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**ADDENDUM 1**

This addendum (Version 1.01) replaces Edition 1.0 published in November 2021.

NOTE: In addition to the updates listed below, minor editorial/typographical amendments may have been made.

**List of updates**

<b>Section</b>	<b>Description</b>
4.3.2	New NOTE added
5.1.1	New list item m) amended New addition to section
5.1.4	List item a) amended List item g) amended New list item l) added
5.1.5	New list item j) added
5.3.1	New addition to section
5.3.2	First paragraph of addition to section amended
5.7	Four new paragraphs added to section
5.9	New addition to section
5.12.2.1	New addition to section
5.16.2	New addition to section
5.20.1	New addition to section
5.20.2	New addition to section
5.33.1	New addition to section
6.1	First paragraph amended
9.1.2	Amendment * of first paragraph replaced with section replacement New Table 9 added
10.3.7	Section heading 10.3.7.1 added before addition * to section New sections 10.3.7.2, 10.3.7.3 and 10.3.7.4 added
D.12	Six new paragraphs added to section
E.11	Six new paragraphs added to section
Table G.1	Row "Springs", column "QL-2" of table replacement amended
Table J.1	Row "Impact Testing / Toughness Testing" amended

**List of updates** (*continued*)

<b>Section</b>	<b>Description</b>
Table J.2	Row "Impact Testing / Toughness Testing" amended
Table J.3	Row "Impact Testing / Toughness Testing" amended
Table J.4	Row "Impact Testing / Toughness Testing" amended
* Section number from Edition 1.0.	

# Supplementary Specification to API Standard 6DSSX Operator and Mounting Kits for Subsea Pipeline Valves and Manifold Valves

## Revision history

VERSION	DATE	PURPOSE
1.01	March 2026	Addendum 1
1.0	November 2021	First Edition

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## Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

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## Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

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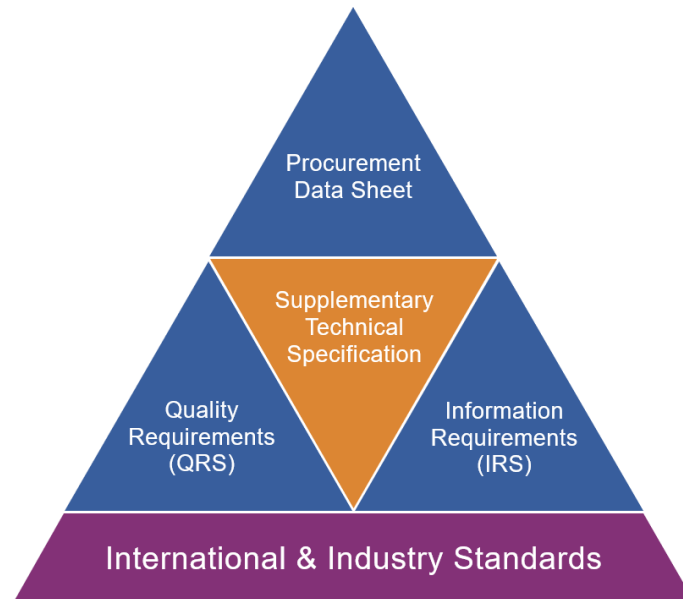
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## Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of operator and mounting kits for subsea pipeline valves and manifold valves in accordance with API 6DSSX, first edition, published March 2021, Operator and Mounting Kits for Subsea Pipeline Valves, for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



### JIP33 Specification for Procurement Documents Supplementary Technical Specification

This specification is to be applied in conjunction with the supporting procurement data sheet, information requirements specification (IRS) and quality requirements specification (QRS) as follows.

#### **IOGP S-731: Supplementary Specification to API Standard 6DSSX Operator and Mounting Kits for Subsea Pipeline Valves and Manifold Valves**

This specification defines the technical requirements for the supply of the equipment and is written as an overlay to API Standard 6DSSX, following the API Standard 6DSSX, clause structure. Clauses from API Standard 6DSSX not amended by this specification apply as written to the extent applicable to the scope of supply.

Modifications to API Standard 6DSSX defined in this specification are identified as Add (add to clause or add new clause), Replace (part of or entire clause) or Delete.

#### **IOGP S-731D: Procurement Data Sheet for Operator and Mounting Kits for Subsea Pipeline Valves and Manifold Valves (API)**

The procurement data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The procurement data sheet may also include fields for supplier provided information attributes subject to purchaser's technical evaluation. Additional purchaser supplied documents may also be incorporated or referenced in the procurement data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

### **IOGP S-731L: Information Requirements for Operator and Mounting Kits for Subsea Pipeline Valves and Manifold Valves (API)**

The IRS defines the information requirements, including contents, format, timing and purpose to be provided by the supplier. It may also define specific conditions which invoke information requirements.

### **IOGP S-731Q: Quality Requirements for Operator and Mounting Kits for Subsea Pipeline and Manifold Valves (API)**

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the data sheet or in the purchase order.

The terminology used within this specification and the supporting procurement data sheet, IRS and QRS follows that of API Standard 6DSSX and is in accordance with ISO/IEC Directives, Part 2 as appropriate.

The procurement data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The supplementary specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) purchaser defined requirements (procurement data sheet, IRS, QRS);
- d) this specification;
- e) API Standard 6DSSX.

## 1 Scope

In first paragraph, replace "subsea pipeline valves that conform to API Specification 6DSS" with

subsea pipeline valves and manifold valves

## 2 Normative References

Add to section

API Recommended Practice 17A:2017, *Design and Operation of Subsea Production Systems-General Requirements and Recommendations*

API Recommended Practice 17F:2017, *Standard for Subsea Production Control Systems*

API Recommended Practice 17N:2017, *Recommended Practice on Subsea Production System Reliability, Technical Risk, and Integrity Management*

API Recommended Practice 17Q:2018, *Recommended Practice on Subsea Equipment Qualification*

API Specification 6A:2018, *Specification for Wellhead and Tree Equipment*

API Specification 6DSS:2017, *Specification for Subsea Pipeline Valves*

API Specification 20A:2017, *Carbon Steel, Alloy Steel, Stainless Steel, and Nickel Base Alloy Castings for Use in the Petroleum and Natural Gas Industry*

API Specification 20B:2013, *Open Die Shaped Forgings for Use in the Petroleum and Natural Gas Industry*

API Specification 20C:2020, *Closed Die Forgings for Use in the Petroleum and Natural Gas Industry*

API Standard 6ACRA, *Age-hardened Nickel-based Alloys for Oil and Gas Drilling and Production Equipment*

ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4<sup>1</sup>/<sub>2</sub> in. (50.8 to 114 mm) Steel Castings*

ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness*

DNVGL-RP-0034, *Steel forgings for subsea applications - technical requirements*

DNVGL-RP-F112, *Duplex stainless steel – design against hydrogen induced stress cracking*

EN 10228-4, *Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings*

IOGP S-561, *Supplementary Specification to API 17D Subsea Trees*

IOGP S-708:2020, *Supplementary Specification to API Specification 6DSS Subsea Pipeline Valves*

IOGP S-724, *Supplementary Specification to API Specification 20E Subsea Fasteners (Alloy and Carbon Steel Bolting)*

IOGP S-725, *Supplementary Specification to API Specification 20F Subsea Fasteners (Corrosion-resistant Bolting)*

ISO 17781, *Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels*

### 3 Terms, Definitions, Acronyms, Abbreviations, Symbols, and Units

#### 3.1 Terms and Definitions

Add new term

##### 3.1.59

##### **compensated parts** **compensated cavities**

Parts, connected to the compensation system, which are designed to contain compensation fluid.

Add new term

##### 3.1.60

##### **noncompensated parts** **noncompensated cavities**

Parts, not connected to the compensation system, which are designed to contain fluid and withstand external pressure to prevent water ingress.

Add new term

##### 3.1.61

##### **rated working pressure (control systems)**

Design pressure of the control system, as defined by the purchaser.

#### 3.2 Acronyms, Abbreviations, Symbols, and Units

Add to section

MDS material data sheet

### 4 Operator Types and Configurations

#### 4.1 General

Add new list item e)

e) ROT receptacle.

#### 4.3 Actuator Types

##### 4.3.2 Electric

Add new NOTE

NOTE API Standard 17F provides guidance on electrical actuator power systems.

### 5 Design

#### 5.1 Design Input

##### 5.1.1 General

Delete "(see API 6DSS)" from list item f)

Add new list item m)

m) safety integrity level (SIL) when specified.

Delete "(see API 6DSS)" from list item 1)

Add to section

If specified, actuated valves shall include a manual override with ROV or diver operation.

#### **5.1.4 Hydraulic Actuator Data Input**

Add to list item a)

and data sheet

Add new list item c1) after list item c)

c1) rated working pressure (control system),

Add to list item g)

(e.g. pre-charged accumulator)

Add new list item l)

l) stem ejection force corresponding to 1.5 times the valve design pressure.

#### **5.1.5 Electric Actuator Data Input**

Add new list item j)

j) electrical connector type.

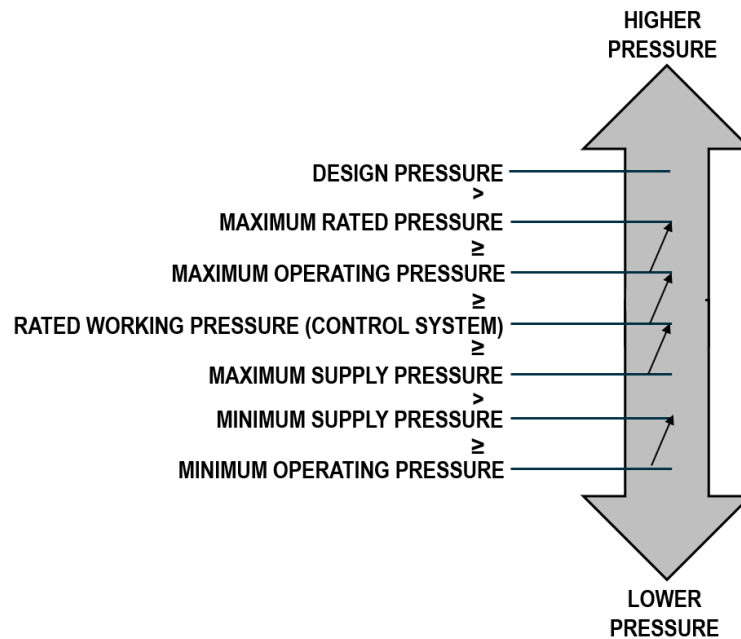
### **5.3 Design Requirements**

#### **5.3.1 General**

Add new section

c) rated working pressure (control system) shall be defined by the purchaser and shall be less than or equal to maximum operating pressure and greater than or equal to the maximum supply pressure.

Replace Figure 1 with



**Figure 1—Relationship Between Design, Rated and Supply Pressures**

Replace first sentence of fourth paragraph with

Gearbox systems shall be part-turn or multi-turn.

Mechanical override systems shall be part-turn, multi-turn or linear.

Add to section

For operators that require rotation to operate, direction of closing shall be clockwise, as viewed from the end of the stem.

### **5.3.2 Design Basis**

Add to section

Compensated and noncompensated parts shall be designed to at least 25 bar (362.5 psi) above external ambient pressure or a pressure in accordance with 5.13, whichever is higher.

NOTE The manufacturer may propose alternate pressure values.

The manufacturer shall specify the relief valve set pressure.

The manufacturer shall provide the technology readiness level (TRL) and technology criticality rating (TRC) of each operator in accordance with API Recommended Practice 17N.

A failure modes, effects and criticality analysis (FMECA) for the operator design shall be performed.

## 5.6 Mechanically Loaded Parts

### Add new list item

— torque/thrust generated at design pressure, for hydraulic actuators.

## 5.7 Springs and Spring Modules

### In second paragraph, replace "600 times" with

5000 times

### Add to section

The design of the coil spring shall include the worst-case manufacturing tolerances to prevent a coil bound condition at compressed spring length.

Coil springs shall be formed by hot rolling, followed by quenching and tempering heat treatment.

Test bars shall be from the same heat treatment batch as the spring bars.

Springs shall be shot peened.

## 5.8 Mounting Kit

### In first list item, replace "torque/thrust generated at maximum supply pressure" with

torque/thrust at maximum rated pressure

### Replace fourth list item with

— rated torque/thrust of ROT interface;

### 5.8.1 Interface with the Valve

#### Delete "(see API 6DSS)" from NOTE 1

## 5.9 Drive Trains

### Add to section

The drive train shall be designed for a minimum of 600 cycles at full actuator output load.

## 5.11 Sealing

### 5.11.1 General

#### Delete first sentence

#### In list item g), replace "compression/squeeze" with

compression/squeeze and prevent extrusion

## 5.12 Fluid Requirements

### 5.12.1 Hydraulic Control Fluid

#### 5.12.1.2 Cleanliness

Replace "class -/15/12" with

class 17/15/12

### 5.12.2 Compensation Fluid

#### 5.12.2.1 Operator

Add to section

The cleanliness of the compensation fluid shall be checked prior to filling in the compensation system in accordance with the compensation fluid cleanliness requirements defined by the operator manufacturer.

#### 5.12.2.2 Cavities between the Valve and the Operator

Delete second paragraph

## 5.13 Compensation System

### 5.13.2 Swept Volume System

Add NOTE

NOTE Consideration should be given to methods that ensure bladders are not damaged prior to installation and operation.

#### 5.13.6 Sizing of Compensation Tank Volume

In third paragraph, replace "to accommodate of minimum a 120 % of the calculated volumetric change" with

in accordance with API Recommended Practice 17F, 4.3.2.6.

## 5.15 Retrievable Operators

### 5.15.1 General

In last paragraph, replace "can" with

shall

### 5.15.2 Interfaces for Retrievable Operators

#### 5.15.2.1 Valve-to-operator Interface

Add to section

For retrievable operators, the connection system with the valve shall incorporate lock and unlock markings for viewing by an ROV/diver.

### **5.15.3 Protection and Pressure Cap**

#### **5.15.3.1 General**

Add to section

When a pressure cap is provided, it shall comply with the requirements of API Specification 6DSS, 5.25.

### **5.16 Operator Override**

#### **5.16.1 Mechanical Override System for Actuator (ROT)**

Add to section

A rotary type mechanical override used on fail closed valves shall open the valve with a counter-clockwise rotation as viewed from the end of the stem.

A push-pull-type mechanical override used on fail closed valves shall open the valve with a push on the override.

#### **5.16.2 Overload Factor of Safety**

Add to section

A push-pull-type override shall sustain the valve stem ejection force provided by the valve manufacturer in accordance with 5.1.4 I).

#### **5.16.3 Self-locking Feature**

Add to NOTE

Ball/roller screw designs cannot provide self-locking functionality.

### **5.19 Remotely Operated Tool System**

#### **5.19.1 General**

Add to section

The ROT interface and drive train shall withstand an input torque/thrust of at least 1.25 times the ROT torque/thrust class/type in accordance with API Recommended Practice 17H, without sustaining any damage or permanent deformation against the travel end stop and mechanical components in any position of the travel.

Delete NOTE 1

#### **5.19.2 Extension**

In list item 1), replace "maximum operator input torque/thrust" with

design torque/thrust

## 5.20 Input Interface Operation Strength

### 5.20.1 Handwheel Interface

Add to section

Valve handles and attachments for ROV manipulator operation shall withstand a minimum torque of 400 N·m (295 ft-lbf) and a minimum force of 3000 N (2213 lbf) applied from any direction.

### 5.20.2 ROT Interface

Add to section

ROT interface shall withstand and be operable at a minimum bending moment of 3000 N·m (2213 ft-lbf) and an axial force of 3000 N (674 lbf) at the ROV interface.

## 5.23 Environmental and Operational Conditions

Add to section

When specified, dropped or dragged object protection shall be designed in accordance with the dropped object loads in API Recommended Practice 17A, Table 1 and Table 2.

## 5.25 Water Depth Performance

Replace second paragraph with

It shall be demonstrated that the operator is suitable for the required water depth by testing in accordance with Annex F.

Delete "(if requested)" from third paragraph

## 5.26 Corrosion Resistant Overlay

Add to first paragraph

All other dynamic seal areas manufactured from carbon steel or low alloy steel shall be protected with a corrosion-resistant overlay.

## 5.29 Hydraulic Connections

Delete "When specified by the purchaser" from last paragraph

Add to section

NOTE For detailed guidance on hydraulic fitting requirements, see IOGP S-561, 7.20.2.6.

Add to section

Hydraulic connectors for interfacing with flying leads shall be in accordance with API Recommended Practice 17F.

## 5.30 Electrical Connections

Add to section

Electrical connectors for interfacing with flying leads shall be in accordance with API Recommended Practice 17F.

## 5.32 Instrumentation and Accessories

Replace first sentence with

When specified, the following shall be provided:

Delete list item c)

Add to section

Receptacles shall be provided with covers secured with plastic or stainless steel braided wire, rope or chain.

## 5.33 Position Indication

### 5.33.1 General

Add to section

The position indicators shall be designed such that their failure or damage to them does not prevent the required functionality of the operator in any anticipated failure scenario.

## 5.34 Travel Stops

### 5.34.1 General

Delete NOTE 2

Add to section

Travel stops shall be in accordance with IOGP S-708:2020, 5.16.

## 5.35 Assembly Practice

### 5.35.2 Flushing

Add to section

Flushing shall include a minimum of three full strokes of the actuator.

Add new section

## 5.36 Design Temperature

The design temperatures shall be defined in accordance with the following:

- minimum design temperature no greater than -10 °C (14 °F);
- maximum design temperature no less than 70 °C (158 °F).

## 6 Materials

### 6.1 Material Specification

In first paragraph, add after "metallic pressure-containing"

, springs

Add new list item e) to first paragraph

e) reference to applicable international manufacturing standard.

Add to section

Material test reports shall be provided for pressure-containing and pressure-controlling metallic parts.

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

### 6.2 Tensile Test Requirements

In second paragraph, replace "separate or attached block" with

sacrificial part or integral test block or prolongation

In first sentence of third paragraph, replace "Pressure-containing parts" with

Pressure-containing, pressure-controlling and mechanically-loaded parts

In second sentence of third paragraph, replace "yield strength" with

tensile properties

Add to third paragraph

Tensile property parameters, i.e. SMYS, ultimate tensile strength, percentage elongation and percentage reduction in area, shall be reported in material certificates.

Add to section

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

### 6.5 Forged Material

Replace first sentence with

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

Add to section

Forgings in duplex/super duplex stainless steel and nickel alloys shall comply with the requirements given in Annex J.

## 6.6 Composition Limits

### 6.6.1 General

In first paragraph, replace "carbon and alloy steel pressure-containing parts" with

pressure-containing and pressure-controlling parts

### 6.6.2 Carbon Steel

Add to section

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

### 6.6.4 Duplex and Super Duplex Stainless Steel

Replace section with

The chemical composition of pressure-containing and pressure-controlling parts shall be in accordance with the applicable material data sheets (MDSs) in Annex J.

## 6.7 Impact Test Requirements

Replace first sentence of first paragraph with

Except austenitic grades, carbon, alloy and stainless steels and any material for pressure-containing and pressure-controlling parts shall be impact tested at -10 °C (14 °F) or below.

Delete NOTE

In fourth paragraph, replace "separate or attached block" with

sacrificial part or integral prolongation

Delete sixth paragraph

Replace seventh paragraph with

Impact test results for bolting material shall meet the requirements of IOGP S-724 or IOGP S-725, as applicable.

In eighth paragraph, replace "Each impact specimen" with

Each retest impact specimen

Add after eighth paragraph

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

Materials covered by MDSs in Annex J shall be impact tested in accordance with the applicable MDSs.

In last paragraph, replace "Charpy impact values" with

Charpy impact values and test temperatures

Replace section 6.8 title with

## **6.8 Pressure Boundary Bolting and Pressure-controlling Bolting**

Replace section with

Pressure boundary bolting and pressure controlling bolting shall conform to the requirements of IOGP S-724 or IOGP S-725, as applicable.

### **6.8.2 Carbon and Alloy Steel Bolting**

Replace "API 20E" with

IOGP S-724

### **6.8.3 CRA Bolting**

Replace "API 20F" with

IOGP S-725

Delete NOTE

## **6.9 Cathodic Protection**

Add to second paragraph

Alloys 716 and 725 shall not be exposed to cathodic protection system.

Delete ",including bolting," from list item a)

Delete NOTE

Add to section

For duplex stainless steel materials exposed to external cathodic protection, the risk of hydrogen-induced stress cracking shall be minimized by meeting the requirements specified in DNVGL-RP-F112.

## **7 Welding**

### **7.2 Welding Procedure and Welder/Welding Operator Qualifications**

Delete "EN 287-1" from second paragraph

Add to beginning of seventh paragraph

Overlay welding shall be a minimum of two layers.

### **7.3 Impact Testing**

Replace second paragraph with

Except austenitic grades, carbon, alloy, and stainless steel and any material for pressure-containing and pressure-controlling parts shall be impact tested in accordance with MDSs in Annex J, if applicable.

Other material for pressure-containing and pressure-controlling parts shall be tested at minimum design temperature in accordance with the appropriate material standard or at -10 °C (14 °F), whichever is lower.

Delete NOTE

Delete "at 0 °C (32 °F) or below" from sixth paragraph

Replace last sentence of last paragraph with

If the material specification or Annex J MDSs require higher impact values than those shown in 6.7, the higher values shall apply.

## **7.5 Repairs**

Delete "unless otherwise agreed" from third paragraph

Delete NOTE

## **7.7 Structural Welding**

Delete "EN 287-1" from second paragraph

Add new section

## **7.8 Other Welding Requirements**

### **7.8.1 Seal Welding**

When seal welding is carried out with an integral shoulder:

- seal welding shall be performed with two passes; and
- the throat thickness shall be 3 mm (0.12 in.) minimum.

### **7.8.2 Welding on Threads**

Welding shall not be performed on the threaded area.

## **8 Quality Control**

### **8.5 Measuring and Test Equipment**

#### **8.5.3 Pressure-measuring Devices**

Add new section

##### **8.5.3.4 Calibration Records**

Calibration of measuring and testing equipment shall be documented.

### **8.8 NDE of Repairs**

In third paragraph, replace "Annex I" with

Annex G

In fourth paragraph, replace "8.1" with

8.4

Add new section

## 8.11 Positive Material Identification (PMI)

### 8.11.1 Material

Positive material identification shall be performed on the material grades included in Annex J.

### 8.11.2 Overlay Welding

Positive material identification shall be performed on overlay welding.

## 9 Sizing Methodology

### 9.1 Sizing Method

#### 9.1.2 Safety Factor

Replace section with

The specified safety factor group shall determine the applicable safety factors in accordance with Table 9.

Add new Table 9

**Table 9—Safety Factor Groups**

Safety Factor Groups	Safety Factor Group 1	Safety Factor Group 2	Safety Factor Group 3	Safety Factor Group 4
Actuators output closing: spring operation	1.5	2.25	2.0	2.0
Actuators output opening: hydraulic output (based on maximum supply pressure)	1.5	1.5	2.0	1.5
Actuators output opening: hydraulic output (based on minimum supply pressure)	1.0	1.0	1.0	2.0
Gears output and ROT interface (direct operated)	1.5	2.25	1.5	1.5
ROV override: mechanical output based on maximum input force or torque	1.5	2.0	2.0	1.5

#### 9.1.3 Hydraulic Actuator

Add NOTE

NOTE For spring return actuators in direct hydraulic systems, sizing should consider a minimum backpressure of 0.69 Mpa (100 psi) plus the difference between the control head pressure and the hydrostatic pressure related to the maximum design water depth developed in the return line during the entire returning stroke of the actuator.

## 9.2 Design and Sizing Output Data

### 9.2.1 Hydraulic Actuator

Add to list item e)

Values to be provided for ambient and rated maximum water depth conditions.

## 10 Testing

### 10.1 Validation

Replace section with

Design validation testing shall be in accordance with Annex D or Annex E (as applicable) and Annex F.

NOTE A new design validation is not required if existing design validation is approved by the purchaser. The manufacturer would be required to provide a gap analysis of this specification and existing design validations.

### 10.2 Effect of Changes in Product

#### 10.2.1 Changes

Replace list item c) with

c) type and material of sealing elements;

### 10.3 Factory Acceptance Test

#### 10.3.3 Actuator Testing

##### 10.3.3.1 General

Add to first sentence of second paragraph

and compensation system, if applicable.

Delete "cast" from third paragraph

Delete NOTE

Add to section

After actuator assembly and prior to filling with hydraulic fluid, the supply side and compensation side shall be low-pressure gas tested under the following conditions:

- a) supply side test pressure between 5.5 bar (80 psi) to 6.9 bar (100 psi);
- b) compensation side test pressure as specified by the manufacturer in the FAT;
- c) minimum test duration of five minutes once pressure stabilization has been achieved.

Add NOTE 2

NOTE 2 The testing medium may be filtered shop air.

Add to section

No visible leakage shall be allowed.

**10.3.3.3 Hold Periods**

**10.3.3.3.1 Start of Hold Periods**

Replace section with

Hold periods shall not start until:

- the test pressure has been reached;
- the pressure and temperature stabilization has occurred; and
- the equipment with a pressure-monitoring device has been isolated from the pressure source.

The pressure applied shall not be higher than 5 % of the test pressure.

The temperature shall be monitored throughout the hold period.

**10.3.3.3.3 Pressure Maintenance**

Replace first sentence with

The rate of change of pressure shall not be more than 3 % of the test pressure per hour during the test hold period.

**10.3.3.4 Hydraulic Actuator Hydrostatic Shell Test**

Replace section with

**10.3.3.4.1 Actuator Cylinder and Piston Shell Test**

Each hydraulic actuator cylinder and piston shall be subjected to a hydrostatic test to demonstrate structural integrity.

The test pressure shall be a minimum of 1.5 times the design pressure of the actuator.

The test shall consist of three parts:

- a) primary pressure-holding period;
- b) reduction of the pressure to zero;
- c) secondary pressure-holding period.

The primary pressure-holding period shall not be less than three minutes.

The secondary pressure-holding period shall not be less than one hour.

The external surfaces of the parts shall be dried.

No visible leakage shall be allowed.

#### 10.3.3.4.2 Compensated or Noncompensated Parts Shell Test

Each hydraulic compensated or noncompensated part shall be subjected to a hydrostatic test to demonstrate structural integrity.

The test pressure shall be a minimum of 1.5 times the design pressure of the internal chambers in accordance with 5.3.2 or a pressure determined by the manufacturer, whichever is higher.

The test shall consist of three parts:

- a) primary pressure-holding period;
- b) reduction of the pressure to zero;
- c) secondary pressure-holding period.

The primary pressure-holding period shall not be less than three minutes.

The secondary pressure-holding periods shall not be less than one hour.

The external surfaces of the parts shall be dried.

No visible leakage shall be allowed.

#### 10.3.3.6 Hydraulic Actuator Compensation Circuit Test

In first sentence of first paragraph, replace "compensation chamber" with

compensation chamber and circuit

Delete "housing" from second sentence of first paragraph

Add to first paragraph

The relief valve shall be removed to allow testing of the environmental seals.

#### 10.3.3.7 Actuator Operational Test

##### 10.3.3.7.2 Relief Valves

Add to section

The relief valve testing shall be performed as follows:

- a) The valve inlet shall be filled in, at a pressurization rate of 1 to 2 psi/sec, until discharge of fluid is observed.
- b) The inlet pressure shall be monitored continuously to allow the verification of the valve crack pressure.
- c) On opening the relief valve, the pressure source shall be isolated.

NOTE The valve inlet pressure will then gradually reduce until the valve is completely reseated.

- d) Reseat pressure shall be the pressure at which the pressure stabilization is achieved.

- e) After pressure stabilization is achieved, the ability of the relief valve to seal in the normal flow direction shall be tested for a period of three minutes.
- f) Steps a) and b) shall be repeated two more times.
- g) The relief valve shall be rejected in case of failure to:
  - crack in a pressure range of 95 % to 105 % of the set pressure; or
  - reseal at a minimum pressure of 80 % of the set pressure; or
  - provide sealing in the normal flow direction.

#### **10.3.3.7.3 Force Measurement**

##### Replace last paragraph with

The output shall be measured at the maximum rated pressure/input torque, and minimum and maximum supply pressure/input torques during the entire stroke of the actuator.

#### **10.3.4 Gearbox Testing**

##### Add to section

Hold periods shall be as stated in 10.3.3.3.

The compensated and noncompensated parts of the gearbox assembly shall be low-pressure gas tested.

##### Add NOTE

NOTE The testing medium may be filtered shop air.

##### Add to section

The test pressure shall be specified by the manufacturer in the FAT.

The minimum test duration shall be five minutes after pressure stabilization has been achieved.

No visible leakage shall be allowed.

#### **10.3.4.1 Gearbox Housing and Compensation Chamber Seal Test**

##### Add before first paragraph

Each compensated or noncompensated gearbox housing shall be hydrostatically tested to demonstrate structural integrity.

The test pressure shall be a minimum of 1.5 times the internal chambers design pressure as per 5.3.2 or a pressure determined by the manufacturer, whichever is higher.

The test shall consist of three parts:

- a) primary pressure-holding period;
- b) reduction of the pressure to zero;
- c) secondary pressure-holding period.

The primary pressure-holding period shall not be less than three minutes.

The secondary pressure-holding period shall not be less than one hour.

The external surfaces of the parts shall be dried.

No visible leakage shall be allowed.

### **10.3.6 Pressure Cap**

#### Add to first paragraph

For gas service, the pressure cap shall be gas tested at 1.1 times the maximum operating pressure in addition to the hydrostatic test.

The gas test shall be performed on the mounting kit and valve.

The minimum hold period for the pressure cap gas test shall be 10 minutes.

### **10.3.7 Testing of Valve and Operator Assembly**

#### In first paragraph, replace "API 6DSS" with

IOGP S-708:2020

#### In NOTE 1, replace "API 6DSS" with

IOGP S-708

#### Add new section

#### **10.3.7.1**

The following tests shall be performed on the complete assembly:

- a) When applicable, the operator end stops shall be set to match the closure member position in the fully open and fully closed positions.
- b) Once set, the valve shall be stroked using a hydraulic supply from fully closed to fully open for a minimum of two times to confirm these settings.
- c) Verification of the position indicator operation shall be performed.
- d) The minimum hold-open or hold-close pressure shall be measured.
- e) The ROT or manual interface shall be verified.
- f) The number of turns required to operate the valve, stroked using the actuator ROV interface, shall be recorded.
- g) For a retrievable operator, a valve/operator connection and disconnection test in the open and closed positions of the valve shall be performed.
- h) Connection/connector make-break between the retrievable actuator/pressure cap and the valve mounting spool shall be tested.

- i) The functional test in accordance with IOGP S-708:2020,10.4 shall be performed.
- j) The closing/opening times for valve operations shall be recorded.

Add new section

**10.3.7.2**

The hydraulic actuation pressure readings for four pressure cycles of the functional test shall remain within  $\pm 5\%$  of the mean pressure value.

Add new section

**10.3.7.3**

The fail closed / fail open minimum pressure test shall include the following steps:

- a) The actuator shall be stroked to the fully open (or closed) position, using the maximum rated supply pressure.
- b) The supply pressure shall be reduced, until the actuator begins to close (for fail closed actuators) or open (for fail open actuators).
- c) The pressure at which the actuator begins to open or close shall be recorded.
- d) The test shall be repeated three times.

Add new section

**10.3.7.4**

The following pass criteria for the fail closed / fail open minimum pressure test shall apply:

- a) The measured pressure shall be lower than the minimum supply pressure.
- b) The measured pressures shall not vary beyond 5 % of the mean recorded values.

## **11 Surface Protection**

Delete "non-corrosion-resistant" from first paragraph

Delete second paragraph

## **13 Preparation for Shipment**

Add to section

Blanked off supply ports that prevent the ROT override from being used due to the hydraulic lock shall be identified with a temporary warning label on the ROV override interface.

## **14 Documentation**

Replace section with

Documentation shall be provided in accordance with IOGP S-731L, as applicable.

## **Annex A** **(informative)** **Optional Documentation**

*Replace Annex A with*

Refer to IOGP S-731L for documentation requirements.

## **Annex B (normative) Purchasing Guidelines**

*Replace Annex B with*

Refer to the procurement data sheet IOGP S-731D.

## Annex C (normative) Record Retention

**Table C.1—Record Retention**

*In Table C.1, "Electric Actuators" column, add "A" to the following rows*

Item	Description	Electric Actuators
6	Weld procedure specification (WPS)	A
7	Weld procedure qualification record (PQR)	A
8	Welder performance qualification (WPQ)	A
9	Qualification records of NDE personnel	A
11	Material test report for pressure-containing parts, traceable to the unique serial number	A
12	Material test report for spring and spring canister, traceable to the unique serial number	A
13	Serial number	A
14	Certificate of compliance to ISO 15156 (all parts)	A
18	Coating certificate	A

In Annex D title, replace "informative" with "normative"

## **Annex D (normative) Design Validation—Actuators**

### **D.1 General**

Delete first paragraph

### **D.2 Products for Validation**

#### **D.2.1 General**

Add to first paragraph

The geometric dimensioning and tolerancing (GD&T) and surface finishing of the equipment subjected to validation test shall be in accordance with production equipment manufacturing drawings and materials.

When lubricant is required for assembly of actuator internals, a viscosity not exceeding that of SAE 10W motor oil or equivalent shall be used.

Replace list item a) with

a) all seals and polymer/polymer-impregnated metal bearings replaced;

Add new list item a1) after list item a)

a1) drive train components that cannot withstand minimum of 1200 cycles replaced;

Add NOTE 2

NOTE 2 Drive train components are expected to withstand qualification cycles plus the cycles in design life. Fatigue analysis is an accepted method to demonstrate the compliance to this requirement.

#### **D.2.2 Testing Product**

Add to section

When the primary and secondary seal mechanisms in redundant designs (see 5.11.4) are not identical, the seal mechanisms shall be independently validated.

### **D.4 Test Orientation**

Replace first paragraph with

The orientation of the actuator during validation testing shall be per the specified installed orientation.

### **D.8 Temperature Stabilization**

Add to section

The temperature shall remain at or beyond the extreme during the hold period but should not go beyond the minimum and maximum temperatures by more than 11 °C (20 °F).

## D.9 Scaling

### D.9.1 General

Add to section

Scaling shall only be applied if specified.

If scaling is applied, additional verification by finite element analysis (FEA) shall be performed.

### D.9.2 Product Family

Add new list item d)

d) compensation system.

### D.9.3 Validation by Output Torque/Thrust

In first sentence, replace "50% x [x/2] and 150% x [1.5x]" with

75 % x and 125 % x

Add to section

Validation of the actuator shall qualify the actuator at equal or shallower water depths.

### D.9.4 Validation by Hydraulic Design Pressure

Replace section with

Scaling of design pressure shall not be permitted.

## D.10 Documentation

### D.10.2 Contents of Validation Files

Add new list item i)

i) place and time of test, with test personnel signature.

## D.11 Validation Procedure

### D.11.1 General

Replace first sentence of first paragraph with

Validation of actuators shall be performed by:

- a) following the procedure listed in Table D.1;
- b) completing endurance cycles as identified in D.14; and
- c) hyperbaric testing as per Annex F.

In third paragraph, replace "it shall simulate or exceed" with

it shall simulate the maximum capacity of the actuator or exceed

**Table D.1—Design Validation for Actuator**

Add new row before "fluid cleanliness check D.11.2"

Design Validation Tests	Reference Section
Make/break testing for retrievable actuators	D.13

Replace "Actuator operational test" (row 6) with

Design Validation Tests	Reference Section
Actuator operational test and relief valve test	D.11.7

Add new row after "Static operating torque/thrust output measurement (fixture only) D.11.8"

Design Validation Tests	Reference Section
Testing of valve and actuator assembly (when qualified with valve)	D.11.18

Add new row after "Actuator Operational Test (repeat) D.11.15"

Design Validation Tests	Reference Section
Testing of valve and actuator assembly (when qualified with valve) (repeat)	D.11.18

#### **D.11.5 Hydraulic Actuator Piston Seal Test**

Replace section with

The actuator seal test shall be performed three times in accordance with 10.3.3.5.

During the third test, the minimum hold period shall not be less than one hour, with 1 times the hydraulic design pressure applied.

Replace section D.11.7 title with

#### **D.11.7 Actuator Operational Test and Relief Valve Test**

Add to section

The actuators shall be tested in accordance with 10.3.3.7.1.

Relief valves shall be tested in accordance with 10.3.3.7.2.

#### **D.11.8 Static Operating Torque/Thrust Output Measurement (Fixture Only)**

In first paragraph, replace "pressure /input torque" with

pressure, input torque/thrust

### **D.11.9 Dynamic Open/Close Cycling Test at Ambient Temperature (Fixture or Valve)**

#### **D.11.9.2 Procedure**

In first sentence of fourth paragraph, replace "measured and recorded on cycles 1, 40, 80, 120 and 160." with

measured and recorded for each cycle.

### **D.11.10 Dynamic Test at Minimum/Maximum Rated Temperature**

In first sentence of second paragraph, replace "measured and recorded on cycles 1, 5, 10, 15 and 20." with

measured and recorded for each cycle.

### **D.11.11 Pressure and Temperature Cycle Test**

#### **D.11.11.2 Test Pressure and Temperature**

Replace second and third sentences with

Test temperature extremes shall be in accordance with 5.36.

#### **D.11.11.3 Test Procedure**

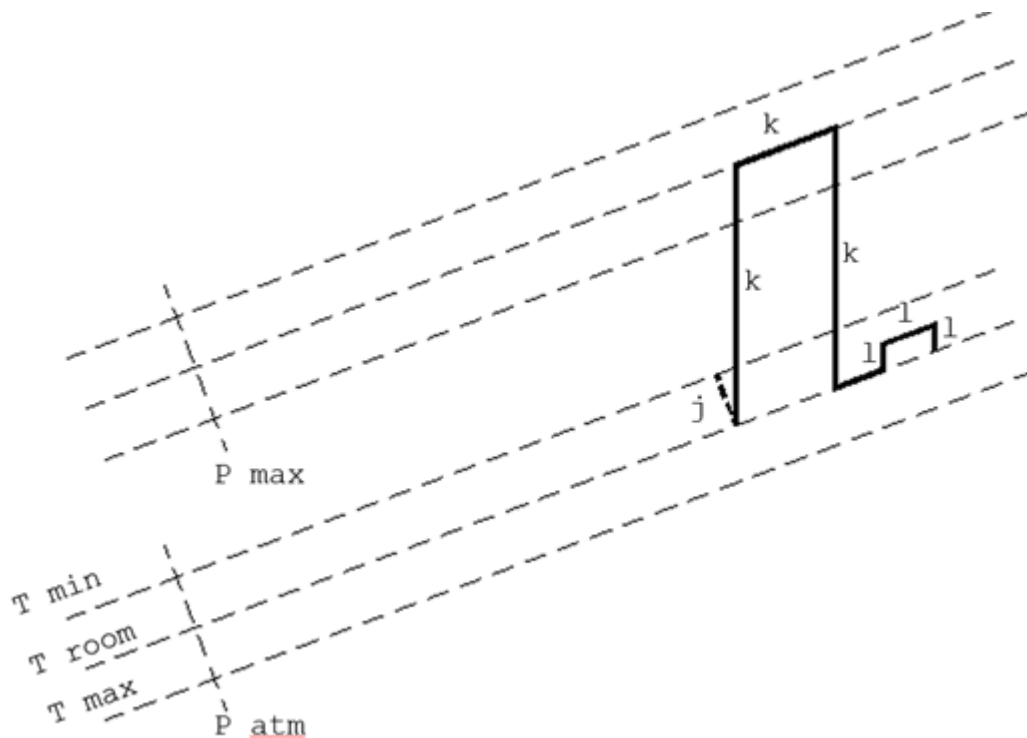
Add new list item k)

k) Apply the test pressure, hold for a minimum period of one hour, and then release the pressure.

Add new list item l)

l) Apply 5 % to 10 % of the test pressure, hold for a minimum period of one hour, and then release the pressure.

Add new steps k and l to Figure D.1



**Figure D.1—Test Procedure for Pressure Temperature Cycle**

Add to section

The pressure change observed during hold periods at high or low temperatures (steps b, d, g and i) shall be less than 5 % of the test pressure or 3.45 MPa (500 psi), whichever is less.

For hold periods at room temperature, pressure maintenance shall be as per 10.3.3.3.3.

No visible leakage shall be allowed.

Add new section

#### **D.11.18 Testing of Valve and Actuator Assembly**

Actuators shall be tested in accordance with 10.3.7.

#### **D.12 Post-test Examination**

Add to section

The tested prototype shall be disassembled and inspected.

Critical parts shall be photographed before and after the design validation test.

The design validation test procedure shall include traceability ID, critical dimensions, geometrical tolerances and surface finishes for critical components.

Critical dimensions, geometrical tolerances and surface finishes for critical components shall be compared pre- and post-test to ensure that they are within the design tolerances.

NDE methods used for the finished machined components during production shall be used for the post-test examination.

Fluorescent dye penetrant testing after strip down of the validation assembly shall be performed on metallic critical components.

Add new section

### D.13 Make/Break Testing for Retrievable Operators

Connection/connector make-break between the retrievable operator/pressure cap and valve mounting spool shall be tested for a minimum of three times.

Add new section

### D.14 Endurance Cycle Testing

Actuators shall be subjected to lifecycle/endurance testing in accordance with Table D.2.

Cycles performed with manual override and pressure cycling test shall not count towards the endurance cycles specified in Table D.2.

Design validation shall require the following:

- a) Completing the testing per Table D.1 in Annex D satisfies 200 of the endurance cycles.
- b) Completing the 200 hyperbaric cycles performed in accordance with F.2.2.2.4 step 3 satisfies 200 endurance cycles.
- c) Additional endurance cycles if specified in Table D.2 shall be performed in accordance with F.2.2.2.4 Step 3 or D.11.9 .
- d) After completion of total number of cycles as per Table D.2, following actuator functional tests shall be performed.
  - 1) Static operating force output measurement as per D.11.8.
  - 2) Hydraulic actuator seal test as per 10.3.3.5.
  - 3) When compensation chamber is provided, compensation chamber seal test as per 10.3.3.6.

Add new Table D.2

**Table D.2—Endurance Cycles**

Design Validation Cycles	Actuators for Pipeline Valves	Actuators for Manifold Valves
a) Minimum number of endurance cycles completed (PR2)	200	200
b) Minimum number of endurance cycles completed (hyperbaric)	200	200
c) Additional endurance cycles to be performed	200 <sup>a</sup>	200
<sup>a</sup> Additional endurance cycles if specified.		

In Annex E title, replace "informative" with "normative"

## **Annex E (normative) Design Validation—Gearbox**

### **E.1 General**

Delete first paragraph

### **E.2 Products for Validation**

#### **E.2.1 General**

Add to first paragraph

The geometric dimensioning and tolerancing (GD&T) and surface finishing of the equipment subjected to validation test shall be in accordance with production equipment manufacturing drawings and materials.

When lubricant is required for assembly of actuator internals, a viscosity not exceeding that of SAE 10W motor oil or equivalent shall be used.

Replace list item a) with

a) all seals, polymer/polymer-impregnated metal bearings replaced;

Add new list item a1) after list item a)

a1) drive train components that cannot withstand 1200 cycles minimum replaced;

Add NOTE 2

NOTE 2 Drive train components are expected to withstand qualification cycles plus the cycles in design life. Fatigue analysis is an accepted method to demonstrate the compliance to this requirement.

#### **E.2.2 Testing Product**

Add to section

When the primary and secondary seal mechanisms in redundant designs (see 5.11.4) are not identical, the seal mechanisms shall be independently validated.

### **E.4 Test Orientation**

Replace first paragraph with

The orientation of the gearbox during validation testing shall be per the specified installed orientation.

### **E.7 Temperature Stabilization**

Add to section

The temperature shall remain at or beyond the extreme during the hold period but should not go beyond the maximum and minimum temperatures by more than 11 °C (20 °F).

## E.8 Scaling

### E.8.1 General

Add to section

Scaling shall only be applied if specified.

If scaling is applied, additional verification by finite element analysis (FEA) shall be performed.

### E.8.3 Validation by Output Torque/Thrust

Replace “50 %X [X/2] and 150 % X [1.5X]” with

75 % x and 125 % x

Add to section

Validation of the gearbox shall qualify the gearboxes at equal or shallower water depths.

## E.9 Documentation

### E.9.2 Contents of Validation Files

Add new list item i)

i) place and time of test with test personnel signature.

## E.10 Validation Procedure

### E.10.1 General

Replace first sentence of first paragraph with

Validation of gearbox shall be performed by:

- a) following the procedure listed in Table E.1;
- b) completing endurance cycles as identified in E.12; and
- c) hyperbaric testing as per Annex F.

In third paragraph, replace “it shall simulate or exceed” with

it shall simulate the maximum capacity of the operator or, if specified, exceed

**Table E.1—Design Validation for Gearbox**

Add new row before “electrical continuity check E.10.2”

Design Validation Tests	Reference Section
Make/break testing for retrievable gearboxes (if applicable)	D.13

Add new row after "Static operating torque/thrust output measurement (fixture only) E.10.5"

Design Validation Tests	Reference Section
Testing of valve and gearbox assembly (when qualified with valve)	E.10.12

Add new row after " Operational Test (repeat) E.10.9"

Design Validation Tests	Reference Section
Testing of valve and gearbox (when qualified with valve) (repeat)	E.10.12

## E.10.6 Dynamic Test at Ambient Temperature

### E.10.6.2 Procedure

In first sentence of third paragraph, replace "measured and recorded on cycles 1, 40, 80, 120, and 160." with

measured and recorded for each cycle.

## E.10.7 Temperature Cycle Test

### E.10.7.2 Test Temperature

Replace section with

Test temperature extremes shall be in accordance with 5.36.

Add new section

## E.10.12 Testing of Valve and Gearbox Assembly

Gearboxes shall be tested in accordance with 10.3.7.

## E.11 Post-test Examination

Add to section

The tested prototype shall be disassembled and inspected.

Critical parts shall be photographed before and after the design validation test.

The design validation test procedure shall include traceability ID, critical dimensions, geometrical tolerances and surface finishes for critical components.

Critical dimensions, geometrical tolerances and surface finishes for critical components shall be compared pre- and post-test to ensure they are within the design tolerances.

NDE methods used for the finished machined components during production shall be used for the post-test examination.

Fluorescent dye penetrant testing after strip down of the validation assembly shall be performed on metallic critical components.

Add new section

**E.12 Endurance Cycle Testing**

Gearboxes shall be subjected to lifecycle/endurance testing in accordance with Table E.2.

Cycles performed under pressure cycling test shall not count towards the endurance cycles specified in Table E.2.

Design validation cycles shall require the following:

- a) Completing the testing as per Table E.1 satisfies 200 of the endurance cycles.
- b) Completing the 200 hyperbaric cycles performed in accordance with F.2.2.2.4 step 3 satisfies 200 of the endurance cycles.
- c) Additional endurance cycles if specified in Table E.2 shall be performed in accordance with F.2.2.2.4 Step 3 or E.10.6.
- d) After completion of total number of cycles as per Table E.2, following gearbox functional tests shall be performed:
  - 1) Static operating force output measurement as per E.10.5.
  - 2) Gearbox operational test as per 10.3.4.
  - 3) When compensation chamber is provided, gearbox housing and compensation chamber seal test as per 10.3.4.1.

Add new Table E.2

**Table E.2—Endurance Cycles**

<b>Design Validation Cycles</b>	<b>Gearboxes for Pipeline Valves</b>	<b>Gearboxes for Manifold Valves</b>
a) Minimum number of endurance cycles completed (PR2)	200	200
b) Minimum number of endurance cycles completed (hyperbaric)	200	200
c) Additional endurance cycles to be performed	200 <sup>a</sup>	200
<sup>a</sup> Additional endurance cycles if specified by purchaser		

In Annex F title, replace "informative" with "normative"

## **Annex F (normative) Hyperbaric Validation Testing**

### **F.1 General**

Delete "which shall be applied if specified by the manufacturer or purchaser" from first paragraph

Replace second paragraph with

The operator shall be tested on a valve or on a test fixture simulating the opening/closing dynamic force profile of the valve with the appropriate differential pressure.

When localized testing or testing using fixtures is required due to size limitations of the hyperbaric chamber, the design validation procedure shall provide the details of the test set-up and execution.

Delete NOTE

Add to section

When a test fixture is used, the test fixture shall simulate the maximum capacity of the operator or exceed the opening/closing static and dynamic thrust/torque values provided in 5.1.3, in the corresponding positions.

### **F.2 Minimum Design Validation Test Requirements**

#### **F.2.2 Hyperbaric Validation Tests**

##### **F.2.2.2 Hyperbaric Testing**

Replace section F.2.2.2.3 title with

##### **F.2.2.2.3 Step-2—Hydrostatic Shell Test and Pressure Cycling Test in Hyperbaric Conditions**

Add new section heading before first paragraph

##### **F.2.2.2.3.1 Step-2.1—Hydrostatic Shell Test in Hyperbaric Conditions**

###### a) Requirements

Replace first paragraph with

A hydrostatic shell test (see Table F.1) shall be performed with external hyperbaric pressure equal to 1.1 times the design water depth.

The test pressure in the hydraulic operator cylinder shall be the environmental pressure plus at least 1.1 times the design pressure of the actuator.

The test shall consist of three parts:

- 1) primary pressure-holding period;
- 2) reduction of the pressure to zero;
- 3) secondary pressure-holding period.

The primary pressure-holding period shall not be less than three minutes.

The secondary pressure-holding period shall not be less than one hour.

The test period shall not start until:

- the test pressure has been reached;
- the test pressure stabilization has occurred; and
- the equipment and pressure-monitoring device have been isolated from the pressure source.

Internal pressure shall be monitored throughout testing.

Add new section

**F.2.2.2.3.2 Step 2.2—Pressure-cycling Test in Hyperbaric Conditions**

Hydraulic actuators shall be subjected to repetitive pressure-cycling tests that occur in long-term service considering a static working condition.

The hydraulic actuator cylinder and piston shall be alternately pressurized and depressurized in a static condition with the external hyperbaric pressure equal to 1.1 times the design water depth applied, as follows.

- a) For double acting actuators, the hydraulic actuator cylinder and piston seals shall be alternately pressurized to the environmental pressure plus the design pressure and then fully depressurized for a minimum of 200 pressurization-depressurization cycles.
- b) For single acting actuators, the hydraulic actuator cylinder and piston seals shall be alternately pressurized to the environmental pressure plus the design pressure and then depressurized at the minimum holding pressure, as defined by the actuator manufacturer, for a minimum of 200 pressurization-depressurization cycles.

**F.2.2.2.4 Step 3—Hyperbaric Endurance Test**

- a) Requirements

In first paragraph, replace "design pressure specified in 5.4" with

environmental pressure plus maximum rated pressure

- b) Acceptance criteria

Add to section

Actuator stroking times (open and close) shall be equal to the minimum permitted by the design.

Add new section

**F.2.2.2.5 Step 4—Actuator Seal Test**

- a) Requirements

The hydraulic actuator piston seal test shall be performed as per 10.3.3.5 with the following holding period and test pressures.

The minimum hold time shall be one hour for the secondary test.

The test pressures shall be:

- environmental pressure plus at least 0.2 times the hydraulic cylinder design pressure for primary test; and
- environmental pressure plus at least 1.0 times the hydraulic design pressure of the actuator for secondary test.

The external hyperbaric pressure shall be 1.1 times the design water depth applied.

b) Acceptance criteria

The acceptance criterion shall be “no visible detectable leakage”.

Add new section

**F.2.2.2.6 Step 5—Hyperbaric Ingress Test (Repeat)**

The hyperbaric ingress test shall be repeated in accordance with F.2.2.2.2.

**F.3 Scaling**

In second paragraph, replace "50 %x [x/2] and 150 %x [1.5x]" with

75 % x and 125 % x

Replace last paragraph with

If scaling is applied, additional verification by finite element analysis (FEA) shall be performed.

## **Annex G** (normative) **Requirements for Nondestructive Examination**

### **G.1 General**

Replace section with

The NDE requirements for operator components shall be in accordance with quality level 2 (QL-2).

### **G.2 Specification of Quality Levels**

Delete "QL-1 and" from first sentence

### **G.5 Ultrasonic Testing (UT) of Castings**

Add to section after second paragraph

For hollow sections where surface NDE is not possible, UT shall be performed with a beam probe with normal beam probe 1.6 mm (0.06 in.) flat bottom hole in addition to the regular volumetric NDE practices.

A UT scan plan shall be prepared prior to the examination.

### **G.6 UT of Forgings and Plate**

Add to section

A UT scan plan shall be prepared prior to the examination.

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

### **G.9 Magnetic Particle Testing (MT) of Castings on 100 % of Surface Area**

Add to section after first paragraph

Machined surfaces shall be examined using wet fluorescent particles.

When MT is not possible on internal diameters of hollow/machined castings after the final machining stage, UT shall be performed in accordance with G.5 at the rough machining stage.

Add to section

The magnetization scan plan shall be prepared prior to examination.

### **G.10 MT of Forgings, Weldments, and Bolting**

Add to section after first paragraph

Machined surfaces shall be examined using wet fluorescent particles.

When MT is not possible on internal diameters of hollow/machined forgings after the final machining stage, UT shall be performed in accordance with G.6 at the rough machining stage.

Add to section

Surface examination of bolting shall be performed in accordance with IOGP S-724 or IOGP S-725.

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

## **G.12 Penetrant Testing (PT) of Castings**

Add to section after first paragraph

When PT is not possible on internal diameters of hollow/machined castings after the final machining stage, UT shall be performed in accordance with G.5 at the rough machining stage.

## **G.13 PT of Forgings, Weldments, Weld Overlay, Bolting, and Seal Welds**

Replace second paragraph with

For stainless steel or higher-grade material, the acceptance criteria shall be in accordance with ASME BPVC, Section VIII, Division 1, Appendix 8, with the following modification: no relevant rounded indication with a major dimension equal to or greater than 3 mm ( $1/8$  in.).

Add to section

PT for carbon steel and low-alloy steel forgings shall be performed only when it is not possible to access the surface for MT.

When PT is not possible on internal diameters of hollow/machined forgings after final machining stage, UT shall be performed in accordance with G.6 at the rough machining stage.

PT examination and acceptance criteria shall be in accordance with IOGP S-724 or IOGP S-725.

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

Replace section G.16 title with

## **G.16 VT of Forgings, Plate, and Bolting**

Replace section with

Forgings and plate in the final condition shall be visually examined on all accessible surfaces.

The light intensity at the examination surface shall be a minimum of 1076 lx.

Forgings and plate shall be free from cracks, seams, laps, folds, pipe, segregation, underfills, scale and other imperfections.

VT examination and acceptance criteria shall be in accordance with IOGP S-724 or IOGP S-725.

Pressure-containing carbon steel or low alloy steel forgings, including forged bars, shall be in accordance with DNVGL-RP-0034 SFC-1, unless otherwise specified in the data sheet.

## G.19 Visual Examination (VT) of Sealing Surfaces

Replace first paragraph with

Examination shall be carried out in accordance with ASME *BPVC*, Section V, Article 9 or ISO 17637.

Replace second paragraph with

No surface indications shall be permitted on or within 3 mm (0.125 in.) of sealing surfaces.

**Table G.1—NDE Requirements**

Replace Table G.1 with

Part	QL-2		
	Cast	Forged	Plate
Pressure containing parts	VT1 and RT3 and UT4 and MT1 or PT1	VT2 and UT2 and MT1 or PT1	VT2 and UT2 and MT1 or PT1
Stem or shaft or rod a, b	N/A	VT2 and UT2 and MT1 or PT1	N/A
Bolting (pressure-containing)	N/A	VT2 and UT2 and MT1 or PT1	N/A
Corrosion-resistant overlay	VT3 and UT3 and PT1		
Seal and gaskets	VT4		
Springs	VT4 and UT2		
Pressure-containing welds <sup>c</sup>	VT3 and RT2 or UT3 and MT1 or PT1		
Reinforcement and stiffening welds	VT3		
Fillet and attachment welds to pressure-containing parts	VT3 and MT1 or PT1		
Plating	VT4		
Hardfacing	VT4 and PT1 and VT5		
Sealing surfaces	VT2 and MT2 or PT2		
NOTE 1 See Table G.2 for specification of the examinations referred to in this table.			
NOTE 2 N/A means that the manufacturer is not allowed to use this material form for that specific part.			
NOTE 3 All the NDE activities listed above for a specific product form or forms to be performed.			
<sup>a</sup> MT or PT to be performed prior to coating or overlay. <sup>b</sup> Requirements for examination of bar material shall be as for forgings. <sup>c</sup> In case of narrow groove welds (below 25°), both RT and UT shall be performed.			

**Table G.2—Extent, Method, and Acceptance Criteria of NDE/Item Examination Code**

*In Table G.2, replace item PT1 with*

<b>Exam</b>	<b>NDE</b>	<b>Extent</b>	<b>Method</b>	<b>Acceptance</b>
PT1	PT all products	100 % accessible external and internal surfaces	G.12, G.13	G.12, G.13

## **Annex H (informative) Castings and Forgings**

### **H.1 General**

Delete NOTE

Add new Annex J

## Annex J (normative) Material Data Sheets (MDSs)

**Table J.1—Material Data Sheet No. S-731M-22CrB**

Material Data Sheet		MDS No. S-731M-22CrB <sup>a</sup>			Rev. 01
<b>TYPE OF MATERIAL:</b> Ferritic -Austenitic Stainless Steel Type 22Cr Duplex					
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT	
Bars	ASTM A276	UNS S31803	-	-	
	ASTM A276	UNS S32205	-	-	
	ASTM A479	UNS S31803	-	-	
	ASTM A479	UNS 32205	-	-	
	ASTM A182	F51 (UNS S31803)	-	-	
	ASTM A182	F60 (UNS S32205)	-	-	
<b>Scope</b>	<p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 or NPS 4 and under manufactured from bars. Valve parts with holes/bores may be machined from bar provided the axis of the bore is in the same direction as axis of the bar.</p> <p>Product covered by this MDS is limited to a maximum thickness of 300 mm (12 in.).</p>				
<b>Qualification</b>	Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS.				
<b>Metal Making</b>	The melt shall be refined by argon oxygen decarburization (AOD) or equivalent method.				
<b>Manufacturing</b>	<p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> <li>– bar forgings as defined in ASTM A788 and certified to ASTM A182; or</li> <li>– hot or cold finished cylindrical shaped bar manufactured to ASTM A276 or A479 with maximum diameter of 300 mm (12 in.).</li> </ul> <p>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination). Cold drawing and cold forming are not permitted.</p>				
<b>Chemical Composition</b>	<p>UNS S31803: N = 0.14 % - 0.20 %</p> <p>PREN ≥ 34.0 (where PREN = Cr% + 3.3 * (Mo% + 0.5*W%) + 16* N%)</p> <p>A product chemical analysis shall be taken per melt of material.</p>				
<b>Heat Treatment</b>	<p>Bars shall be solution annealed followed by water/liquid quenching.</p> <p>Bars shall be placed to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.</p>				
<b>Tensile Testing</b>	Tensile testing shall be carried out at a minimum of T/4 from external surface. Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centerline of the tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370-19e1, Annex A1.				
<b>Impact Testing / Toughness Testing</b>	<p>Except as modified in this MDS, sampling and acceptance criteria shall comply with the specified ISO 17781 QL.</p> <p>When impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J (33 ft lbf) average, 35 J (26 ft lbf) minimum single.</p>				
<b>Corrosion Testing</b>	The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the bar.				

<b>Material Data Sheet</b>		<b>MDS No. S-731M-22CrB <sup>a</sup> (continued)</b>	<b>Rev. 01</b>
<b>Micrographic Examination</b>	The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the bar and sample an area of 10 mm (0.4 in.) by 10 mm (0.4 in.) minimum.		
<b>Extent of Testing</b>	Tensile tests, impact tests and corrosion tests, and micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484.		
<b>Test Sampling</b>	<p>The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance of minimum 100 mm (4 in.) from the end of the bar.</p> <p><u>Valve parts manufactured from bar</u></p> <p>For bars with outside diameter <math>\geq</math> 100 mm (4 in.) intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. The tangential specimen shall be located at the same location as the longitudinal sample. Acceptance criteria shall comply with this MDS.</p>		
<b>Non-destructive Testing</b>	<p><u>Visual inspection</u></p> <p>VT shall be carried out on each bar in accordance with the Annex G. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.</p> <p><u>Ultrasonic inspection</u></p> <p>Required on all bars and as per EN 10228-4. Use Annex G for acceptance criteria.</p> <p><u>Dye penetrant inspection</u></p> <p>All components after final machining shall be inspected as per ASTM E165 with acceptance criteria as per Annex G.</p>		
<b>Repair of Defects</b>	Weld repair are not permitted		
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements)</b>	<p>When sour service requirements are specified, the material shall conform to ISO 15156 /NACE MR0175 and the following additional requirements of this MDS.</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 28 HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.</p>		
<b>Surface Treatment and Finish</b>	The finished product shall be white pickled and passivated. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.		
<b>Marking</b>	The bars shall be marked to ensure full traceability to heat and heat treatment lot.		
<b>Certification</b>	<p>The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.</p> <p>The inspection documents shall be prepared in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> <li>– Material process specification (MPS) identification or the manufacturing process qualification record (MPQR)/ qualification test record/ report (QTR) number used.</li> <li>– Steel manufacturer of starting material and steelmaking practice.</li> <li>– Solution annealing temperature, holding time and quenching medium.</li> <li>– Original digital microstructure photographs describing the exact location of sampling, magnification and detailing the findings clearly.</li> <li>– A list of all NDE carried out stating which standards the material complies with.</li> </ul>		
<p><sup>a</sup> The supplementary suffix “S” shall be used to designate a material delivered in accordance with this MDS plus the additional requirements for sour service.</p>			

**Table J.2—Material Data Sheet No. S-731M-22CrF**

Material Data Sheet		MDS No. S-731M-22CrF <sup>a</sup>			Rev. 01
<b>TYPE OF MATERIAL:</b> Austenitic Stainless Steel Type 22Cr Duplex					
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT	
Forgings	ASTM A182	F51 (UNS S31803)	-	-	
	ASTM A182	F60 (UNS S32205)	-	-	
<b>Scope</b>	This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. Product covered by this MDS is limited to a maximum thickness of 300 mm (12 in.). Material process specification (MPS) and MPQ shall be prepared prior to production.				
<b>Qualification</b>	Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.				
<b>Metal Making</b>	The melt shall be refined by argon oxygen decarburization (AOD) or equivalent method.				
<b>Manufacturing</b>	Forgings shall have minimum reduction ratio / forging ratio of 4:1. Reduction ratio shall be calculated as defined in API 20B.				
<b>Chemical Composition</b>	UNS S31803: N = 0.14 % - 0.20 % PREN ≥ 34 (where PREN = Cr% + 3.3 * (Mo% + 0.5*W%) + 16* N%) A product chemical analysis shall be taken per melt of material.				
<b>Heat Treatment</b>	Forgings shall be solution annealed followed by water/liquid quenching. Forgings shall be placed in such a way as to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.				
<b>Tensile Testing</b>	Tensile testing shall be carried out in both longitudinal and transverse directions and sampling locations shall be as per API Specification 6A.				
<b>Impact Testing / Toughness Testing</b>	Sampling and acceptance criteria shall comply with the specified ISO 17781 QL.				
<b>Corrosion Testing</b>	The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the forging.				
<b>Extent of Testing</b>	Tensile tests, impact tests and corrosion tests, and micrographic examination including ferrite measurements shall be carried out for each heat – heat treatment lot as defined below: The testing shall be carried out on the forging with heaviest wall thickness within the heat treatment load. A test lot shall not exceed: – 2 000 kg (4 400 lb) for forgings with as forged weight up to 50 kg (110 lb); and – 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb).				
<b>Micrographic Examination</b>	The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the forging and sample an area of 10 mm (0.4 in.) by 10 mm (0.4 in.) minimum.				
<b>Test Sampling</b>	Test sampling shall be carried out on prolongation or a sacrificial as per ISO 17781. Prolongation shall be integral part of the main forging until last heat treatment is carried out. Tensile test samples shall be taken at same location and in transverse direction, when size permits, as Charpy V-notch (CVN) test samples.				
<b>Non-destructive Testing</b>	<p><u>Visual inspection</u> VT shall be carried out on each 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.</p> <p><u>Ultrasonic inspection</u> Required on all forgings and as per EN 10228-4. Use Annex G for acceptance criteria. Scan plan shall be included in pre-production documents.</p> <p><u>Dye penetrant inspection</u> All components after final machining shall be inspected as per ASTM E165 with acceptance criteria as per Annex G.</p>				

<b>Material Data Sheet</b>		<b>MDS No. S-731M-22CrF <sup>a</sup> (continued)</b>	<b>Rev. 01</b>
<b>Repair of Defects</b>	Weld repair are not permitted.		
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements)</b>	<p>When sour service requirements are specified by the purchaser, the material shall conform to ISO 15156 /NACE MR0175 and the following additional requirements to this MDS.</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with ASTM A370/A1058 on two forgings per lot. The maximum hardness shall be 28 HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.</p>		
<b>Surface Treatment and Finish</b>	The finished product shall be white pickled and passivated. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.		
<b>Marking</b>	The forgings shall be marked to ensure full traceability to heat and heat treatment lot.		
<b>Certification</b>	<p>The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> <li>– MPS identification or the manufacturing process qualification record (MPQR)/ qualification test record/ report (QTR) number used.</li> <li>– Steel manufacturer of starting material and steelmaking practice.</li> <li>– Solution annealing temperature, holding time and quenching medium shall be stated.</li> <li>– Microstructure (original digital) photographs describing exact location of sampling, magnification and detailing the findings clearly.</li> <li>– All NDE carried out stating which standards material complies with.</li> </ul>		
<p><sup>a</sup> The supplementary suffix "S" shall be used to designate a material delivered in accordance with this MDS plus the additional requirements for sour service.</p>			

**Table J.3—Material Data Sheet No. S-731M-25CrB**

Material Data Sheet		MDS No. S-731M-25CrB <sup>a</sup>			Rev. 01
<b>TYPE OF MATERIAL:</b> Ferritic -Austenitic Stainless Steel Type 25Cr Duplex					
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT	
Bars	ASTM A276	UNS S32750	-	-	
	ASTM A276	UNS S32760	-	-	
	ASTM A479	UNS S32750	-	-	
	ASTM A479	UNS S32760	-	-	
	ASTM A182	F53 (UNS S32750)	-	-	
	ASTM A182	F55 (UNS S32760)	-	-	
<b>Scope</b>	<p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 or NPS 4 and under manufactured from bars. Valve parts with holes/bores may be machined from bar provided the axis of the bore is in the same direction as axis of the bar.</p> <p>Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in.).</p>				
<b>Qualification</b>	Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or Norsok M-650. The qualification testing shall meet the requirements of this MDS.				
<b>Metal Making</b>	The melt shall be refined by argon oxygen decarburization (AOD) or equivalent method.				
<b>Manufacturing</b>	<p>Bars shall be manufactured to the following requirements:</p> <ul style="list-style-type: none"> <li>– bar forgings as defined in ASTM A788 and certified to ASTM A182; or</li> <li>– hot or cold finished cylindrical shaped bar manufactured to ASTM A276 or A479 with maximum diameter of 200 mm (8 in.).</li> </ul> <p>Cold finishing shall be restricted to turning, grinding or polishing, singly or in combination. Cold drawing and cold forming are not permitted.</p>				
<b>Chemical Composition</b>	<p><math>PREN \geq 40.0</math> (where <math>PREN = Cr\% + 3.3 * (Mo\% + 0.5 * W\%) + 16 * N\%</math>)</p> <p>A product chemical analysis shall be taken per melt of material.</p>				
<b>Heat Treatment</b>	<p>Bars shall be solution annealed followed by water/liquid quenching.</p> <p>Bars shall be placed to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.</p>				
<b>Tensile Testing</b>	Tensile testing shall be carried out a minimum of T/4 from external surface. Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centerline of the tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370-19e1, Annex A1.				
<b>Impact Testing / Toughness Testing</b>	<p>Except as modified in this MDS, sampling and acceptance criteria shall comply with the specified ISO 17781 QL.</p> <p>When impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J (33 ft lbf) average, 35 J (26 ft lbf) minimum single.</p>				
<b>Corrosion Testing</b>	The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the bar.				
<b>Micrographic Examination</b>	The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the bar and sample an area of 10 mm (0.4 in.) by 10 mm (0.4 in.) minimum.				
<b>Extent of Testing</b>	Tensile tests, impact tests and corrosion tests, and micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484.				

<b>Material Data Sheet</b>		<b>MDS No. S-731M-25CrB<sup>a</sup> (continued)</b>	<b>Rev. 01</b>
<b>Test Sampling</b>	<p>The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance of minimum 100 mm (4 in.) from the end of the bar.</p> <p>Valve parts manufactured from bar:</p> <p>For bar with outside diameter <math>\geq</math> 100 mm (4 in.) intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. The tangential specimen shall be located at the same location as the longitudinal sample. Acceptance criteria shall comply with this MDS.</p>		
<b>Non-destructive Testing</b>	<p><u>Visual inspection</u></p> <p>VT shall be carried out on each 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.</p> <p><u>Ultrasonic inspection</u></p> <p>Required on all bars and as per EN 10228-4. Use Annex G for acceptance criteria.</p> <p><u>Dye penetrant inspection</u></p> <p>All components after final machining shall be inspected as per ASTM E165 with acceptance criteria as per Annex G.</p>		
<b>Repair of Defects</b>	<p>Weld repair shall not be permitted.</p>		
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements)</b>	<p>When sour service requirements are specified by the purchaser, the material shall conform to ISO 15156 /NACE MR0175 and the following additional requirements of this MDS.</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with ASTM A370/A1058 on the end surface of one bar per lot. The maximum hardness shall be 32 HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.</p>		
<b>Surface Treatment and Finish</b>	<p>The finished product shall be white pickled and passivated. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.</p>		
<b>Marking</b>	<p>The bars shall be marked to ensure full traceability to heat and heat treatment lot.</p>		
<b>Certification</b>	<p>The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> <li>– Material process specification (MPS) identification or the manufacturing process qualification record (MPQR)/ qualification test record/ report (QTR) number used.</li> <li>– Steel manufacturer of starting material and steelmaking practice.</li> <li>– Solution annealing temperature, holding time and quenching medium.</li> <li>– Original digital microstructure photographs describing the exact location of sampling, magnification and detailing the findings clearly.</li> <li>– A list of all NDE carried out stating which standards the material complies with.</li> </ul>		
<p><sup>a</sup> The supplementary suffix “S” shall be used to designate a material delivered in accordance with this MDS plus the additional requirements for sour service.</p>			

**Table J.4—Material Data Sheet No. S-731M-25CrF**

Material Data Sheet		MDS No. S-731M-25CrF <sup>a</sup>			Rev. 01
<b>TYPE OF MATERIAL:</b> Ferritic -Austenitic Stainless Steel Type 25Cr Duplex					
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT	
Forgings	ASTM A182	F53 (UNS S32750)	-	-	
	-	F55 (UNS S32760)	-	-	
	ASTM A182	F61 (UNS S32550)	-	-	
<b>Scope</b>	This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. Product covered by this MDS is limited to a maximum thickness of 200 mm (8 in.). Material process specification (MPS) and MPQ shall be prepared prior to production.				
<b>Qualification</b>	Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.				
<b>Metal Making</b>	The melt shall be refined by argon oxygen decarburization (AOD) or equivalent method.				
<b>Manufacturing</b>	Forgings shall have minimum reduction ratio / forging ratio of 4:1. Reduction ratio shall be calculated as defined in API Specification 20B.				
<b>Chemical Composition</b>	$PREN \geq 40.0$ (where $PREN = Cr\% + 3.3 * (Mo\% + 0.5*W\%) + 16* N\%$ ) A product chemical analysis shall be taken per melt of material.				
<b>Heat Treatment</b>	Forgings shall be solution annealed followed by water/liquid quenching. Forgings shall be placed to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.				
<b>Tensile Testing</b>	Tensile testing shall be carried out in both longitudinal and transverse directions and sampling locations shall be as per API Specification 6A.				
<b>Impact Testing / Toughness Testing</b>	Sampling and acceptance criteria shall comply with the specified ISO 17781 QL.				
<b>Corrosion Testing</b>	The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the forging.				
<b>Micrographic Examination</b>	The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the center of the forging and sample an area of 10 mm (0.4 in.) by 10 mm (0.4 in.) minimum.				
<b>Extent of Testing</b>	Tensile tests, impact tests and corrosion tests, and micrographic examination including ferrite measurements shall be carried out for each heat – heat treatment lot as defined below: The testing shall be carried out on the forging with heaviest wall thickness within the heat treatment load. A test lot shall not exceed: – 2 000 kg (4 400 lb) for forgings with as forged weight up to 50 kg (110 lb); and – 5 000 kg (11 000 lb) for forgings with as forged weight > 50 kg (110 lb).				
<b>Test Sampling</b>	Test sampling shall be carried out on prolongation or a sacrificial as per ISO 17781. Prolongation shall be integral part of the main forging until last heat treatment is carried out. Tensile test samples shall be taken at same location and in transverse direction, when size permits, as Charpy V-notch (CVN) test samples.				
<b>Non-destructive Testing</b>	<u>Visual inspection</u> VT shall be carried out on each 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. <u>Ultrasonic inspection</u> Required on all forgings and as per EN 10228-4. Use Annex G for acceptance criteria. Scan plan shall be included in pre-production documents. <u>Dye penetrant inspection</u> All components after final machining shall be inspected as per ASTM E165 with acceptance criteria as per Annex G.				
<b>Repair of Defects</b>	Weld repairs are not permitted.				

<b>Material Data Sheet</b>		<b>MDS No. S-731M-25CrF<sup>a</sup> (continued)</b>	<b>Rev. 01</b>
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements)</b>	<p>When sour service requirements are specified by the purchaser, the material shall conform to ISO 15156 /NACE MR0175 and the following additional requirements of this MDS.</p> <p><u>Hardness testing</u></p> <p>Production hardness testing shall be performed in accordance with ASTM A370/A1058 on two forgings per lot. The maximum hardness shall be 32 HRC from three readings taken in close proximity.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.</p>		
<b>Surface Treatment and Finish</b>	<p>The finished product shall be white pickled and passivated. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.</p>		
<b>Marking</b>	<p>The forgings shall be marked to ensure full traceability to heat and heat treatment lot.</p>		
<b>Certification</b>	<p>The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> <li>– MPS identification or the manufacturing process qualification record (MPQR)/ qualification test record/ report (QTR) number used.</li> <li>– Steel manufacturer of starting material and steelmaking practice.</li> <li>– Solution annealing temperature, holding time and quenching medium shall be stated.</li> <li>– Original digital microstructure photographs describing the exact location of sampling, magnification and detailing the findings clearly.</li> <li>– A list of all NDE carried out stating which standards the material complies with.</li> </ul>		
<p><sup>a</sup> The supplementary suffix “S” shall be used to designate a material delivered in accordance with this MDS plus the additional requirements for sour service.</p>			

**Table J.5—Material Data Sheet No. S-731M-625F**

Material Data Sheet		MDS No. S-731M-625F <sup>a</sup>			Rev. 01
TYPE OF MATERIAL: Nickel alloy type 625					
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT	
Forgings	ASTM B564	UNS N06625	-	ASTM B564 S5.3	
<b>Scope</b>	This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.				
<b>Metal Making</b>	Basic electric furnace (EF) melt shall be refined by argon oxygen decarburization (AOD) or vacuum oxygen decarburization (VOD) followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR.				
<b>Heat Treatment</b>	Forgings or forged bars shall be supplied in annealed condition. Forgings shall be placed to ensure free circulation of heating and cooling media around each component during the heat treatment process including any rapid cooling/quenching.				
<b>Extent of Testing</b>	A lot shall consist of all forgings of the same type, size, and wall thickness, manufactured from one heat of material which are heat treated in same batch. A test sampling plan shall be prepared as part of the manufacturing procedure specification.				
<b>Non-destructive Testing</b>	All NDE shall be carried out in accordance with Annex G.				
<b>Repair of Defects</b>	Weld repairs are not permitted.				
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements) <sup>a</sup></b>	The material shall conform to ISO 15156 /NACE MR0175 and this MDS. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.				
<b>Surface Treatment and Finish</b>	The finished components shall be pickled. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.				
<b>Marking</b>	The component shall be marked to ensure full traceability to heat and heat treatment lot.				
<b>Certification</b>	The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard. The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification. The inspection documents shall include the following information: – Heat treatment condition (annealing temperature shall be stated).				
<sup>a</sup> The supplementary suffix “S” designates a material delivered in accordance with this MDS plus the additional requirements for sour service.					

**Table J.6—Material Data Sheet No. S-731M-625B**

Material Data Sheet		MDS No. S-731M-625B <sup>a</sup>			Rev. 01
TYPE OF MATERIAL: Annealed nickel alloy					
PRODUCT FORM	STANDARD	GRADE	ACCEPTANCE CLASS	SUPPLEMENTARY REQUIREMENT	
Bars	ASTM B446	UNS N06625 Grade 1	-	-	
<b>Scope</b>	<p>This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.</p> <p>This MDS includes additional requirements for valve parts DN 100 or NPS 4 and under manufactured from bars. Valve parts with holes/bores may be machined from bar provided the axis of the bore is in the same direction as axis of the bar.</p> <p>Product covered by this MDS is limited to a maximum thickness of 300 mm (12 in.).</p>				
<b>Metal Making</b>	Basic electric furnace (EF) melt shall be refined by argon oxygen decarburization (AOD) or vacuum oxygen decarburization (VOD) followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR.				
<b>Heat Treatment</b>	Bars shall be placed to ensure free circulation of heating and cooling media around each bar during the heat treatment process including any rapid cooling/quenching.				
<b>Non-destructive Testing</b>	All NDE shall be carried out in accordance with Annex G.				
<b>Repair of Defects</b>	Weld repairs are not permitted.				
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements)</b>	<p>The material shall conform to ISO 15156 /NACE MR0175 and this MDS.</p> <p>The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.</p>				
<b>Surface Treatment and Finish</b>	The finished bars shall be white pickled. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.				
<b>Marking</b>	The bars shall be marked to ensure full traceability to heat and heat treatment lot.				
<b>Certification</b>	<p>The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> <li>– Heat treatment condition (annealing temperature shall be stated).</li> </ul>				
<sup>a</sup> The supplementary suffix "S" designates a material delivered in accordance with this MDS plus the additional requirements for sour service.					

**Table J.7—Material Data Sheet No. S-731M-718F**

<b>Material Data Sheet</b>		<b>MDS No. S-731M-718<sup>a</sup></b>			<b>Rev. 01</b>
<b>TYPE OF MATERIAL:</b> Nickel alloys					
<b>PRODUCT FORM</b>	<b>STANDARD</b>	<b>GRADE</b>	<b>ACCEPTANCE CLASS</b>	<b>SUPPLEMENTARY REQUIREMENT</b>	
Forging / Forged bar / Rolled bar	API Standard 6ACRA	UNS N07718	120K	ASTM A962 S56	
<b>Scope</b>	This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.				
<b>Heat Treatment</b>	Solution annealing and ageing heat treatment shall be carried out after the final hot forming operation. Quenching media is restricted to the qualified manufacturing route.				
<b>Impact Testing / Toughness Testing</b>	The impact testing requirements of API Standard 6ACRA shall apply.				
<b>Hardness</b>	Maximum hardness 40 HRC.				
<b>Macro Etch/ Micrographic Examination</b>	Forging or bar shall be examined in accordance with API Standard 6ACRA and meet the required acceptance criteria.				
<b>Extent of Testing</b>	Extent of testing in accordance with API Standard 6ACRA.				
<b>Non-Destructive Testing</b>	All NDE shall be carried out in accordance with Annex G.				
<b>Repair of Defects</b>	Weld repairs are not permitted.				
<b>Sour Service (Additional Metallurgical, Manufacturing, Testing and Certification Requirements)</b>	The material shall conform to ISO 15156 /NACE MR0175 and this MDS. The material shall be traceable in accordance with ISO 15156-3 /NACE MR0175-3:2015, 7.2 and this MDS.				
<b>Surface Treatment and Finish</b>	White pickled. Machined surfaces do not require pickling provided proper handling and storage procedures are implemented avoiding any contamination.				
<b>Marking</b>	Each forging/bar shall be marked to ensure full traceability to melt and heat treatment lot.				
<b>Certification</b>	<p>The manufacturer shall demonstrate that the quality management arrangements established for the supply of products and services conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard.</p> <p>The inspection documents shall be issued in accordance with ISO 10474 or EN 10204 Type 3.1 and shall confirm compliance with this specification.</p> <p>The inspection documents shall include the following information:</p> <ul style="list-style-type: none"> <li>– Material process specification (MPS) identification or the manufacturing process qualification record (MPQR)/ qualification test record/ report (QTR) number used.</li> <li>– Steel manufacturer, melting and refining practice.</li> <li>– Heat treatment condition. Solution annealing temperature, quenching medium, ageing temperature and holding time.</li> <li>– Legible photo micrographs stating phases detected, topographical duplex grains, intermetallic phases or precipitates, etc.</li> </ul>				
<sup>a</sup> The supplementary suffix "S" designates a material delivered in accordance with this MDS plus the additional requirements for sour service.					



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