

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 158

**Material and special process for valves
(MDS & manufacturing processes)**

00	11/2018	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/IP/TEC	Managing entity: DSO/IP/TEC/PVV
Other Approving entity(ies):	

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 2 of 74

Contents

1. Scope	4
2. Reference documents	5
3. Terms, Definitions, Acronyms and Abbreviations	8
3.1 Terms and Definitions	8
3.2 Acronyms and Abbreviations	8
4. Valve Material Data Sheets	10
4.1 General	10
4.2 MDS Numbering System	10
4.3 Implementation of Statutory Regulations	11
4.4 Ferritic/austenitic Stainless Steels (MDS VDX series)	11
4.5 Mechanical Testing	11
4.6 Machining of Valve Components from Bar	11
4.7 NDE of Valve Components	12
4.8 Pilot Castings	12
4.9 Carbon Steel Valves	13
4.10 Austenitic Stainless Steel Valves	13
4.11 Toughness Test Requirements	13
4.12 Casting Material	14
4.13 Repair	15
4.14 NDE of Castings	16
4.15 NDE of Forged Materials and Bars	18
5. Electroless Nickel Plating	18
6. Tungsten Carbide Coating	19
7. Weld overlay procedure for seal pockets and seal contact surface of obturators	19
Bibliography	20
Appendix 1 Valve Material Data Sheets	21
Appendix 2 Electroless nickel plating procedure	65



General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 3 of 74

Appendix 3	Tungsten carbide coating procedure	67
Appendix 4	Alloy 625 or SS TP 316L - Weld overlay procedure for seal pockets and seal contact surface on obturators	71

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 4 of 74

1. Scope

This specification prescribes, for onshore or offshore facilities, requirements for materials and specific processes for the most commonly used components for use in valves for Normal, High Pressure, Low Temperature or Category D fluid service as defined in [ASME B31.3](#).

This specification is not necessarily suitable for services defined in [ASME B31.3](#) as Category M fluid service, elevated temperature fluid service, high purity fluid service, severe cyclic conditions and design to codes or standards other than those listed in this specification.

This specification addresses specific minimum requirements for materials exposed to sour environments as defined in [ISO 15156 / NACE MR 0175](#).

However, this specification does not provide guidelines for material selection and the selection of suitable materials for a specific service including any necessary additional material requirements remains the responsibility of the end (equipment) user.

The material data sheets cover the following material types:

- Non-impact tested carbon steel (CS - Carbon Steel)
Note: Non-impact tested carbon steel terminology addresses material usually non-impact tested from ASTM.
- Impact tested carbon steel (LTCS - Low Temperature Carbon Steel)
- Ferritic/austenitic stainless steel: types 22Cr duplex and 25Cr duplex
- Austenitic stainless steel: type 316/316L, type 304/304L
- Nickel base alloys: type 625
- High strength, low alloy steels.

In the event of a conflict between this specification and a relevant local law or regulation, the relevant law or regulation shall be followed. If this Specification creates a higher obligation, it shall be followed as long as this also achieves full compliance with the law or regulation. The end user is responsible for specifying any appropriate additional requirements necessary to meet the design and design code or specification and local law or regulation.

This standard is not intended to preclude the use of alternative generic materials or grades within a referenced standard specification. Where the use of alternative materials/grades are considered appropriate, the end user is responsible for specifying any additional requirements necessary to meet design and design code or specification.

However, the selection of suitable materials for a specific service remains the responsibility of the end (equipment) user.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 5 of 74

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
ANSI/MSS SP-55	Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components - Visual Method for Evaluation of Surface Irregularities
API SPEC 6D	Specification for Pipeline and Piping Valves
ASME B16.34	Valves - Flanged, Threaded and Welding End
ASME B31.3	Process Piping
ASME BPVC Section IX	ASME Boiler and Pressure Vessel Code (BPVC) - Section IX: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators
ASME BPVC Section V	ASME Boiler & Pressure Vessel Code - Section V: Non destructive Examination
ASME BPVC Section VIII Div 1	ASME Boiler & Pressure Vessel Code - Section VIII: Rules for Construction of Pressure Vessels - Division 1: Pressure Vessels
ASNT SNT-TC-1A	Recommended practice for personal qualification and certification in nondestructive testing
ASTM A105/A105M	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A1058	Standard Test Methods for Mechanical Testing of Steel Products-Metric
ASTM A182/A182M	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Se
ASTM A216/A216M	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A276/A276M	Standard Specification for Stainless Steel Bars and Shapes
ASTM A29/A29M	Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
ASTM A350/A350M	Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 6 of 74

Reference	Title
ASTM A351/A351M	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A479/A479M	Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A488/A488M	Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel
ASTM A494/A494M	Standard Specification for Castings, Nickel and Nickel Alloy
ASTM A609/A609M	Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof
ASTM A694/A694M	Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
ASTM A696	Standard Specification for Steel Bars, Carbon, Hot-Wrought or Cold-Finished, Special Quality, for Pressure Piping Components
ASTM A703/A703M	Standard Specification for Steel Castings, General Requirements, for Pressure-Containing Parts
ASTM A781/A781M	Standard Specification for Castings, Steel and Alloy, Common Requirements, for General Industrial Use
ASTM A788/A788M	Standard Specification for Steel Forgings, General Requirements
ASTM A957/A957M	Standard Specification for Investment Castings, Steel and Alloy, Common Requirements, for General Industrial Use
ASTM A961/A961M	Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
ASTM A985/A985M	Standard Specification for Steel Investment Castings General Requirements, for Pressure-Containing Parts
ASTM A995/A995M	Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts
ASTM B446	Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06650) Rod and B
ASTM B564	Standard Specification for Nickel Alloy Forgings

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 7 of 74

Reference	Title
ASTM B733	Standard Specification for Autocatalytic (Electroless) Nickel-Phosphorus Coatings on
EN 10204	Metallic products - Types of inspection documents
ISO 10474	Metallic products - Inspection documents
ISO 11970	Specification and qualification of welding procedures for production welding of steel castings
ISO 148-1	Metallic materials - Charpy pendulum impact test - Part 1: Test method
ISO 15156 (All parts)	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - All parts
NACE MR 0175	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production
ISO 15614-7	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 7: Overlay welding
ISO 17781	Petroleum, petrochemical and natural gas industries - Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels
ISO 17945 / NACE MR 0103	Petroleum, petrochemical and natural gas industries - Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments
ISO 4527	Metallic coatings - Autocatalytic (electroless) nickel-phosphorus alloy coatings - Specification and test methods
ISO 6892-1	Metallic materials - Tensile testing - Part 1: Method of test at room temperature
ISO 9001	Quality Management Systems-Requirements
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP PVV 154	Ball Valves according to API SPEC 6D or API SPEC 6A
GS EP PVV 611	Welding of pressure containing piping and equipment

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 8 of 74

3. Terms, Definitions, Acronyms and Abbreviations

3.1 Terms and Definitions

3.1.1 Stainless steel type 304 and 316

Austenitic stainless steel certified to meet both 304/304L or 316/316L properties.

3.1.2 Stainless steel type 22Cr duplex

Ferritic/austenitic stainless steel alloys with $30 \leq \text{PREN} < 40$ and $\text{Cr} \geq 19\%$ (by mass).

3.1.3 Stainless steel type 25Cr duplex

Ferritic/austenitic stainless steel alloys with $40 \leq \text{PREN} < 48$, often referred to as "super duplex".

3.1.4 Pilot Casting

Casting made and tested as part of the initiation and development of the production method such as the first casting from a new or modified pattern produced using identical foundry practices as the production castings it is intended to represent.

3.1.5 Nominal pipe size

Numerical designation of size in inches which is common to components in piping systems.

3.1.6 End (equipment) user

Company or organisation (normally an oil company) that is responsible for the operation of an installation/facility and its component (e.g. piping, valve, etc.).

3.1.7 Purchaser

Party which purchases a product from a Manufacturer. In the context of this specification an oil Company, contractor or buyer are Purchasers.

3.1.8 Manufacturer (material)

Party, including subcontractors, which carries out operations (e.g. forming, heat treatment, welding, etc.) which affect the material properties of the finished product.

3.2 Acronyms and Abbreviations

The following acronyms and abbreviations apply for this specification and are presented alphabetically.

ACCP	ASTN Central Certification Program
ANSI	American National Standards Institute
AOD	Argon Oxygen Decarburisation
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 9 of 74

ASNT	American Society for Nondestructive Testing
ASTM	American Society of Testing and Materials
BPVC	Boiler and Pressure Vessel Code
CE	Carbon Equivalent $(\% C + \% Mn / 6 + (\% Cr + \% Mo + \% V) / 5 + (\% Ni + \% Cu) / 15)$
CLR	Crack Length Ratio
CS	Carbon Steel
CSR	Crack Sensitivity Ratio
CTR	Crack Thickness Ratio
DN	Nominal Diameter
EBW	Electron Beam Welding
EDS	Element Data Sheet
EEMUA	Engineering Equipment & Materials Users Association
EN	European Norm (standard)
FCAW	Flux-Cored Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat-Affected Zone
HBW	Brinell hardness with Tungsten ball
HIC	Hydrogen-Induced Cracking
HIP	Hot Isostatic Pressing
HR	Rockwell Hardness
HRB	Rockwell Hardness, B scale
HRC	Rockwell Hardness, C scale
HV	Vickers Hardness
HVOF	High Velocity Oxygen Fuel
ISO	International Organization for Standardization
LBW	Laser Beam Welding
LTCS	Low temperature carbon steel
MDS	Material data sheet
MSS	Manufacturers Standardization Society
MT	Magnetic-particle Testing
NACE	National Association of Corrosion Engineers
NDE	Non-Destructive Examination

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 10 of 74

NPS	Nominal Pipe Size
OD	Outer Diameter
PREN	Pitting Resistance Equivalent Number (%Cr + 3.3 x % (Mo + 0.5W) + 16 x %N)
PSL	Product Specification Level
PT	Penetrant Testing
PTAW	Plasma Transfer Arc Welding
PWHT	Post Weld Heat Treatment
QSL	Quality Specification Level
RT	Radiographic Testing
SAW	Submerged Arc Welding
SMAW	Shielded-Metal Arc Welding
SMYS	Specified Minimum Yield Strength
TCC	Tungsten Carbide Coating
UNS	Unified Numbering System
UT	Ultrasonic Testing
VT	Visual Testing

4. Valve Material Data Sheets

4.1 General

The material data sheets are collated in Annex A. MDSs define applicable options and/or requirements that supplement or amend the referenced material standard or specification. The material shall be delivered in accordance with the standard specification referenced in the MDSs including any additional requirements specified therein. Unless otherwise specified in the MDSs, all the requirements of the referenced standard specification shall apply. The latest issue of the referenced standard specification at the time of use shall apply.

4.2 MDS Numbering System

Each MDS number consists of a two-letters prefix followed by a two-digits sequential number. The first letter is fixed and consists of the letter "V" to indicate a Valve MDS.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 11 of 74

The 2nd letter identifies the type of material with the following interpretation:

- C - carbon steels
- D - ferritic/austenitic stainless steels, type 22Cr duplex, type 25Cr duplex
- N - nickel base alloys
- O - overlay welding, corrosion – resistant
- S - austenitic stainless steels: type 316/316L
- X - high strength low alloyed steels.

4.3 Implementation of Statutory Regulations

This specification is not intended to address any statutory regulations. The responsibility for complying with any such statutory regulations and the specification of any further additional requirements is the responsibility of the end (equipment) user.

4.4 Ferritic/austenitic Stainless Steels (MDS VDDX series)

The compositional and microstructural requirements including ferrite content and acceptance criteria for intermetallic phases and precipitates in parent material and welds are specified in accordance with [ISO 17781](#). Compliance with the [ISO 17781](#) is considered to fulfil the microstructural requirements of [ISO 15156-3 / NACE MR 0175](#).

4.5 Mechanical Testing

Tensile testing shall in general be carried out in accordance with the referenced standard specifications in the respective MDS. Where testing to [ASTM A370](#) is specified, testing in accordance with [ISO 6892-1](#) is considered equivalent and thereby also acceptable. The elongation shall be measured and reported in accordance with the selected tensile test standard [ASTM A370](#) or [ISO 6892-1](#). For specimens to [ASTM A370](#) the gauge length shall be 50 mm as far as is practically possible.

Impact testing shall, in general, be carried out in accordance with the referenced standard specifications in the respective MDS. Where testing to [ASTM A370](#) is specified, testing in accordance with [ISO 148-1](#) using a striker radius of 8 mm is considered equivalent and thereby also acceptable.

The test temperature for carbon and duplex stainless steels is in general specified to be minus 46°C. The use of a lower test temperature is acceptable, but the specified minimum absorbed energy shall apply unless otherwise agreed with the end (equipment) user.

4.6 Machining of Valve Components from Bar

When allowed by the product standard specifications, hollow cylindrically shaped parts, including valve bodies for weld-end and integral flanged valves and pressure-controlling parts of valves, may be manufactured from cylindrically shaped bars, provided the requirements in the relevant MDS are met in full.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 12 of 74

4.7 NDE of Valve Components

4.7.1 General

Where MDSs specify NDE requirements, this is intended to represent the minimum level of NDE that shall be performed at the material manufacturing stage.

NDE of fabricated piping systems are not included in the MDSs and additional NDE may be required for components when is specified by the Purchaser in the valve data sheet or Purchase Order documentation.

Where MDSs do not specify additional NDE requirements, the relevant material standard shall apply with no additional requirements except as specified below in this section.

Where a frequency of inspection less than 100% is specified, at least one item per lot shall be examined. If defects outside the acceptance criteria are detected, two or more items from the same lot shall be tested, and if any of these two fails, all items in the lot shall be examined.

4.7.2 NDE Personnel

NDE personnel shall be qualified in accordance with [ISO 9712](#) or [ASNT SNT-TC-1A](#). Personnel performing NDE evaluation shall be certified according to Level 2. Certification shall be performed by an independent 3rd party Certification Body, or Authorised Qualifying Body in accordance with [ISO 9712](#) or the ASNT Central Certification Program (ACCP).

4.8 Pilot Castings

The casting foundry/manufacturer shall produce a pilot casting (see definition in section 3.1.4) prior to the production of castings, when one or more of the following conditions apply:

- First use of a pattern
- Changes are made in the risers, gating, chilling, coring and moulding
- A new pattern is made
- The pattern is revised
- The cast alloy grade is changed from one material grade to another (except for changes from UNS S31803 to UNS S32205 and vice versa)
- Changes are made in the process (i.e., melt practice, casting technique, core making, sand control)
- The pattern is sent to another casting foundry/manufacturer
- The pilot casting is rejected
- Upon identification of recurring defects in production castings requiring major repairs.

The pilot casting may be taken from the first production order of castings, subject to Purchaser approval. Acceptance of a production casting as pilot casting shall require that NDT complies with the requirements for pilot casting including 100% RT and all testing specified in the MDS for production casting shall be met.

All pilot castings shall be evaluated without weld repairs.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 13 of 74

All accessible internal and external surfaces and 100% of the volume of the pilot casting shall be inspected by VT, PT or MT and RT. The acceptance criteria shall be as stated in the applicable casting MDS, unless agreed otherwise with the end (equipment) user.

A pilot casting that fails to comply with the requirements of the MDS shall be rejected. Corrective actions shall be implemented by the casting foundry/manufacturer and a new pilot casting shall be made to confirm effectiveness of the corrective actions.

Upon completion of all required examinations and tests the documentation for the pilot casting shall be maintained and be available for review at the casting foundry/manufacturer.

4.9 Carbon Steel Valves

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

Where the material selection does not reference a MDS, carbon steel valves with welded ends (either butt-weld or socket-weld ends), for which welding is used as part of the fabrication method (e.g. end flanges welded to the body or welded body, etc.) or for all welding overlay on carbon steel valve parts shall comply with [API SPEC 6D](#) clause 6.5, based on the ladle analysis produced for the construction of valves.

4.10 Austenitic Stainless Steel Valves

Where the material selection does not reference a MDS, the carbon content of austenitic stainless steel material shall comply with [API SPEC 6D](#) clause 6.5.

The carbon content of type 321 stainless steel shall be less than or equal to 0.03%. Component shall be supplied in the solution annealed condition in accordance with the corresponding ASTM standards.

4.11 Toughness Test Requirements

Where the material selection does not reference a MDS in this specification, impact test results for full-size specimens shall meet the requirements of [GS EP PVV 154](#) clause 6.6 (amendment to [API SPEC 6D](#)) and the hereafter Table A for casting materials.

General Specification			GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)			
Rev.: 00	Effective date: 11/2018	Page: 14 of 74	

Table A - Impact testing requirements on casting material in delivery conditions

Material	Valve Minimum Design Temp.	Wall thickness. Valve component	Impact Test Temperature	Minimum Impact Test Value (unless otherwise specified)
Carbon Steel	T ≥ -29°C	< ½ inch	NA	Impact testing not required
Low alloy steel		≥ ½ inch	-29°C	min. 20 J average for 3 specimen min. 16 J for individual specimen
Low Temperature Carbon Steel	T ≥ -46°C	All thickness	-46°C	according to API SPEC 6D clause 6.6
Low alloy steel				
Duplex St. Steel	T ≥ -46°C	All thickness	-46°C	according to API SPEC 6D clause 6.6
For all materials: the minimum impact test values are related to tests performed on full-section impact test specimen (10x10 mm). Values for sub-sized specimen (when required) shall be agreed on by Company. For castings with a weight of 250 kg or more, the test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations including any post-weld heat treatment. Local regulation or specific project conditions may specify higher impact test values. 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.				

4.12 Casting Material

4.12.1 General

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

Unless otherwise specified steel casting for pressure-containing parts shall comply with general requirements of [ASTM A703/A703M](#) including relevant supplementary requirements.

The entirety requirements of [ASTM A703/A703M](#) also applies to pressure-controlling parts when casting is allowed.

Use of scraps is not allowed for cryogenic stainless steel, duplex or superduplex 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.

Weld repairs shall be documented as soon as they come under section S20 of [ASTM A703/A703M](#) for any material including those not covered by the standard.

Note: Clause 4.13 shall be considered.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 15 of 74

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 acceptable.

The part identification mark shall also identify the material grade, heat, ladle charge and the sequential number in the ladle as per [ASTM A703/A703M](#). Any time of the manufacturing sequence, products of the same heat furnace charge are deemed to be of a single ladle. Combining ladles in the same casting is subject to Company approval. The allowance will apply to heavy valve body of carbon steel casting that exceeds 30 tons net weight or whose nominal wall thickness exceeds 150 mm, respectively 10 tons or 75 mm for other material.

4.13 Repair

Weld repair shall comply with [API SPEC 6D](#) clause 7.5.

[Replace last two paragraphs of API SPEC 6D clause 7.5 with](#)

Weld repair of forgings, plates, seamless products and bars is not permitted for the purpose of correcting material defects. Minor weld repair to correct machining errors shall be subject to the purchaser's approval.

Weld repairs are not permitted on stem or trim component. Weld repairs are allowed on clad surfaces.

Any weld repair on pressure-containing and controlling parts will be subject to company approval.

When allowed, major welds repairs are those defined in clause S20 of [ASTM A703/A703M](#). Major repairs shall be identified on a welding map for each individual valve. The welding map shall be part of the final documentation of the valve.

All major weld repairs shall be documented in accordance with the MDS and the requirements of the applicable valve specification.

Weld repair of castings shall be in accordance with the applicable material data sheet in Appendix 1, and the following:

- Weld repairs are not permitted for castings that leak during pressure testing.
- Depth of cavity for any major repair shall not exceed 50% of the nominal local wall thickness after final machining.
- In any case, all through thickness repairs in casting are strictly prohibited. One repair of that kind shall lead to the rejection of all identical valve parts of the same source whatever the material specification and heat charges corresponding to that production.
- Defective casted 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 shall be in accordance with [ASME BPVC Section IX](#) or [ASTM A488/A488M](#) for steel and Nickel alloys castings. The weld repair qualification procedures for castings shall cover all weld repair works irrespective of the stage in production at which weld repairing is carried out.
- Low temperature carbon steel, low alloy steel, austenitic stainless steel and other casting alloys that have been subjected to weld repairs shall be subject to the heat treatment after

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 16 of 74

repairs. The heat treatment delivery conditions are defined by the applicable material standards unless otherwise specified.

- Except for weld repair procedures qualified and executed by the casting manufacturer, any subsequent repair procedures and supporting welding procedure qualification records shall be submitted for the purchaser's acceptance.
- All weld repairs shall be inspected to the same standard as used to inspect the casting.
- Examination of major repair welds on pressure containing parts shall also include RT or UT.

4.14 NDE of Castings

All non-destructive examination shall be performed on castings after all heat treatment, including post-weld heat treatment after welding repair.

All pressure containing or pressure controlling cast parts shall have a surface NDE inspection after final heat treatment and final machining operations.

All sealing surfaces shall be inspected after final machining in accordance with clause 4.14.2.

Where the material selection does not reference a MDS, the following non-destructive examinations shall apply.

PT, MT and RT frequency of production valve castings shall comply with the applicable valve specification for valves other than ball, axial and axial check valves.

4.14.1 Visual Testing (VT)

Visual testing (VT) shall be carried out on 100% of casting components in accordance with [ANSI/MSS SP-55](#).

- Extent of examination: 100% of accessible surfaces (including bolt holes and welding ends).
- Method: [ANSI/MSS SP-55](#)
- Acceptance criteria: [ANSI/MSS SP-55](#). Defect type I & II none acceptable. Cracks or crack-like defects are not acceptable.

4.14.2 Penetrant Testing (PT) / Magnetic-particle Testing (MT)

Penetrant (PT) or magnetic-particle testing (MT) shall be carried out on 100% of casting pressure containing or controlling parts in accordance with [ASME BPVC Section V](#) (the testing shall be carried out after final machining).

For ferrous materials, magnetic particle testing shall be used in preference to penetrant testing.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 17 of 74

Penetrant testing (PT):

- Extent of examination: 100% of accessible surfaces (including bevels preparation).
100% of sealing surfaces (after final machining).
- Method: [ASME BPVC Section V, Article 6.](#)
- Acceptance criteria: [ASME BPVC Section VIII Div 1, Appendix 7.](#)
Rounded or linear indications are not acceptable on sealing surfaces.

Magnetic-particle testing (MT):

- Extent of examination: 100% of accessible surfaces (including bevels preparation).
100% of sealing surfaces (after final machining).
- Method: [ASME BPVC Section V, Article 7.](#)
- Acceptance criteria: [ASME BPVC Section VIII Div 1, Appendix 7.](#)
Rounded or linear indications are not acceptable on sealing surfaces.

4.14.3 Radiographic Testing (RT)

Radiographic testing (RT) shall be carried out on pressure containing parts in accordance with the following requirements:

- **Frequency:**
 - a) Pilot casting: 100%.
 - b) Production castings for ball, axial and axial check valves:

NPS	DN	Pressure class				
		150	300	600	900	≥1500
<2	<50	N/R	N/R	N/R	N/R	N/R
≥2	≥50	10%	10%	20%	20%	20%
≥6	≥150	10%	20%	20%	50%	100%
≥10	≥250	10%	20%	50%	100%	100%
≥16	≥400	10%	20%	100%	100%	100%
≥20	≥500	20%	100%	100%	100%	100%

- c) Welding Ends: 100%.

Note: Frequency of inspection 100% means that each item shall be examined.

When random examination (10, 20 or 50%) is specified, a minimum of one item per lot of each pattern in any purchase order shall be examined.

- **Method:** [ASME BPVC Section V, Article 2](#)

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 18 of 74

- **Extent:**

- a) Pilot casting: 100% RT.

- b) Production castings for ball, axial and axial check valves:

Areas defined by [ASME B16.34](#) for special class valves, at abrupt changes in sections and at the junctions of risers, gates or feeders to the casting.

- **Acceptance criteria:** [ASME BPVC Section VIII Div 1](#), Appendix 7.

For specific location of castings, where remaining areas cannot be covered by RT, ultrasonic testing (UT) shall be carried out as follows:

- Frequency: According to RT.
- Method: [ASME BPVC Section V](#), Article 5.
- Extent: Remaining areas not covered by RT.
- Acceptance criteria: [ASTM A609/609M](#), Table 2, Quality Level 2.

4.14.4 Welding End additional requirements

Ultrasonic testing (UT) shall be carried out on welding ends in accordance with the following requirements:

- Frequency: 100%.
- Method: [ASME BPVC Section V](#), Article 5.
- Extent: 100%.
- Acceptance criteria: [ASTM A609/609M](#), Table 2, Quality Level 1.

4.15 NDE of Forged Materials and Bars

4.15.1 Visual Testing (VT)

Visual testing shall be carried out on all pressure containing and controlling parts in accordance with the product standard.

4.15.2 Penetrant, Magnetic-particle and Ultrasonic Testing (PT, MT & UT)

Unless otherwise specified, non-destructive examinations shall be defined by the valve manufacturer in accordance with the supplied material criticality and consistent with its own Quality Management System in order to guarantee that products have been satisfactorily controlled in relation to its functionality.

The purchaser will as necessary specified additional non-destructive examinations in accordance with criticality level of the final location and use of valves.

5. Electroless Nickel Plating

Electroless nickel plating requirements shall comply with the Appendix 2.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 19 of 74

6. Tungsten Carbide Coating

Tungsten carbide coating requirements shall comply with the Appendix 3.

7. Weld overlay procedure for seal pockets and seal contact surface of obturators

Weld overlay requirements shall comply with the Appendix 4.

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 20 of 74

Bibliography

Reference

ASTM A358/A358M

ASTM A403/A403M

ASTM G48

IOGP S-563

Title of the publication

Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications

Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

Material data sheets for piping and valves

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 21 of 74

Appendix 1

Appendix 1 Valve Material Data Sheets

List of material data sheets

The material data sheets are listed in Table 1 and compiled in this Appendix.

Table 1 - List of valve material data sheets per type of material

Type of Material	Material Standard and Grade(s)	Product Form	MDS no.	MDS Rev.
Non-impact tested carbon steel (CS)	ASTM A105	Forgings	VC04	0
	ASTM A216 Grade WCB and WCC	Castings	VC06	0
Impact tested carbon steel (LTCS)	ASTM A350 Grade LF2	Forgings	VC14	0
	ASTM A352 Grade LCC	Castings	VC16	0
Ferritic/austenitic stainless steel type 22Cr Duplex	ASTM A182 Grade F51	Forgings	VD44	0
	ASTM A995 Grade 4A (UNS J92205)	Castings	VD46	0
	ASTM A276 / ASTM A479 UNS S31803	Bars	VD47	0
Ferritic/austenitic stainless steel type 25Cr Duplex	ASTM A182 Grade F53 (UNS S32750), Grade F55 (UNS S32760)	Forgings	VD54	0
	ASTM A995 Grade 6A (UNS J93380), Grade 5A (UNS J93404)	Castings	VD56	0
	ASTM A276 / ASTM A479 UNS S32750 and S32760	Bars(solution annealed)	VD57	0
Nickel alloys	ASTM B564 UNS N06625	Forgings	VN04	0
	ASTM A494 Grade CW-6MC, CX 2MW	Castings	VN06	0
	ASTM B446 UNS N06625	Bars	VN07	0
Austenitic stainless steel type 316	ASTM A182 Grade F316, F316L	Forgings	VS04	0
	ASTM A351 Grade CF3M, CF8M	Castings	VS06	0
	ASTM A276 / ASTM A479 Grade 316, 316L	Bars	VS07	0
Austenitic stainless steel type 304	ASTM A182 Grade F304, F304L	Forgings	VS24	0
	ASTM A276 / ASTM A479 Grade 304, 304L	Bars	VS27	0
High strength low alloy steel	ASTM A694 Grade F52, F60, F65	Forgings	VX24	0

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 22 of 74

Appendix 1

Valve material data sheets

Material Data Sheet		MDS No. VC04		Rev. 0
TYPE OF MATERIAL: Non-impact tested carbon steel (CS)				
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT
Forgings	ASTM A105	-	-	ASTM A105 S2, S4
Scope	This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.			
Manufacturing	When permitted by ASTM A105 and ASTM A961, hollow sections and valve parts of NPS 4 and under may be manufactured from hot-forged or hot-rolled/wrought bars provided the finished product complies with this MDS and the following additional requirements: - Bar forgings as defined in ASTM A788, or - ASTM A696 Grade C (& ASTM A29), hot rolled/wrought bars with a maximum outside diameter 250 mm (10 in), or - ASTM A696 Grade C (& ASTM A29), hot-rolled/wrought and cold finished bars with a maximum outside diameter 230 mm (9 in) - All bars shall be supplied in either the normalised or normalised and tempered or quenched and tempered heat treatment conditions. Note: Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted.			
Chemical Composition	Supplementary requirement S4 applies with the following restrictions: C ≤ 0.23%, S ≤ 0.020%, P ≤ 0.025%, CE ≤ 0.43% Microalloying elements (Nb, V, Ti, B) shall not be deliberately added.			
Heat Treatment	Normalised or normalised and tempered or quenched and tempered. During the heat treatment process, components shall be placed in such a way as to ensure free circulation around each component including any quenching operation.			
Mechanical Properties	Hot-forged or hot rolled/wrought bars intended for the manufacture of parts NPS 4 and under shall meet the specified minimum requirements of ASTM A105.			
Test Sampling	Sampling of test specimens shall be taken: - After all heat treatments are completed - From the maximum heat-treated thickness of the forging part, or - From a prolongation of the forging part representing the maximum heat-treated thickness.			
Non-destructive Examination	Non-destructive examination shall be carried out after all heat treatments. <u>Visual Inspection</u> VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.			
Repair of Defects	Weld repair is not permitted.			
Sour Service (additional metallurgical, manufacturing, testing and certification requirements)	When sour service requirements are specified by the Purchaser, the material shall conform to the requirements of ISO 15156 / NACE MR 0175 and the following additional requirements to the MDS: <u>Hardness testing</u> Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 187HBW from three readings in close proximity. The material shall be clearly marked in accordance with Clause 9 of ISO 15156-2 / NACE MR 0175 and this MDS. The inspection documents required in this MDS shall also include a statement confirming compliance with ISO 15156 / NACE MR 0175.			
Marking	The component shall be marked to ensure full traceability to melt and heat treatment lot.			

General Specification		GS EP PVV 158
Material and special process for valves (MDS & manufacturing processes)		
Rev.: 00	Effective date: 11/2018	Page: 23 of 74

Appendix 1

Material Data Sheet		MDS No. VC04		Rev. 0
TYPE OF MATERIAL: Non-impact tested carbon steel (CS)				
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT
Forgings	ASTM A105	-	-	ASTM A105 S2, S4
Certification	The material manufacturer shall have a quality system certified in accordance with ISO 9001 or another quality requirements standard accepted by Company.			
	The inspection documents comply with the valve specifications.			
	The inspection documents shall be issued in accordance with ISO 10474 / EN 10204.			
	Type 2.2 inspection documents shall confirm compliance with this specification.			
	Type 3.1 inspection documents shall confirm compliance with this specification and include the following information: Heat treatment condition. For tempered condition, tempering temperature shall be stated.			