

TECHNICAL SPECIFICATION

VALVES – GENERAL REQUIREMENTS

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PART I INTRODUCTION

1.1 SCOPE

This MESC SPE specifies general requirements for valves. It contains requirements for materials, heat treatment, corrosion testing, welding, NDE and certification (see Part II).

This specification shall apply in addition to the applicable MESC Buying Description, purchase order or requisition sheet.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this MESC SPE is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This MESC SPE is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and, where applicable, supply/distribution installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this MESC SPE the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this MESC SPE which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this MESC SPE as closely as possible.

1.3 DEFINITIONS

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Inspector** is the party appointed by the Principal to check that the products supplied comply with this MESC SPE.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. Under SPC, a process behaves predictably to produce as much conforming product as possible within defined control limits, with the least possible waste. SPC is applied to controlling manufacturing lines and to any process with a measurable output. Key tools in SPC are control charts, a focus on continuous improvement and designed experiments. In order to avoid over-application of inspection and testing per batch, particularly for smaller batches, pro-active application of statistical process control of parameters which are critical to the manufacturer to produce goods to the intended quality level is deemed a strong enabler to achieve product quality. Statistical process control can be demonstrated by e.g. satisfactory tests carried out for other customers. In case no other formal NDE is required,

when SPC is specified, periodic sampling and testing of materials supplied is expected (i.e. less than 100%). ISO 11462 and ISO 2859/ISO 3951 provide further guidance for the implementation of SPC and sampling procedures. Statistical process control is different from the required NDE (resulting in certificates submitted with the order), in that records shall be auditable but records do not need to be submitted with every order.

1.4 CHANGES SINCE PREVIOUS EDITION

The previous edition of this MESC SPE was dated February **2019**. **The main changes are to clarify Quality Specification Level (QSL) requirements in case two Quality Specification Levels are specified in the MESC buying descriptions**

1.5 COMMENTS ON THIS MESC SPE

Comments on this MESC SPE may be sent to the MESC SPE Administrator at MESC@shell.com.

PART II VALVE GENERAL REQUIREMENTS

1. INTRODUCTION

The requirements specified in this part are the general requirements for valves.

2. MATERIAL REQUIREMENTS

2.1 CHEMICAL COMPOSITION

2.1.1 General

Unless specified otherwise, the restrictions in the chemical composition contained in clauses 2.1.2 through 2.1.8 apply to the pressure containing parts of the valve (body, bonnet and cover) and the stem for each valve.

2.1.2 Carbon steel

Carbon steel forgings to ASTM A105 and to ASTM A350 Grade LF2 Class 1 shall have the following restrictions in their chemical composition:

- The carbon content shall not exceed 0.23 %.
- The carbon equivalent (CE) shall not exceed 0.43.
- The Silicon content of ASTM A105 shall not be lower than 0.15 %wt.

Carbon steel castings to ASTM A216 Grades WCB and WCC and to ASTM A352 Grade LCC shall have the following restrictions in their chemical composition:

- The carbon content shall not exceed 0.25 %.
- The carbon equivalent (CE) shall not exceed 0.43.

The carbon equivalent (CE) shall be calculated with the following formula:

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

2.1.3 1.25Cr-0.5Mo steel

The chemical composition of 1¼Cr-½Mo forgings to ASTM A182 Grade F 11 base materials shall meet the following additional chemical requirements by heat analysis:

Element	C	P	S	Cu	Ni	X-bar
Max allowed	0.15%	0.012 wt%	0.007 wt%	0.20%	0.30%	14 ppm

X-bar shall be calculated with the following formula:

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

If meeting the above requirement leads to unacceptable lead times or cost increase, F22 material may be selected for: 350 °C (750 °F) ≤ design temperature ≤ 450 °C (840 °F). In case the design temperature exceeds 450 °C (840 °F), F22 material compliant with additional requirements in accordance (2.1.4) may be selected. F11 materials not meeting above

chemical composition requirements shall not be accepted in case the design temperature exceeds 350 °C (750 °F).

Unless specified otherwise, 1.25Cr-0.5Mo castings to ASTM A217 Grade WC6 shall have the following restriction in the chemical composition:

- The phosphorous content shall not exceed 0.010 %.

2.1.4 2.25Cr-1.0Mo steel

Except where steam service is designated in the MESC specification, or unless specified otherwise, the restrictions in the chemical composition of 2.25Cr-1.0Mo forgings to ASTM A182 Grade F22 shall be one of the following two options:

1. The carbon content shall not exceed 0.14 % and both the phosphorous and sulphur content shall not exceed 0.010 %.
2. The J-factor shall be calculated in accordance with API 934 and shall not exceed 120.

For valves furnished to ASTM A182 Grade F22 where steam service is designated in the MESC specification, the following shall apply:

1. The J-factor shall be calculated in accordance with API 934 and shall not exceed 180.

2.1.5 Austenitic stainless steel

For valves with a design temperature ≤ 450 °C (≤ 840 °F), the carbon content of austenitic stainless steel forgings to ASTM A182 Grade F316 and castings to ASTM A351 Grade CF8M shall not exceed 0.03 % by mass, except a carbon content up to 0.08 % by mass is permissible under the following conditions:

1. If the material is stabilised with niobium through substitution with ASTM A351 grade CF10MC, or
2. If the material is stabilised with titanium through substitution with ASTM A182 grade F316Ti, or
3. For components that contain no welds: if the valve design temperature is ≤ 427 °C (≤ 800 °F), or
4. For valve bodies and bonnets, of designs without welded bonnet or other fabrication welds, where the valve design temperature is ≤ 427 °C (≤ 800 °F), cast to ASTM A351: if additional requirement S50 is applied (post weld solution heat treatment after casting repairs) - before Stellite if applicable.
 - a. Minor repair by welding without solution heat treatment is acceptable, provided it is in the gasket seating area (under compressive load and not wetted). The cumulative size of all repairs on one face shall be smaller than twice the size of imperfections allowed by ASME B16.5.

For applications having a design temperature greater than 450 °C (840 °F) and up to and including 816 °C (1500 °F), the following applies:

1. Castings to ASTM A351 Grade CF8M: supplementary requirement S50 applies and in addition all castings require corrosion testing per ASTM A262, Practice E.
2. Forgings to ASTM A182, bars to ASTM A479 and plates to ASTM A240 for Grade F316H: repair by welding is not permitted and in addition corrosion testing per ASTM A262, Practice E shall be executed as statistical process control.

2.1.6 Duplex stainless steel

All duplex stainless steel castings, forgings and bar material (not limited to pressure containing parts) shall have the following restrictions in the chemical composition:

1. For “22Cr” duplex (austenitic-ferritic) stainless steels, the Pitting Resistance Equivalent (PREN) shall be 34 or higher and the Mo mass fraction (wMo) 2.5% or higher and the N fraction (wN) 0.14% or higher.
2. For “25Cr” super duplex (austenitic-ferritic) stainless steels, the Pitting Resistance Equivalent (PREN) shall higher than 40 and the N fraction (wN) 0.20% or higher.
3. The PREN shall be calculated as given in Equation (1):

$$\text{PREN} = \text{wCr} + 3.3(\text{wMo} + 0.5\text{wW}) + 16\text{wN} \quad (1)$$

where

- wCr is the mass fraction of chromium in the alloy, expressed as a percentage mass fraction of the total composition;
 - wMo is the mass fraction of molybdenum in the alloy, expressed as a percentage mass fraction of the total composition;
 - wW is the mass fraction of tungsten in the alloy, expressed as a percentage mass fraction of the total composition;
 - wN is the mass fraction of nitrogen in the alloy, expressed as a percentage mass fraction of the total composition.
4. Per lot, one product analysis shall be made. One lot is defined as a group of valves of similar dimensions, manufactured from one heat of material and heat treated as one heat treatment batch.

Duplex stainless steel castings to ASTM A890 and ASTM A995 Grade 4a shall have the following restrictions in the chemical composition:

1. The U-factor shall be at least 25.
2. The U-factor shall be calculated with the following formula:

$$U = -43.64 + (4.76 \cdot \text{Si}) + (2.65 \cdot \text{Cr}) + (3.44 \cdot \text{Mo}), \text{ with the values in } \%$$

Manufacturer shall be qualified according to NORSOK M-650 or through the TAMAP audit process. NORSOK M-650 certification (if applicable) shall be submitted as part of documentation.

2.1.7 Alloy 825

Alloy N08825 (Alloy 825) shall be supplied with Nickel content greater than 39% and a PREN greater than 30.

2.1.8 Other materials

The restrictions in the chemical composition of other materials shall conform to:

1. Castings to ASTM A487-CA6NM and ASTM A743-CA6NM shall have a carbon content of 0.03 % maximum.
2. Castings to ASTM A351-CN7M, ASTM A743-CN7M and ASTM A744-CN7M shall have a carbon content of 0.03 % maximum and a sulphur content of 0.02 % maximum.

2.2 HEAT TREATMENT

2.2.1 General

All heat treatment procedures shall be subject to a statistical process control (see 1.3) to ensure that the final material properties comply with the applicable material standard and this MESC SPE. Statistical process control is not required for heat treatment records that are supported by a type 3.1 certificate.

Post-weld heat treatment (PWHT) shall be performed as required in the applicable material standard. Unless specified otherwise, PWHT only applies to all welds affecting the integrity of the pressure retaining boundary and does therefore not necessarily apply to tack welds, seal welds or attachment welds such as those for backseat bushings, seat rings, lifting lugs and auxiliary connections.

2.2.2 Carbon steel

Carbon steel forgings to ASTM A105 shall be furnished in the normalised condition or quenched and tempered condition. Forgings produced in accordance with ASTM A105 furnished in the quenched and tempered condition, shall at least show a microstructure equal to the normalized condition, and shall be able to meet additional requirement S1.1.

2.2.3 Cr-Mo steel

Cr-Mo forgings and castings of flanged-end valves and butt-weld-end steam service valves shall be furnished in the normalised and tempered condition.

Except where steam service is designated in the MESC specification, forgings and castings of welded-end valves shall conform to either of the following two options:

1. The forgings and castings shall be supplied in the normalised and tempered condition. The tempering temperature shall be $740^{\circ}\text{C} \pm 8^{\circ}\text{C}$ ($1365^{\circ}\text{F} \pm 13^{\circ}\text{F}$). The forgings and castings shall be furnished in the post weld heat treated condition if fabrication welding or weld repair has been carried out. The post weld heat treatment temperature shall be $715^{\circ}\text{C} \pm 10^{\circ}\text{C}$ ($1318^{\circ}\text{F} \pm 18^{\circ}\text{F}$). The tensile properties shall be in accordance with the material standard.
2. The forgings and castings shall be supplied in the normalised and tempered condition. The minimum tempering temperature shall be 720°C (1330°F). The forgings and castings shall be furnished in the post weld heat treated condition if fabrication welding or weld repair has been carried out. After all processing, one sample from each heat shall undergo three simulated PWHT cycles at $730^{\circ}\text{C} \pm 8^{\circ}\text{C}$ ($1345^{\circ}\text{F} \pm 14^{\circ}\text{F}$) with a holding time as per ASME B31.3 Table 331.1.1 for each cycle. Tensile tests according to the material standard shall be performed after each cycle. If results from all tests are conform to the material standard, all forgings and castings from that heat are accepted.

2.2.4 Austenitic stainless steel

Austenitic stainless steel forgings and castings shall be furnished in the solution heat-treated condition.

Heat treatment of CN7M castings shall be held at the solution annealing temperature for 1 hour per inch of thickness with a minimum hold time of 1 hour.

If specified for type 321, 321H, 347, 347H, 348, 348H, CF8C or CF10MC, austenitic stainless steel forgings and castings shall be subjected to a stabilisation heat-treatment with a stabilising temperature between 870°C (1598°F) and 900°C (1652°F), and a duration of 4 hours.

2.2.5 Duplex stainless steel

The heat treatment of (super) duplex (austenitic – ferritic) stainless steel forgings, bar and castings shall comply with the following:

1. Forgings, castings or bars shall be solution annealed at a temperature that is within the temperature range specified in the applicable material standard, for a minimum of 30 minutes per inch of thickness or a minimum of one hour, whichever is the greater.
2. The thickest section of the forging, casting or bar shall be used to determine the soak time at the solution annealing temperature.
3. Immediately (within 60 seconds) after solution annealing, forgings, castings or bars shall be water quenched. The start and end temperature of the quenching water shall not exceed 40 °C (104 °F). The temperature of the quenching water shall be recorded during quenching and not exceed 50 °C (122 °F).
4. The Manufacturer may submit an alternative solution annealing procedure for review and approval by the Principal.

2.2.6 13Cr steel

The heat treatment of 13Cr castings to ASTM A487-CA6NM shall consist of normalising and double tempering as follows:

1. Austenitising at 1010 °C (1850 °F) to 1065 °C (1950 °F), followed by air-cooling to room temperature.
2. Intermediate tempering at 675 °C (1250 °F) ± 15 °C (± 25 °F), followed by air-cooling to room temperature.
3. Final tempering at 610 °C (1125 °F) to 620 °C (1150 °F), followed by air-cooling to room temperature.

2.2.7 Nickel alloys

1. Nickel alloy castings to ASTM A494 Grade N-7M shall be solution annealed at 1180 °C [–10 °C / +20 °C] (2156 °F [–18 °F / +36 °F]), after PWHT. Annealing at other temperatures may be accepted, provided the qualification tests show that this leads to a fully solution annealed structure that is free of precipitates. This is subject of approval by the Principal.
2. If specified, PWHT for Alloy 400 forgings to ASTM B564 UNS N04400 or castings to ASTM A494 Grade M35-1, shall be carried out at 590 °C (1094 °F) for at least 1 hour.
3. Valves manufactured from Cast ASTM A494 CY-40 CLASS 2 shall be capable of withstanding the Pressure Temperature ratings in accordance with ASME B16.34 group 2.4. Each heat of material shall be subjected to a hot yield test at 300 °C (572 °F) with a minimum yield strength value of 150 MPa (21.8 ksi).
4. Valves manufactured from Cast ASTM A494 CU5MCuC shall be capable of withstanding the Pressure Temperature ratings in accordance with ASME B16.34 group 3.8. Each heat of material shall be subjected to a hot yield test at 400 °C (752 °F) with a minimum yield strength value of 192 MPa (27.8 ksi).

2.3 IMPACT TESTING

2.3.1 General

Impact testing is required where this is a requirement of the applicable standard specification or design code such as ASME B31.3. Exemption from impact testing or relaxation of the minimum impact toughness requirement as permitted in the design codes, when the design stress is reduced relative to the allowable stress, shall only be invoked with the approval of the principal.

A minimum of one set of impact tests, comprising of three individual tests, shall be performed on a representative test bar of each heat of the material in the final heat-treated condition.

Test specimens shall be cut from a separate or attached block taken from the same heat, reduced by forging where applicable, and heat-treated to the same heat treatment, including stress-relieving, as the product materials, except that it is not necessary to retest pressure-containing parts stress-relieved at or below a previous stress-relieving or tempering temperature.

Impact test specimens shall be located at mid thickness.

Where sub-size specimens are permitted or necessary, the required absorbed energy shall be adjusted accordingly by the ratio of the specimen width parallel to the notch to the width of a full-size specimen (10mm) as indicated in ASTM A370.

Additional requirements for quality control purposes are given here for certain valve materials.

For the impact values of material types and grades listed below, below listed values shall prevail.

2.3.2 Carbon steel

Impact testing is required for pressure containing parts of low temperature carbon steel forgings and castings, in cases indicated in the ASTM standard or the applicable design code.

Low temperature carbon steels valves shall be impact tested at a temperature of minus 50 °C (minus 58 °F). Impact test results as an average of three tests shall be at least 27 J for standard size specimen (10 mm x 10 mm). Only one result may be lower than 27 J, but it shall be at least 21 J.

Alternatively, the impact tests may be carried out at minus 46 °C (minus 50 °F) but the impact test results as an average of three tests shall be at least 33 J (24 ft.lbs) for standard size specimens (10 mm x 10 mm). Only one result may be lower than 33 J (24 ft.lbs), but it shall be at least 27 J (20 ft.lbs).

If nuts of grade 4, 7 or 7M are specified, ASTM A194 Supplementary Requirement S3 shall apply.

2.3.3 Austenitic Stainless Steel

Where lower design temperature is indicated as below -101 Deg C, welds are to be made in accordance with a welding procedure qualified by impact testing as required by ASME B31.3.

Where XM-19 materials are offered for parts of valves with a minimum design temperature lower than -29 °C (-20 °F), these parts shall be subject to impact tests in accordance with ASTM A370 at the minimum design temperature. Impact test results as an average of three tests shall be at least 27 J for standard size specimen (10 mm x 10 mm). Only one result