requirement
- Maintain test pressure and temperature for the specified duration
- Depressurise the equipment
- One hour stand-by at zero pressure
- Repeat this sequence five times
- Replace the test gas by nitrogen for purging, within 24 hours maximum
- Open the test vessel and perform an immediate visual examination of the seals.

5. Inspection and testing

Following the last decompression cycle, the specimens shall be removed from the test vessel within no more than 24 hours, this time being necessary for final inerting and cooling.

An optical macroscopic examination at a magnification of 10 and 20 of the specimens shall be made immediately after removal of the specimens. No visible cracks, splitting, blistering, swelling, or channelling shall be shown. Additionally, any changes in volume, weight, density, tensile strength, elongation, modulus and hardness shall be measured and reported.

Additionally each of three o-rings is cut in four segments and defects are rated according to NORSOK standard M710.

6. Reporting

Testing reports [EN 10204](#) (type 3.1) must be sent to the COMPANY for approval and shall be attached to the Valve documentation.

The test reports shall include:

- A schematic diagram of the testing installation and main features of the testing apparatus
- The pressure and temperature cycles chart records with time scale for the complete five cycled tests
- The material data sheet issued by the “O”-rings Manufacturer
- Macro examination photographs for the three “AED” tested “O”-rings. The photographs shall be original colored digital pictures or laser copies, and shall show the samples before and after “AED” tests at the two required magnifications of 10 and 20. The most significant areas shall be shown.
- The mechanical test report including details as required by the applicable standards, and conforming to the format attached hereafter
- The tensile test elongation chart record.

Mechanical tests results on elastomer "O"-rings

Material		Date of tests	
Batch identification number		Name and Signature of the Inspector	

a) Before AED tests

"O"-ring physical characteristics	Sample 1	Sample 2	Sample 3	Mean value
Cross-section (mm)				
Inside diameter (mm)				
Weight (g)				
Density (g/cm ³)				
Shore A hardness after 15 sec.				
IRHD hardness after 15 sec.				

"O"-ring mechanical characteristics (on sample 4)	value
Tensile strength (MPa)	
Ultimate elongation (%)	
Tensile strength at 100% elongation (MPa)	

b) After AED tests

"O"-ring physical characteristics	Sample 1	Sample 2	Sample 3	Mean value
Cross-section (mm)				
Inside diameter (mm)				
Weight (g)				
Density (g/cm ³)				
Shore A hardness after 15 sec.				
IRHD hardness				

"O"-ring mechanical characteristics (on sample 1, 2 or 3)	value
Tensile strength (MPa)	
Ultimate elongation (%)	
Tensile strength at 100% elongation (MPa)	

Appendix 9 Valve data sheet form

Valve data sheet no.

Item	Company item number	Valve tag number	(For actuated valves)
Valve type	(Ball, Gate, Globe, Check, etc.)	Piping class	(Re. GS EP PVV 112)
Service class	(Re. GS EP PVV 142 table 2.6)	Min/Max operating temp °C	
Pressure class	(Re. ASME B16.34)	Min/Max design temp °C	
Size	(Nominal diameter in inches)	Main Fluid	(Indicate whether liquid or gas and nature)
Bore	(FB or RB)	H ₂ S max content (%)	
Internal bore (mm)	(For pipeline valves)	Methanol max content (if > 5% only)	
Valve installation position		CO ₂ max content %	
		Solid particles in fluid	
		Line acid treatment	

Design		Metallic Materials	
Body construction	(Side or top entry)	Body	
Floating ball or trunnion		Ball	
Disc type		Disc	
Operation	(Actuator or manual)	Stem/trunnion	
Gear operator		Seats	
End connection		Bolts	
Face/Face dimensions		Internal Seals Materials	
		"O"-rings	
		Stem seals	
		Seat inserts	
		Seat springs	Type and material

Appendix 10 Actuated valves detailed torque table form

Valve item/TAG number:						
Actuator model:						
Maximum valve differential pressure (bars)		Maximum actuator supply pressure (bars) (4)		Minimum actuator supply pressure (bars)		Safety factor (6)
Valve opening break torque (Nm)		Actuator opening break torque (Nm)		Actuator opening break torque (Nm)		
Valve opening running torque (Nm)		Actuator opening running torque (Nm)		Actuator opening running torque (Nm)		
Valve opening end torque (Nm)		Actuator opening end torque (Nm)		Actuator opening end torque (Nm)		
Valve closing break torque (Nm)		Actuator closing break torque (Nm)		Actuator closing break torque (Nm)		
Valve closing running torque (Nm)		Actuator closing running torque (Nm)		Actuator closing running torque (Nm)		
Valve closing end torque (Nm)		Actuator closing end torque (Nm)		Actuator closing end torque (Nm)		
		Maximum actuator allowable pressure (bars) (5)				
Maximum allowable valve torque (Nm) (2)		Maximum actuator output				

Notes:

- (1) All torque values are subject to test checks in MANUFACTURERS premises prior to acceptance of the related equipment.
- (2) This value must be justified by appropriate calculations and shall be submitted to Total for approval.
- (3) This value corresponds to the actuator stall at the maximum air supply pressure.
- (4) This value may be equal to the maximum regulated pressure on the actuator provided a safety valve is supplied on the related actuator.
- (5) This is the maximum allowable working pressure of the actuator, i.e. the maximum pressure that can be applied to it without damage.
- (6) The safety factor is the ratio of the actuator output torque at the minimum supply pressure over the valve required torque at the maximum differential pressure. This value must be a minimum of 1.30, unless larger values are specified in the requisition or in the valve data sheets.