International Association of Oil & Gas Producers

SPECIFICATION
S-707

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Supplementary Specification to ISO 12490 Actuators for On-off Valves

JIP33
JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
1.0	October 2020	Issued for Use

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).

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 2014).

Table of Contents

List of Tables

List of Figures

Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of actuators for on-off valves in accordance with ISO 12490 First Edition, 2011, Petroleum and natural gas industries — Mechanical integrity and sizing of actuators and mounting kits for pipeline valves, for application in the petroleum and natural gas industries.

This JIP33 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 data sheet, quality requirements specification (QRS) and information requirements specification (IRS) as follows.

IOGP S-707: Supplementary Specification to ISO 12490 Actuators for On-off Valves

This specification defines the technical requirements for the supply of the equipment and is written as an overlay to ISO 12490, following the ISO 12490 clause structure. Clauses from ISO 12490 not amended by this specification apply as written to the extent applicable to the scope of supply.

Modifications to ISO 12490 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-707D: Data Sheet for Actuators for On-off Valves

The data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The 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 data sheet, to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-707Q: Quality Requirements for Actuators for On-off Valves

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 systems (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.

IOGP S-707L: Information Requirements for Actuators for On-off Valves

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.

The terminology used within this specification and the supporting data sheet, QRS and IRS follows that of ISO 12490 and is in accordance with ISO/IEC Directives, Part 2 as appropriate.

The data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. This 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 (data sheet, QRS, IRS);

d) this specification;

e) ISO 12490.

1 Scope

Replace clause with

This specification amends and supplements ISO 12490:2011 for the design, selection, mechanical integrity, sizing, manufacture, assembly and integration testing of actuators and actuator control equipment for on-off valves.

This specification is applicable to all types of electric, pneumatic, hydraulic and electro-hydraulic actuators, with or without gear boxes, and mounting kit for part turn, multi turn and linear valves.

This specification covers the actuators installed in oil and gas (offshore and onshore), petrochemical and chemical facilities.

This specification is not applicable to actuators installed on control valves, valves being used for regulation, valves in subsea service, Xmas tree valves, handheld power devices and stand-alone manually operated gearboxes.

2 Conformance

2.3 Compliance with this International Standard

Replace first paragraph with

The supplier shall demonstrate that the quality management arrangements established for the supply of actuators for on-off valves to this specification conform to ISO 9001, ISO 29001, API Specification Q1 or an equivalent quality management system standard agreed with the purchaser.

Delete NOTE

3 Normative references

Add to clause

API Recommended Practice 14FZ, *Recommended Practice for Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1, and Zone 2 Locations*

API Recommended Practice 500, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum, Petrochemical and Natural Gas Industry*

ASTM D4752, *Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

BS 1490, *Specification for aluminium and aluminium alloy ingots and castings for general engineering purposes*

EN 13906-1, *Cylindrical helical springs made from round wire and bar - Calculation and design - Part 1: Compression springs*

EN 15714-2:2009, *Industrial valves - Actuators - Part 2: Electric actuators for industrial valves - Basic requirements*

EN 15714-3:2009, *Industrial valves - Actuators - Part 3: Pneumatic part-turn actuators for industrial valves - Basic requirements*

EN 15714-4:2009, *Industrial valves - Actuators - Part 4: Hydraulic part-turn actuators for industrial valves - Basic requirements*

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60085, *Electrical insulation - Thermal evaluation and designation*

IEC 60721-2-1, *Classification of environmental conditions - Part 2-1: Environmental conditions appearing in nature - Temperature and humidity*

IEC 60721-3-0, *Classification of environmental conditions - Part 3-0: Classification of groups of environmental parameters and their severities - Introduction*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEEE 1, *Recommended Practice - General Principles for Temperature Limits in the Rating of Electrical Equipment and for the Evaluation of Electrical Insulation*

ISO 3522, *Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties*

ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

ISO 4628-6, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 6: Assessment of degree of chalking by tape method*

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 8501-3, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 3: Preparation grades of welds, edges and other areas with surface imperfections*

ISO 8503-2, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure*

ISO 8503-5, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 5: Replica tape method for the determination of the surface profile*

ISO 8573-1, *Compressed air — Part 1: Contaminant and purity classes*

ISO 9001, *Quality Management Systems — Requirements*

ISO 12944-2, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems*

ISO 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods*

ISO 12944-9, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 9: Protective paint systems and laboratory performance test methods for offshore and related structures*

ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*

ISO 17945, *Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments*

ISO 19840, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces*

ISO 22899-1, *Determination of the resistance to jet fires of passive fire protection materials — Part 1: General requirements*

ISO/TS 29001, *Petroleum, petrochemical and natural gas industries — Sector-specific quality management systems — Requirements for product and service supply organizations*

NACE No. 2 / SSPC-SP 10, *Near-White Metal Blast Cleaning*

NAMUR NE 004, *Mounting of Positioners/ Position Transmitters to Actuators*

NAMUR NE 014, *Attachment of Pneumatic Part-Turn Actuators to Valves*

NAMUR NE 019, *Mounting of Solenoid Valves to Part Turn Actuators*

NEMA MG 1, *Motors and Generators*

NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

SSPC-SP 16, *Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals*

UL 1709, *Standard for Safety - Rapid Rise Fire Tests of Protection Material for Structural Steel*

4 Terms and definitions

4.19

Replace term with

network pressure, maximum supply

Replace definition with

maximum available network pressure at the control panel inlet, as defined by the purchaser

4.21

Replace term with

network pressure, minimum supply

Replace definition with

minimum available network pressure at the control panel inlet for which the actuator torques/thrusts are delivered including the on-demand correction factor and sizing safety factors, as defined by the purchaser

Add new term

4.37
air to end torque/thrust/hydraulic to end torque/thrust
ATE/HTE
minimum torque/thrust available at end of travel at minimum network supply pressure

Add new term

4.38
air to run torque/thrust/ hydraulic to run torque/thrust
ATR/HTR
torque/thrust available as a minimum during the full valve travel at minimum air or hydraulic network supply pressure

Add new term

4.39
air to start torque/thrust/ hydraulic to start torque/thrust
ATS/HTS
torque/thrust available at start of the travel (breakaway) at minimum air or hydraulic network supply pressure

Add new term

4.40
breakaway angle or percent of stroke
the point at which the valve seat breaks/makes sealing contact with the obturator

Add new term

4.41
network pressure, design
pressure, used to design the actuator control equipment, air receivers or accumulators, which corresponds to compressor design pressure or HPU design pressure

Add new term

4.42
non-intrusive actuator
type of actuator which does not require opening of the electrical enclosure for commissioning or troubleshooting with controls that are accessible externally to the actuator

Add new term

4.43
on demand valve torque correction factor
ODCF
correction factor provided by the valve manufacturer to multiply a net torque/thrust value to correct the effect for process characteristics and frequency of valve operations

Add new term

4.44
sizing safety factor
SSF
dimensionless factor, specified by the purchaser

Add new term

4.45
spring to end torque/thrust
STE
torque/thrust provided at the end of travel under spring action with no air or hydraulic fluid opposed

Add new term

4.46
spring to run torque/thrust
STR
the lowest torque/thrust developed by the spring during travel with any residual pressure remaining in the power cylinder

Add new term

4.47
spring to start torque/thrust
STS
torque/thrust provided at start of travel by fully compressed spring with residual pressure remaining in the power cylinder

5 Symbols and abbreviated terms

5.2 Abbreviated terms

Add to list

AC	alternating current
BTO	break to open
DC	direct current
DD	device description
DTM	device type manager
ESD	emergency shut down
FAT	factory acceptance test
HART	highway addressable remote transducer
IP	ingress protection
PST	partial stroke testing
SIL	safety integrity level
SPDT	single pole double throw
WPQR	welding procedure qualification record

6 Actuator types and configurations

6.2 Actuator types

6.2.1 Electric

Add to subclause

The actuator shall deliver the rated torque/thrust at the specified power supply within the tolerances specified below:

a) nominal voltage ±10 %;

b) frequency variation (AC) ±5 %.

6.2.2 Pneumatic

Replace second sentence of third paragraph with

Pneumatic actuators powered by compressed air shall be designed for use with compressed air supplied at the tie-in point in accordance with ISO 8573-1:

— purity classes of class 6 for particle size;

— class 3 for pressure dew point; and

— class 3 for oil concentration.

6.2.3 Hydraulic

Replace fourth paragraph with

Actuators shall be designed for use with hydraulic fluid cleanliness in accordance with ISO 4406, class 19/17/14 for medium pressure hydraulic system (pump discharge equal to 200 barg (2900 psi)) and class 18/16/13 for high pressure hydraulic system (pump discharge above 200 barg (2900 psi)).

Add new subclause

6.2.4 Electro-hydraulic

6.2.4.1

Electro-hydraulic actuators shall be self-contained units, typically comprised of a hydraulic actuator, electrically powered hydraulic pump, hydraulic accumulator, reservoir, hydraulic cylinder, gearing, travel stops, piston, spring (if needed), screen filters at pump suction, reservoir filler caps, dual filters on the distribution system, check valve, relief valve on pump discharge and local gauges.

6.2.4.2

Actuators shall be designed for use with hydraulic fluid cleanliness in accordance with ISO 4406, class 19/17/14.

6.3 Actuator configuration

6.3.1 Double-acting

Delete entire CAUTION note

Add to subclause

Double acting pneumatic and hydraulic actuators in protective function applications shall be provided with an air receiver or accumulator sized to deliver three strokes of valve operation within the specified operating temperature range (e.g. open to close, close to open and open to close for fail close valves).

Add to subclause

In the event of air or hydraulic supply failure, the air receiver or accumulator system shall be sized to deliver a pressure equal to the network minimum supply pressure.

Add new subclause

6.3.3 Other actuator configurations

Diaphragm type spring return actuators shall not be used for on-off applications.

6.4 Action on loss of supply energy

Replace subclause with

The valve shall be driven to, or remain in, a pre-determined position specified by the purchaser, upon:

— loss of supply energy;

— loss of control signal; or

— loss of supply energy and signal.

7 Design

Replace subclause number 7.1 with subclause number 7.0

7.0 General

Add to subclause

Actuators and actuator control equipment shall be certified to the specified IEC/NEC hazardous area classification by an IECEx certification body / NRTL approved laboratory.

Add to subclause

Actuators, actuator control equipment, junction boxes and enclosures installed outdoors shall meet ingress protection (IP) IP66 to IEC 60529 or NEMA 4X to NEMA 250 or equivalent.

Add to subclause

EMC compatibility shall be in accordance with IEC 61000-4-3.

Add to subclause

Actuator design life shall be minimum 20 years.

Add to subclause

Endurance type testing shall be performed in accordance with the test procedures specified in EN 15714 (Part 2, Part 3 and Part 4), Annex A.

Add to subclause

Ex certified adapters in accordance with the specified hazardous area and cable entry shall be supplied.

Add to subclause

Biodegradable oil shall not be used.

Add to subclause

Actuators and actuator control equipment shall conform to the specified climatic classification in accordance with IEC 60721-2-1 and environmental classification in accordance with IEC 60721-3-0.

Replace Figure 14 with

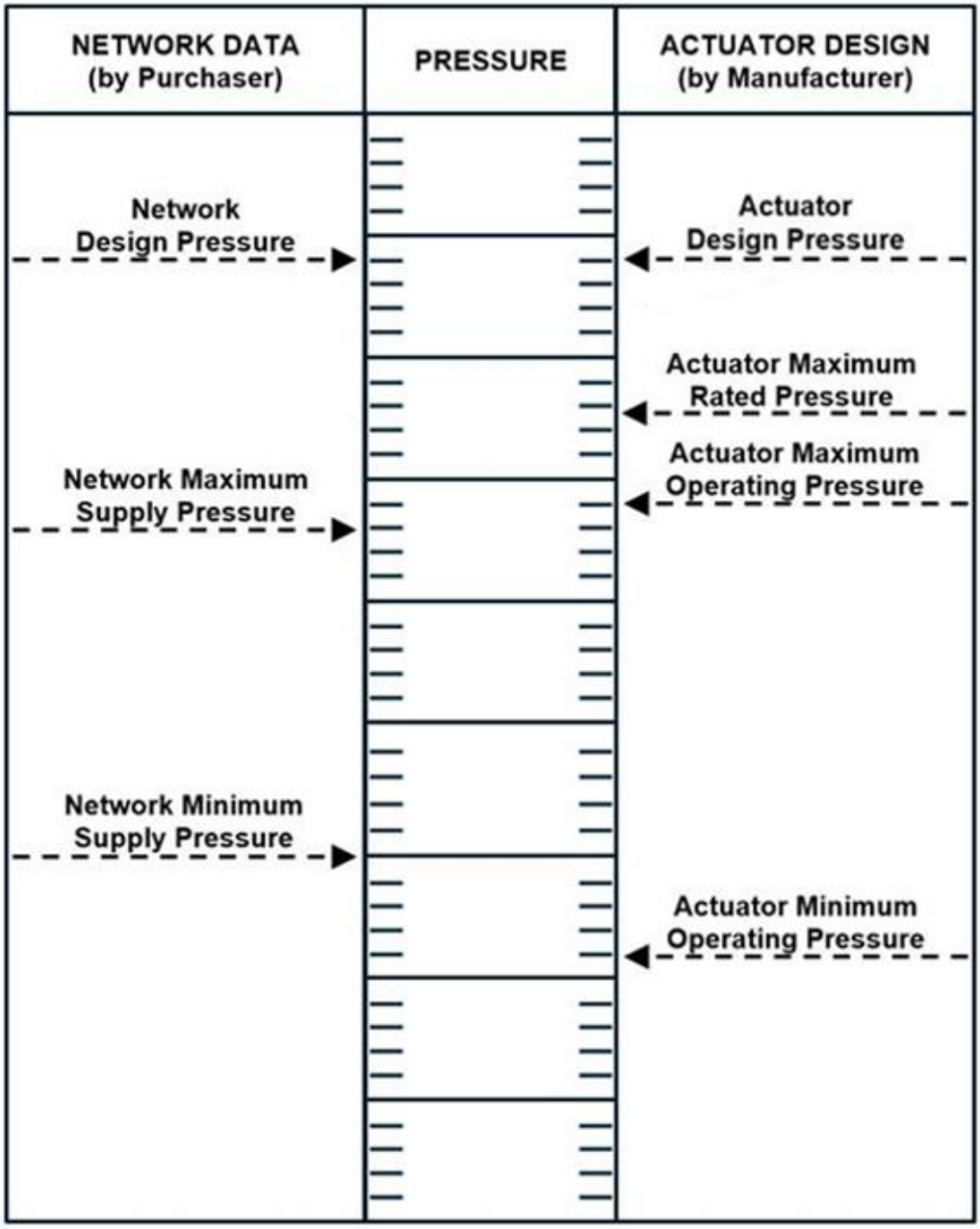

Figure 14 — Relationship between design, supply and rated pressures

Figure 15 — Relationship between energy, torque/thrust and actuator design and sizing

In Figure 15, replace "Minimum supply pressure" with

Minimum network supply pressure

Add new subclause

7.1 Actuator design requirements

7.1.1 Electric actuators

7.1.1.1 General

7.1.1.1.1

The electric actuator design shall be non-intrusive.

7.1.1.1.2

Actuator duty shall be Class A (on-off) or Class B (inching) in accordance with EN 15714-2.

NOTE "inching" is equivalent to analog operation, not on-off in accordance with EN 15714-2.

7.1.1.1.3

The motor insulation system shall be thermal Class F in accordance with IEC 60085 or NEMA MG1 and rated without exceeding thermal Class B temperature limits.

7.1.1.1.4

Actuators shall meet the life endurance criteria in accordance with EN 15714-2 for Class A or Class B defined in Table 1, Table 2 or Table 3.

7.1.1.1.5

Actuators shall provide an isolated power supply for actuator fed control circuits in accordance with the voltage specified by the purchaser.

7.1.1.1.6

An isolated relay contact output (volt free) shall be provided for any status indication specified by the purchaser.

7.1.1.1.7

Gearing shall have a built-in lost motion or jammed valve device that enables the motor to attain full speed before applying the hammer blow to start the valve.

7.1.1.1.8

Actuators and gearbox internals shall be enclosed and packed with lubricant.

7.1.1.1.9

Terminal enclosures shall be provided with three cable entries.

NOTE Requirements for additional entries may be specified in the data sheet based on application design requirements.

7.1.1.1.10

Power terminals shall be protected by an insulating cover and mechanically separated from the terminals for control, feedback and network signals.

7.1.1.1.11

Electric actuators shall be supplied with a separate earth boss on the enclosure, external to the terminal compartment.

7.1.1.2 Actuator local/remote control

7.1.1.2.1

Actuators shall be provided with local indication for:

— closed;

— open;

— intermediate position.

7.1.1.2.2

Actuators shall be provided with local indication to display the valve position.

7.1.1.2.3

Actuators shall accept open and close commands from the control system if remote mode is selected.

7.1.1.2.4

The actuator shall provide valve open and closed position status output (voltage-free single pole double throw (SPDT) contacts) for remote indication.

7.1.1.2.5

The actuator shall provide a fault status output for remote indication, configurable for phase fault, power supply failure and overload.

7.1.1.2.6

Actuators shall be provided with a remote/local status output (SPDT contact) to plant control system if specified by the purchaser.

7.1.1.3 Torque and limit switches

Limit switches (open/closed positions) and/or torque switches shall be used to stop valve travel.

7.1.1.4 Motor protection

7.1.1.4.1

The motor shall be protected against loss of a single phase or more of the power supply.

7.1.1.4.2

The motor shall be protected against high current surges.

7.1.1.4.3

The motor shall be protected against sudden reversal of direction.

7.1.1.4.4

The motor shall be protected against operating outside of the specified duty cycle causing overheating.

7.1.1.4.5

The motor shall be protected against stalling.

7.1.1.4.6

The motor shall be protected against incorrect power wiring i.e. phase sequence or phase rotation independent for alternating current (AC) motor and reverse polarity for direct current (DC) motor.

7.1.2 Pneumatic actuators

7.1.2.1

Actuators and actuator control equipment exhaust ports shall point downwards or be tubed downwards to reduce water ingress to the equipment.

7.1.2.2

Exhaust, vent and breathing ports of actuator / actuator control equipment shall be provided with an accessory to block bugs and prevent ice formation.

7.1.2.3

Pneumatic actuators shall meet the endurance criteria specified in EN 15714-3, Table 1.

7.1.3 Hydraulic actuators

7.1.3.1

Hydraulic chambers shall be provided with two ports for flushing.

7.1.3.2

Hydraulic actuators shall meet the endurance criteria specified in EN 15714-4, Table 2.

7.1.4 Self-contained electro-hydraulic actuators

7.1.4.1

The hydraulic system operating pressures shall be specified by the supplier based on the selected design.

7.1.4.2

Where speed of operation may result in damage to the valve seats, a cushioning device shall be provided.

7.1.4.3

If specified, a hand jack or hand pump connection shall provide motive force for manually opening the valve in the event of a pump failure.

7.1.4.4

Operation of the hand jack or hand pump shall not interfere with, or prevent, the operation of the valve in the event of a trip demand.

7.1.4.5

The reservoir (oil tank) shall have a capacity equal to 1,5 times the total combined displacement of the entire volume of the hydraulic system.

7.1.4.6

The reservoir shall have a facility to drain the water accumulated over a period of time.

7.1.4.7

The electric motor driving the hydraulic pump shall be protected against winding temperatures and currents that may damage the motor.

7.1.4.8

The pump drive shall have start/stop control and auto cut in / cut out to retain the pressure within an operating band.

7.1.4.9

The hydraulic pump, drive and drive coupling design shall facilitate ease of dismantling.

7.1.4.10

The design shall consist of isolation valves, de-pressurization valves and drain valves to support the maintenance of the hydraulic system.

7.5 Springs and modules

Add to subclause

The spring actuation unit shall be constructed and attached in a manner that dismantling is not possible without first releasing the spring to its fully extended position.

7.6 Mounting kit

7.6.1

Replace first paragraph with

The design basis shall be one of the following:

— stress based validated by testing; or

— supplier's alternative where previous experiences in comparative service has been documented to prove that the components have been loaded to the design load values without impairment.

7.8 Lifting

Add to subclause

For horizontal shaft installations, the actuator lifting points shall be positioned to avoid damage to the stem or seals during removal of the actuator.

Add to subclause

Actuator lifting points shall have a design safety factor of 2.

Add to subclause

A corrosion resistant warning plate with the following text shall be fixed near to the actuator lifting point if the lifting point has not been designed to lift the valve assembly.

"Do not use the lifting point for lifting the valve assembly"

7.9 Handwheels and levers for manual override

Add new subclause heading before first paragraph

7.9.1 General

Add new subclause

7.9.2 Handwheels for electric actuators

7.9.2.1

Handwheels shall be fitted for all electric actuators in non-safety applications.

7.9.2.2

The handwheel drive shall be mechanically independent of the motor drive.

7.9.2.3

A clutch shall engage the handwheel for manual use.

7.9.2.4

The clutch shall disengage the handwheel in the powered position to prevent handwheel rotation during powered operation.

7.9.2.5

The clutch shall be lockable in the manual and powered positions.

7.11 Position indicators

Replace subclause with

Actuators shall be supplied with a visible indicator to show the open/closed positions of the valve obturator by color and by "open" / "closed" text.

7.12 Travel stops

Add to subclause

Mechanical type travel stops shall be provided for pneumatic, hydraulic and electro-hydraulic actuators.

Add to subclause

Mechanical type travel stops shall have a locking nut or another similar arrangement to prevent unintentional adjustments.

7.14 Sealing

Replace subclause with

The mounting hardware/kit design shall prevent water accumulation around the stem/packing and top of the actuator yoke stem.

Add new subclause

7.17 Protective function applications (SIL or shutdown applications)

7.17.1 General

7.17.1.1

For protective function applications (safety instrumented level (SIL) applications), the emergency shutdown (ESD) signal shall take precedence over local and remote controls.

7.17.1.2

For protective function applications (SIL applications), SIL certificates and failure data to establish conformance to IEC 61508 shall be provided for all components in the actuated valve assembly.

7.17.2 Partial stroke testing (PST)

7.17.2.1

PST shall continuously monitor pressure, travel position and time during the test and abort the test based on pre-defined parameter limits.

NOTE "Pressure" mentioned in this requirement is not applicable for electric actuators.

7.17.2.2

The emergency shutdown function shall always take precedence, even while performing PST.

7.17.2.3

The PST shall be configurable for travel position and time.

7.17.2.4

The valve signature and valve PST profile shall be captured within the controller or transfer the information to HART devices / control system for comparison purposes.

Add new subclause

7.18 Fire Protection

Fire proofing design for actuators, air receivers and accumulators shall conform to ISO 22899-1 for jet fires or UL 1709 for pool fires, if fire proofing design is specified.

8 Sizing

8.1 Information required for actuator sizing

8.1.2 Valve torque and/or thrust data

Replace first paragraph with

The following data shall be generated by the valve manufacturer:

a) breakaway torque/thrust (break to open torque/thrust, break to close torque/thrust);

b) breakaway angle or percent of stroke;

c) run torque/thrust (run to open torque/thrust, run to close torque/thrust);

d) reseat torque/thrust (end to open torque/thrust, end to close torque/thrust);

e) MAST.

Add to subclause

Valve torque/thrust values shall be calculated on the basis of process maximum shut-off differential pressure across the valve or maximum static pressure of the line.

NOTE The purchaser may specify maximum flange rated pressure on specific process cases for sizing the actuator.

Add to subclause

On demand correction factors shall be provided by the valve manufacturer during actuator torque/thrust evaluation to account for the fluid characteristics (e.g. non-lubricating, clean or sticky service, slurries, polymerization service), operational effects (e.g. staying in same position) and operating temperature effects.

Add to subclause

Valve torque/thrust on demand shall be calculated as valve torque/thrust x ODCF x SSF (e.g. BTO x ODCF x SSF).

8.1.6 Pneumatic/hydraulic actuator data

Replace list item b) with

b) network minimum and maximum air or hydraulic supply pressure;

Delete list item f)

Add new subclause

8.1.7 Actuator torque/thrust validation

8.1.7.1 General

Actuator output torque/thrust (spring and maximum output torque/thrust) shall be greater than valve torque/thrust on demand over the entire travel in open/close directions.

8.1.7.2 Electric actuators

8.1.7.2.1

Stall torque shall be less than MAST, i.e. obturator, stem, stem to obturator connection and mounting kit.

8.1.7.2.2

Actuator maximum torque or thrust at the specified voltage with torque/thrust limiting devices activated shall be less than ISO 5210 and ISO 5211 flange torque/thrust.

8.1.7.3 Pneumatic, hydraulic and electro-hydraulic actuators

8.1.7.3.1

110 % of maximum air/hydraulic to start torque/thrust (ATS max / HTS max) shall be less than the MAST, i.e. obturator, stem, stem to obturator connection and mounting kit.

8.1.7.3.2

Maximum air/hydraulic to start torque/thrust (ATS max / HTS max) shall be less than ISO 5210 and ISO 5211 flange torque/thrust.

8.1.7.3.3

Spring to start torque/thrust (STS/HTS) shall be less than ISO 5210 and ISO 5211 flange torque/thrust.

8.2 Sizing method

Replace second sentence of third paragraph with

For pneumatic/hydraulic actuators, regulators and relief valve combinations shall be used only if the torque/thrust generated by the actuator poses MAST or yield strength issues for the drive train components.

Add to subclause

A torques/thrusts summary table shall be provided during bidding and design phase for the torques/thrusts specified in 8.1.2 and 8.1.7.

Add to subclause

The calculated torque shall be validated on the basis of torque/thrust testing of production actuators.

Replace Clause 9 title with

9 Instrumentation / regulation / actuator control equipment

9.1 Torque limiting settings - Electric actuators

Add to subclause

The torque sensor setting shall be adjustable between 50 % and 100 % of the rated torque.

9.2 Torque/thrust limiting controls - Pneumatic/hydraulic actuators

Replace second sentence of first paragraph with

The torque/thrust output at the relief valve set pressure plus overpressure at full lift shall be less than the valve MAST.

Add new subclause

9.3 Instrumentation and accessories

9.3.1 General

9.3.1.1

Actuator control equipment, air receivers/accumulators and pneumatic/hydraulic components shall be designed for the specified network supply design pressure.

9.3.1.2

Earthing of electronic devices mounted on the actuator shall be through the earth boss of the instrument housing.

9.3.1.3

All accessories shall be accessible for maintenance (repair or replace) without removing any part of the actuator.

9.3.1.4

The supplier should minimize the number of components used to achieve the functional requirements.

NOTE Minimizing the number of components reduces the risk of leakage and unreliability.

9.3.1.5

Manifold systems shall be employed to reduce leakages and footprint.

9.3.2 Air filters and regulators

9.3.2.1

Filters shall be installed in the supply line to the control panel to protect the actuator and actuator control components from entrained particles.

9.3.2.2

Filters shall be fitted with a drain valve.

9.3.2.3

If a filter and regulator are supplied, they shall be provided as a single unit.

9.3.2.4

The adjustment for the regulator setpoint shall be such that it prevents unintentional operation.

9.3.2.5

If a pressure regulator is installed to reduce the torque/thrust, a corrosion resistant warning plate with the following text shall be securely attached or fixed inside the control panel. "Set at XX Barg (psi) to limit the torque/thrust. Do not change the setting"

9.3.2.6

Filter regulators shall be internal relief type with an integral filter and drain.

9.3.3 Valve control panel

9.3.3.1

If specified, a sunshade shall be provided to cover the top and three sides (excluding front and bottom side) of the actuator control panel.

9.3.3.2

A pressure gauge at the outlet of the control panel shall be installed.

9.3.3.3

A hydraulic control panel shall be provided with a filter and integrated check and relief valve for the hydraulic supply.

9.3.3.4

The control panel shall be fitted with earth bosses to connect the earth from the electronic equipment mounted on the control panel.

9.3.3.5

The control panel shall be provided with an earth boss for connecting earth cables less than or equal to 16 mm² (0,025 in²).

9.3.4 Air receivers

Air receivers shall be provided with check and block valve for supply line, drain valve, vent valve and block valve for pressure instrument connection.

9.3.5 Accumulators

9.3.5.1

Hydraulic accumulators shall be bladder type.

9.3.5.2

Hydraulic accumulators shall be sized to account for adiabatic expansion of nitrogen gas while calculating three strokes.

9.3.5.3

Accumulator systems shall typically consist of an accumulator, relief valves/rupture discs, pre-charging port, pressure gauges, check valve, isolation valve and drain valves.

9.3.5.4

Accumulator charging connections shall consist of block valves, vent valves and pressure gauges to facilitate charging.

9.3.5.5

Nitrogen pre-charge pressures shall be specified at ambient temperature, and 5 °C (41 °F) below and 5 °C (41 °F) above the ambient temperature, calculated using an isothermal expansion process.

9.3.6 Speed control device

Speed control devices shall be secured against inadvertent adjustment.

9.3.7 Air lock relay (lockup valve)

9.3.7.1

An air lock relay shall be provided if a "fail lock" position is specified.

9.3.7.2

The air lock relay shall be set above the network minimum air supply pressure.

9.3.8 Solenoid valves

9.3.8.1

Solenoid valves shall be direct acting, spring return with a power consumption less than 10 W.

9.3.8.2

The solenoid coil insulation rating shall conform to IEC 60085 or IEEE 1.

9.3.8.3

The solenoid valve shall have a pull-in time of less than 100 ms and drop-out time of less than 70 ms.

9.3.8.4

Solenoid valves shall be installed between the positioner signal output and the actuator, if solenoid valves and a positioner are specified for the same application by the purchaser.

9.3.8.5

In protective function applications (SIL applications), the solenoid valve connected to the emergency shutdown system should be installed closest to the actuator.

9.3.8.6

The ability to operate the solenoid valves shall be at least 10 years in low demand applications without requiring any maintenance.

9.3.9 Position indication (remote)

9.3.9.1

Limit switches shall be magnetic or inductive proximity type.

9.3.9.2

The adjustable limit switch shall be set at:

— 3° from the open and closed positions for quarter turn actuators; or

— 3 % from the open and closed positions for linear actuators.

9.3.9.3

Limit switches shall be provided with a junction box for termination of the wiring.

9.3.10 Digital positioners and controllers

9.3.10.1 General

A digital positioner or controller shall be used to execute PST and obtain valve diagnostics, if specified.

9.3.10.2 Diagnostics

9.3.10.2.1

The digital positioner or controller shall have a self-diagnostic feature to determine if the valve does not move in accordance with the commanded position within the set time.

9.3.10.2.2

The digital positioner or controller shall have a diagnostic feature to determine if the valve has moved away from the commanded position.

9.3.10.2.3

The digital positioner or controller shall have a diagnostic feature to determine loss of power, air or hydraulic supply.

9.3.10.2.4

The digital positioner or controller shall have a feature to capture valve profiling during trip and partial stroke testing.

9.3.10.2.5

The digital positioner or controller shall have a predictive diagnostics function to alert performance degradation that may lead to malfunction.

9.3.10.3 Cyber Security

9.3.10.3.1

Device type manager (DTM) and device description (DD) files shall be obtained directly from the equipment manufacturer or downloaded from the equipment manufacturer's authorized secure website.

9.3.10.3.2

DTM and DD files shall be signed by the equipment manufacturer using a trusted certificate authority.

9.3.10.3.3

The digital positioner/controller shall be protected against inadvertent changes with the use of a physical switch/jumper or a password.

10 Materials

10.1 Material specification

Add to subclause before first paragraph

The manufacturer shall specify metallic and non-metallic materials for the specified environmental conditions, service and durability (see 10.2).

Replace first paragraph with

Material specifications for metallic, pressure-containing parts and springs shall address the following:

Replace list item a) with

a) material type and grade;

Replace list item f) with

f) impact properties, if applicable;

Add to subclause

Materials for pneumatic/hydraulic actuator components shall conform to the requirements specified in Table 6.

Add to subclause

Materials for electric actuator components shall conform to the requirements specified in Table 7.

Add to subclause

Materials for electro-hydraulic actuator components shall conform to the requirements specified in Table 6 and Table 7.

Add to subclause

Materials for miscellaneous instruments and control panels for offshore/costal/near shore applications shall be SS 316 or SS 316L.

NOTE 1 For onshore applications, the supplier may propose the materials suitable for the specified service and environment.

Add to subclause

Material requirements for pneumatic/hydraulic components, tubing and fittings shall be SS 316 or SS 316L.

Add to subclause

The manufacturer may specify alternate materials or material and surface protection combinations that provide equivalent performance for the specified environment, service and duration.

Add NOTE 2 to subclause

NOTE 2 Atmospheric corrosivity will be specified in accordance with ISO 12944-2 or through nomination of the applicable atmospheric parameters, service fluids and process parameters. Durability will be specified in accordance with ISO 12944-1.

10.2 Service Compatibility

Replace first sentence with

All parts, metallic and non-metallic, in contact with the operating fluids and lubricants shall be compatible for the specified service.

Replace second sentence with

Metallic materials in combination with internal corrosion prevention systems shall be selected to prevent corrosion and galling threats which may result in impaired function or loss of pressure-containment.

NOTE Internal corrosion prevention may include polymeric coating or plating in combination with a closed loop breathing system.

Add new Table 6

Table 6 — Material requirements for pneumatic/hydraulic actuator components

Sl. No.	Item	Material
1	Actuator cylinder/covers/spring housing	Onshore: Carbon steel with coating [a] (Note: Ductile iron can be specified for cylinder flanges) Offshore: Carbon steel with coating [a] or SS 316
2	Stroke adjustment components, piston rods and shafts exposed to external environment	Onshore: Manufacturer to specify Offshore: SS 316 or better
3	Coupling/stem extension (connection between actuator and valve shaft)	Onshore: Manufacturer to specify Offshore: SS 316 or better
4	Mounting kit (connection between valve and actuator)	Carbon steel with coating [a] or SS 316
5	Tie rods/bolts/nuts/washers	SS 316 or low ally steel with coating [a]
6	Actuator/valve connection bolts, nuts, washers, dowel pins/keys	SS 316
7	Brackets for mounting accessories like limit switch box, junction box	SS 316
8	Hand-wheel	Onshore: Carbon steel with coating [a] Offshore: SS 316
9	Accumulator or air receiver	Onshore: Carbon steel with coating [a] Offshore: SS 316
[a] Coating system in accordance with Clause 14 shall be followed.		

Add new Table 7

Table 7 — Material requirements for electric actuator components

Sl. No.	Item	Materials
1	Actuator covers/housing	Marine grade aluminium AlSi7Mg to ISO 3522 (LM25 to BS 1490) with coating [a] or SS 316
2	Power transfer mechanism	Manufacturer to specify
3	Stroke adjustment components and shafts exposed to external environment	Onshore: Manufacturer to specify Offshore: SS 316 or better
4	Coupling/stem extension (connection between actuator and valve shaft)	Onshore: Manufacturer to specify Offshore: SS 316 or better
5	Mounting kit (connection between valve and actuator)	Carbon steel with coating [a] or SS 316
6	Actuator/valve connection bolts, nuts, washers, dowel pins/keys	SS 316
7	Brackets for mounting accessories like limit switch box, junction box	SS 316
8	Handwheel	Onshore: Hot dip galvanized carbon steel with coating [a] Offshore: SS 316 or Marine grade aluminium
[a] Coating system in accordance with Clause 14 shall be followed.		

10.3 Composition limits

10.3.1 Carbon Steel

Replace Equation (1) with

$$CE = \%C + \frac{\%Mn}{6} + \frac{(\%Cr + \%Mo + \%V)}{5} + \frac{(\%Cu + \%Ni)}{15} \quad (1)$$

[SOURCE: International Institute of Welding]

10.3.2 Austenitic stainless steel

Delete second paragraph

11 Welding

11.1 Welding of pressure-containing parts

In first paragraph, delete "or EN 287-1"

11.2 Structural welding

In second paragraph, delete "or EN 287-1"

11.3 Impact testing

Replace second paragraph with

Impact testing for qualification of the WPS shall not be required for non-impact tested base materials.

Replace third paragraph with

A set of three weld metal impact specimens oriented with the notch perpendicular to the surface of the material shall be taken from the weld metal (WM) and from the heat affected zone (HAZ) in accordance with the applicable design code.

Delete fourth paragraph

Figure 16 — Charpy V-notch weld metal (WM) specimen location

Delete Figure 16

Figure 17 — Charpy V-notch heat-affected zone (HAZ) specimen location

Delete Figure 17

12 Quality control

12.3 Qualification of inspection and test personnel

12.3.3 Welding inspectors

Replace subclause with

Personnel performing visual inspection of welding operations and completed welds shall be qualified and certified to ISO 17637, AWS QC1 Certified Welding Inspector or equivalent, or the manufacturer's documented procedure.

12.4 NDE of repairs

12.4.2 Mechanically loaded parts

Add to subclause

Cracks or longitudinal defects identified by visual inspection shall be subjected to a magnetic particle or dye penetrant examination in addition to any visual inspection.

13 Testing

13.1 General

Replace first sentence with

Actuators, control panels, accumulators and air receivers shall be tested prior to shipment from the manufacturing facility.

13.2 Shell test

Replace first paragraph with

The shell test shall be conducted at 1,5 times the design pressure for a duration in accordance with Table 1.

Delete second paragraph

Replace Table 1 with

Table 1 — Minimum duration of shell tests

Test	Test duration
Pneumatic	5 minutes
Hydraulic	5 minutes
Electro- hydraulic	5 minutes

Replace Table 2 with

Table 2 — Minimum duration of piston seal tests

Test	Test duration
Pneumatic	5 minutes
Hydraulic	5 minutes
Electro-hydraulic	5 minutes

13.4 Torque/thrust test - Pneumatic/hydraulic actuators

Replace second paragraph with

Actuators shall be torque/thrust tested in accordance with the procedure defined in A.1.

13.6 Actuator functional test

Replace first paragraph with

Actuators and control panels shall be subjected to functional and performance testing in accordance with the manufacturer's documented procedures, prior to valve integration.

Add new subclause

13.7 Functional and performance test on assembled units (actuator with associated gear box / valve, control panel and air receiver /accumulator)

13.7.1

The functional and performance testing shall be carried out by the supplier on the actuated valve assembly with the control panel and air receiver or accumulator in accordance with Table 8.

NOTE Supplier test report formats may be used to record test results.

13.7.2

The functional and performance test results shall be recorded in the test reports.

Add new Table 8

Table 8 — Functional and performance test -
Assembled units (valve with actuator), control panel, air receiver and accumulator

No.	Tests/checks	Electric actuator	Pneumatic/ hydraulic actuator	Electro-hydraulic actuator	Acceptance criteria
1	**Visual and conformity checks**	Required. Record results as per Table F.1.a and F.1.b.	Required. Record results as per Table F.1.a and F.1.b.	Required. Record results as per Table F.1.a and F.1.b.	Approved data sheet, Approved GA drawing for valve and actuator, control panel, accumulator, Approved painting procedure, pneumatic/hydraulic schematic
2	**Dimensional checks**	Required. Record results as per Table F.2.a and F.2.b.	Required. Record results as per Table F.2.a and F.2.b.	Required. Record results as per Table F.2.a and F.2.b.	Approved GA drawing for valve and actuator, control panel, accumulator
3	**Actuator shell test**	Not applicable	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Subclause 13.2
4	**Actuator piston seal test**	Not applicable	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Subclause 13.3
5	**Stroke test**: Energize and de-energize the solenoid valve and ensure entire assembly function smoothly and trouble free for three cycles. Record time to ensure that there is no frictional issues on the packing.	Not applicable	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Manufacturer's test procedure
6	**Operating time validation test**: The maximum and minimum operating time shall be validated as per the data sheet for opening and closing directions when full DP applied across the valve and minimum / maximum network supply pressure or minimum / maximum supply voltage to the actuator.	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Approved data sheet
7	**Fail action test**: Verify signal/supply failure conditions to validate failure modes defined in the data sheet.	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Required. Record results as per Table F.3.a and F.3.b.	Approved data sheet

Table 8 *(continued)*

No.	Tests/checks	Electric actuator	Pneumatic/ hydraulic actuator	Electro-hydraulic actuator	Acceptance criteria
8	**Functional test for accessories (as applicable)**: a) Solenoid valves; b) Limit switches; c) Position transmitters; d) Local open or close device (as applicable); e) Local reset push button (as applicable).	Required. Record results as per Table F.4.	Required. Re cord results as per Table F.4.	Required. Record results as per Table F.4.	Manufacturer's test procedure
9	**Partial stroke testing (PST)** - Applicable where PST is requested in the data sheet. Energize the solenoid valves to move the valve to pre-determined position, initiate the PST command which shall move the valve to the specified percentage of its fail safe position and then return to normal operating position. Capture the valve signature and store it in the device or other methods of testing as agreed with the purchaser.	Applicable	Required. Record results as per Table F.5.	Required. Record results as per Table F.5.	Subclause A.2
10	**Functional test for double acting actuator with accumulator**: a) Validate that the accumulator capacity is suitable for three strokes. b) Ensure the accumulator pressure is not less than the minimum network supply pressure.	Not applicable	Required. Record results as per Table F.5.	Required. Record results as per Table F.5.	Manufacturer's test procedure
11	**Specific functional tests for electric actuator (as applicable)**: a) Local open/close; b) Remote open/close/stop; c) open/close/fault contacts; d) Torque switch setting verification; e) Open/close limit switch setting verification.	Required. Record results as per Table F.5.	Not applicable	Required. Record results as per Table F.5.	Manufacturer's test procedure
12	**Hand wheel rim operation and rim force verification**, if supplied	Required. Record results as per Table F.5.	Required. if handwheel is provided, record results as per Table F.5.	Required. if handwheel is provided, record results as per Table F.5.	Subclause 7.9

Table 8 *(continued)*

No.	Tests/checks	Electric actuator	Pneumatic/ hydraulic actuator	Electro-hydraulic actuator	Acceptance criteria
13	**Functional test on network interface cards**	Required. If purchased as part of actuator, record results as per Table F.5.	Not applicable	Not applicable	Manufacturer's test procedure
14	**Torque validation check for electric actuators**	Required. Record results as per Table F.6, Table F.7 and Table F.8.	Not applicable	Not applicable	Subclause 8.1.7
15	**Torque validation check for pneumatic, hydraulic and electro-hydraulic actuators**	Not applicable	Required. Record results as per Table F.9, Table F.10 and Table F.11.	Required. Record results as per Table F.9, Table F.10 and Table F.11.	Subclause 8.1.7

Add new subclause

13.8 Cleaning and flushing

13.8.1

Hydraulic actuators, accumulators and control panels shall be flushed to meet cleanliness level 17/15/12 upon completion of the FAT.

13.8.2

Residual water from the valve body shall be drained and the valve dried, post functional testing.

14 Surface protection

Replace first paragraph with

The manufacturer shall specify the coating systems to be applied to actuator and control equipment exposed to the environment or in contact with service fluids, if the material selection for the specified environment, service and durability is dependent on surface protection (see Clause 10).

Replace second paragraph with

Preservation treatments shall be applied to uncoated metallic actuators and actuator control equipment to preclude surface oxidation during storage and delivery of the equipment.

Add to subclause

Coating systems specified for onshore applications shall be selected in accordance with ISO 12944-5 and qualified to ISO 12944-6.

Add to subclause

Coating systems specified for offshore and coastal applications shall be selected in accordance with Table G.1 and Table G.2 and qualified in accordance with ISO 12944-9.

Add to subclause

Coating systems shall be applied in accordance with the qualified coating system procedure and in compliance with:

— environmental conditions;

— surface preparation;

— application and curing requirements.

15 Marking

Replace first sentence with

Actuators shall be marked in accordance with Table 3, Table 4 or Table 9.

Add to subclause

The valve assembly, air receiver/accumulator, solenoid valves, limit switches, controllers and position transmitters shall be identified by their tag numbers.

Table 3 — Marking of electric actuators

Add rows 10 to 16 to Table 3

No.	Marking	Application on
10	Actuator rated torque/thrust	Nameplate
11	Enclosure protection (IP designation)	Nameplate
12	Nominal motor power	Nameplate
13	Nominal motor current	Nameplate
14	Actuator operating time or speed	Nameplate
15	Fail safe action (if applicable)	Nameplate
16	Other mandatory marks (as applicable)	Nameplate

Table 4 — Marking of pneumatic/hydraulic actuators

Add rows 8 to 18 to Table 4

No.	Marking	Application on
8	Rated torque/thrust	Nameplate
9	Maximum network supply pressure	Nameplate
10	Minimum network supply pressure	Nameplate
11	Minimum operating pressure	Nameplate
12	Fluid type	Nameplate
13	Ingress protection	Nameplate
14	Hazardous area certification	Nameplate
15	Loss of control signal	Nameplate
16	Loss of supply energy	Nameplate
17	Filter regulator set point	Nameplate
18	Other mandatory marks (as applicable)	Nameplate

Add new Table 9

Table 9 — Marking of electro-hydraulic actuators

No.	Marking	Application on
1	Manufacturer's name or trademark	Nameplate
2	Model	Nameplate
3	Serial number	Nameplate
4	Supply voltage, phase, frequency	Nameplate
5	Voltage variation	Nameplate
6	Frequency variation	Nameplate
7	Rated torque	Nameplate
8	Rated current / power	Nameplate
9	Maximum rated pressure	Nameplate
10	Maximum operating pressure	Nameplate
11	Enclosure protection (IP designation)	Nameplate
12	Hazardous area certification	Nameplate
13	Hydraulic oil specification	Nameplate
14	Hydraulic volume	Nameplate
15	Fail safe action (if applicable)	Nameplate
16	Year of manufacture	Nameplate
17	Other mandatory marks (as applicable)	Nameplate

Replace Clause 16 title with

16 Packing, Preservation and preparation for shipping

Replace first paragraph with

The manufacturer/supplier shall specify preservation and packing methods for the actuators and the valve assembly.

Add to subclause

The proposed preservation and packaging methods shall preclude damage to the mounting interface, seal surfaces, threads and to coatings.

Add to subclause

Following assembly and testing, each valve and actuator assembly shall be packed for shipping as an assembled unit.

17 Documentation

Replace first paragraph with

The documentation specified in IOGP S-707L shall be provided to the purchaser in accordance with the selected CAS level.

Table 5 — Required documentation

Delete Table 5

Annex D
(normative)

Record retention

Replace Table D.1 with

Table D.1 — Record retention

Description	Electric	Pneumatic / hydraulic	Electro-hydraulic
	Document retention		
Design documents / drawings			
General arrangement drawing (valve with actuator, control panel and accessories)	X	X	X
General arrangement drawing (air receiver and accumulator)		A	A
Cross section drawing with bill of materials (actuator)	X	X	X
Cross section drawing with bill of materials (accumulator)		A	A
Accumulator sizing calculations		A	A
Torque table / calculation	X	X	X
Data sheet (valve, actuator and accessories)	X	X	X
Schematic drawing (pneumatic/hydraulic)		X	X
Pressure vessel design calculations		X	
Electrical and wiring diagram	X		X
Wiring drawing (accessories)	X	X	X
Actuator testing procedures	X	X	X
Functional and performance test procedures (valve and actuator assembly)	X	X	X
Failure data / SIL certificates	A	A	A
NDE Procedures (RT, PT, MT, UT)	A	A	A
Safety data sheet for lubricants/oil	X		X
Lifting lug calculations	A	A	A
Surface preparation and coating procedure	X	X	X
Installation manual	X	X	X
Operation manual	X	X	X
Maintenance manual	X	X	X
Welding procedure specification (WPS)	X	X	X

Table D.1 *(continued)*

Description	Electric	Pneumatic / hydraulic	Electro-hydraulic
	Document retention		
Certificates/ reports / records / results			
Actuator/control panel test results	X	X	X
Supplier internal functional test reports on assembled units (actuator with associated gear box, valve, control panel and air receiver/accumulator)	X	X	X
Actuator type test certificates	X	X	X
Hazardous area certification	X	Y	X, Y
Material traceability for pressure-containing parts and bolts exposed to sour service to ISO 17945 or ISO 15156, all parts (applicable for pipeline gas actuators) (3.1 certificate)		A	A
Material traceability for pressure-containing parts, spring and bolting for pressure-containing parts traceable to the unique serial number (3.1 certificate)	A	X	X
Compliance with local directives and regulations (e.g. including but not limited to PED, ATEX, ASME, CRN)	A	A	A
NDE report (RT, PT, MT, UT)	A	A	A
IP certificate for actuator and accessories	X	X	X
Fire proofing type test certificate	A	A	A
Hydraulic oil cleanliness report		H	H
Weld procedure qualification record (WPQR)	X	X	X
Welder performance qualification (WPQ)	X	X	X
Qualification record of NDE personnel	X	X	X
Coating report	X	X	X
Weight report	A	A	A
Functional and performance test results (valve and actuator assembly)	X	X	X

X indicates mandatory
A indicates mandatory, if applicable to specific design
H indicates hydraulic and electro-hydraulic actuators only
Y indicates accessories only

Add new Annex F

Annex F
(informative)

Functional and performance check sheets on assembled valves

Table F.1.a — Visual and conformity check (header)

Client		**Contractor**		**Project reference**	
Valve tag number		**Valve serial number**		**Actuator serial number**	
Purchase order reference		**Instrument data sheet**		**GA drawing**	
Pneumatic / hydraulic schematic					

Table F.1.b — Visual and conformity check (checks)

Checks	Passed		Not applicable	Reference drawing/documents
Valve				
Valve type	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Valve end connection size	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Valve rating	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Valve bore diameter	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Casting quality	☐ Yes	☐ No	☐ N/A	MSS SP-55
Body heat number	☐ Yes	☐ No	☐ N/A	Material certificate
Bonnet heat number	☐ Yes	☐ No	☐ N/A	Material certificate
Actuator				
Actuator type	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Actuator orientation	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Actuator end stops check (open/close)	☐ Yes	☐ No	☐ N/A	
Control panel				
Control panel type (on plate, cabinet, etc.)	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing / schematic drawing
Control panel interface fitting size	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing / schematic drawing
Control panel components	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing / schematic drawing

Table F.1.b *(continued)*

Checks	Passed		Not applicable	Reference drawing/documents
Control panel *(continued)*				
Tubing size / thickness	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing / schematic drawing
Earth boss for control panel	☐ Yes	☐ No	☐ N/A	Data sheet / GA drawing
Grounding of instruments	☐ Yes	☐ No	☐ N/A	GA drawing
Draining, breathing/venting for cabinets	☐ Yes	☐ No	☐ N/A	GA drawing
Painting				
Painting type for actuator	☐ Yes	☐ No	☐ N/A	Data sheet
Painting type for volume bottle / accumulator	☐ Yes	☐ No	☐ N/A	Data sheet
Color code for actuator	☐ Yes	☐ No	☐ N/A	Data sheet
Color code for volume bottle / accumulator	☐ Yes	☐ No	☐ N/A	Data sheet
Paint thickness for actuator	☐ Yes	☐ No	☐ N/A	Coating and painting specification
Paint thickness for volume bottle / accumulator	☐ Yes	☐ No	☐ N/A	Coating and painting specification
Cable entries, adaptors, plugs				
Number of cable entries	☐ Yes	☐ No	☐ N/A	As per GA drawing / data sheet
Size of cable entries	☐ Yes	☐ No	☐ N/A	As per GA drawing / data sheet
Adaptors for cable entry	☐ Yes	☐ No	☐ N/A	As per GA drawing / data sheet
Plugs for unused entries	☐ Yes	☐ No	☐ N/A	As per GA drawing / data sheet
Tag / Name plate				
Tag plate for assembly	☐ Yes	☐ No	☐ N/A	As per data sheet / this specification
Tag for accessories	☐ Yes	☐ No	☐ N/A	As per data sheet / this specification
Name plate markings actuator and accessories	☐ Yes	☐ No	☐ N/A	As per this specification
Accessories				
Solenoid valve (make/model/quantities)	☐ Yes	☐ No	☐ N/A	Data sheet
Limit switches (make/model/quantities)	☐ Yes	☐ No	☐ N/A	Data sheet
Position transmitter (make/model)	☐ Yes	☐ No	☐ N/A	Data sheet
Positioner (make/model)	☐ Yes	☐ No	☐ N/A	Data sheet
Air filter regulator (make/model)	☐ Yes	☐ No	☐ N/A	Data sheet
Check and thermal relief valve	☐ Yes	☐ No	☐ N/A	Schematic drawing

Table F.1.b *(continued)*

Checks	Passed		Not applicable	Reference drawing/documents
Accessories *(continued)*				
Air lock relay	☐ Yes	☐ No	☐ N/A	Schematic drawing
Speed regulator (tamper proof)	☐ Yes	☐ No	☐ N/A	Schematic drawing
Pressure relief valves	☐ Yes	☐ No	☐ N/A	Schematic drawing
Mechanical position indicator	☐ Yes	☐ No	☐ N/A	GA drawing
Visual beacon position indicator	☐ Yes	☐ No	☐ N/A	GA drawing
Handwheel/lever	☐ Yes	☐ No	☐ N/A	GA drawing
ATEX / IECEx / NEC marking	☐ Yes	☐ No	☐ N/A	GA drawing
Marking	☐ Yes	☐ No	☐ N/A	IOGP S-707
Remarks:				

Table F.2.a — Dimensional check (header)

Client		**Contractor**		**Project reference**	
Valve tag number		**Valve serial number**		**Actuator serial number**	
Purchase order reference		**Instrument data sheet**		**GA drawing**	

Table F.2.b — Dimensional check (checks)

Checks	Passed		Not applicable	Reference drawing/documents
Actuator	☐ Yes	☐ No	☐ N/A	GA drawing
Valve	☐ Yes	☐ No	☐ N/A	GA drawing
Air receiver / accumulator including volume	☐ Yes	☐ No	☐ N/A	GA drawing
Control panel including thickness	☐ Yes	☐ No	☐ N/A	GA drawing
Handwheel	☐ Yes	☐ No	☐ N/A	GA drawing
Remarks:				

Table F.3.a — Actuator shell, piston seal, stroke test and operating time validation check and signal/supply failure test (header)

Project reference		**Client**	
Purchase order reference		**Contractor**	
Valve tag number		**Valve serial number**	
Actuator serial number		**Pneumatic/hydraulic schematic reference**	
Actuator type	☐ Electric	☐ Pneumatic	☐ Hydraulic	☐ Electro-hydraulic

Table F.3.b — Actuator shell, piston seal, stroke test, operating time validation test and signal/supply failure test (checks)

Reference	**Actuator shell test**					
Table 8, row 3	**Test pressure**	**Duration**		**Passed**	**Failed**	**Acceptance criteria**
				☐	☐	As per subclause 13.2
Reference	**Piston seal test**					
Table 8, row 4	**Test pressure**	**Duration**		**Passed**	**Failed**	**Acceptance criteria**
				☐	☐	As per subclause 13.3
Reference	**Stroke test**					
Table 8, row 5		**Time**			**Passed**	**Failed**	**Acceptance criteria**
		1st	**2nd**	**3rd**			
	Air strokes				☐	☐	Manufacturer's test procedure / data sheet
	Spring stroke				☐	☐	Manufacturer's test procedure / data sheet

Reference	**Operating time validation test**				
Table 8, row 6	**Parameters**	**Required value**	**Actual value**	**Checks**	**Acceptance criteria**
	Valve DP			☐ Yes ☐ No	
	Minimum network air / hydraulic system pressure			☐ Yes ☐ No	
	- Closing time			☐ Yes ☐ No	
	- Opening time			☐ Yes ☐ No	
	Maximum network air / hydraulic system pressure			☐ Yes ☐ No	
	- Closing time			☐ Yes ☐ No	
	- Opening time			☐ Yes ☐ No	

Table F.3.b *(continued)*

Reference	Signal/supply failure test				
Table 8, row 7	Check	Fail position	Passed	Failed	Acceptance criteria
	Loss of signal		☐	☐	Data sheet
	Loss of power supply / air supply / hydraulic supply		☐	☐	Data sheet

Table F.4 — Functional test on accessories (tests)

Reference	Functional test for accessories				
Table 8, row 8	Fail close valve				
	Check	Pass	Fail	N/A	Acceptance criteria
a)	**Fail close valve**				
	aa) Solenoid energized				
	Valve open	☐	☐	☐	Pneumatic/hydraulic schematic
	Open limit switch contact to close	☐	☐	☐	Wiring drawing
	Position indication - open	☐	☐	☐	Visual
	Position transmitter output - 100 %	☐	☐	☐	Data sheet
	ab) Solenoid de-energized				
	Valve close	☐	☐	☐	Pneumatic/hydraulic schematic
	Close limit switch contact to close	☐	☐	☐	Wiring drawing
	Position indication - close	☐	☐	☐	Visual
	Position transmitter output - 0 %	☐	☐	☐	Data sheet
b)	**Fail open valve**				
	aa) Solenoid energized				
	Valve close	☐	☐	☐	Pneumatic/hydraulic schematic
	Close limit switch contact to close	☐	☐	☐	Wiring drawing
	Position indication - close	☐	☐	☐	Visual
	Position transmitter output - 0 %	☐	☐	☐	Data sheet
	ab) Solenoid de-energized				
	Valve open	☐	☐	☐	Pneumatic/hydraulic schematic
	Open limit switch contact to close	☐	☐	☐	Wiring drawing
	Position indication - open	☐	☐	☐	Visual
	Position transmitter output - 100 %	☐	☐	☐	Data sheet
NOTE Multiple solenoid valves shall also be tested to ensure functionality.					

Table F.5 — Partial stoke testing, accumulator functional test, functional test for electric actuator, handwheel and network interface cards checks

Reference	Partial stroke testing			Pass	Fail	Acceptance criteria
Table 8, row 9	Check solenoid valve energized			☐	☐	IOGP S-707
	Initiate PST command and check valve moves to specified percentage towards its fail safe position and returns immediately			☐	☐	
	Store valve signature in the device (check valve signature can be transferred to HART communicator or other applications)			☐	☐	
	De-energize solenoid valve for a short duration and re-energize, check valve is moved which ensures that solenoid valve is tested.			☐	☐	Applicable only when using PST controller
	Check open limit switch contact set at 3° or 3 %			☐	☐	
	Check close limit switch contact 3° or 3 %			☐	☐	
	Check position transmitter output, 0 to 100 % corresponds to 4 to 20 mA or 0 to 90° corresponds to 4 to 20 mA			☐	☐	
Reference	**Accumulator functional test**	**Required**	**Results**	**Pass**	**Fail**	**Acceptance criteria**
Table 8, row 10	Number of strokes - Starting from					
	minimum network supply pressure ..... bar g	..... strokes	..... strokes	☐	☐	Data sheet
	Accumulator volume	..... litres	..... litres	☐	☐	IOGP S-707
Reference	**Specific functional tests for electric actuator (as applicable)**			**Pass**	**Fail**	**Acceptance criteria**
Table 8, row 11	Local open/close			☐	☐	Manufacturer's test procedure
	Remote open/close/stop			☐	☐	
	open/close/fault contacts			☐	☐	
	Torque sensor functional check / configuration verification			☐	☐	
	Open/close limit switch setting verification			☐	☐	
Reference	**Hand wheel rim operation and rim force verification**, if supplied	**Specified value**	**Actual rim force measured**	**Pass**	**Fail**	**Acceptance criteria**
Table 8, row 12	Check handwheel operation for easiness and measure/record rim force	N (lbf)	N (lbf)	☐	☐	IOGP S-707
Reference	**Functional test on network interface cards**		**Pass**	**Fail**	**N/A**	**Acceptance criteria**
Table 8, row 13	Check configuration		☐	☐	☐	Manufacturer's test procedure
	Loop few electric actuators in loop and check network functionality		☐	☐	☐	

Table F.6 — Torque/Thrust validation and verification on assembled units - Electric actuators (fail lock)

Table 8, row 14	Fail lock valve - Torque/Thrust validation and verification							
Checks	**Responsibility**	**Torques/Thrusts**						
Valve torques/thrusts		**Break to open (BTO)**	**Run to open (RTO)**	**End to open (ETO)**	**Break to close (BTC)**	**End to close (ETC)**	**MAST**
Measured values / calculated values	Valve supplier	Measured	Measured	Measured	Measured	Measured	Calculated
Actuator torque/thrust		Maximum actuator output torque/thrust					Stall torque
Measured values / calculated values	Actuator supplier	Measured	Measured	Measured	Measured	Measured	Calculated
On demand correction factor based on fluid characteristics such as non-lubricating, clean or sticky service, operating temperatures, long stand still (ODCF)	Valve supplier	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	
Sizing safety factor (SSF)	Purchaser	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify
Validation	Valve supplier	**Maximum actuator output torque/thrust > BTO x ODCF x SSF**	**Maximum actuator output torque/thrust > RTO x ODCF x SSF**	**Maximum actuator output torque/thrust > ETO x ODCF x SSF**	**Maximum actuator output torque/thrust > BTC x ODCF x SSF**	**Maximum actuator output torque/thrust > ETC x ODCF x SSF**	**Stall torque < MAST**
Verification during FAT	Purchaser	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

Table F.7 — Torque/Thrust validation and verification on assembled units - Electric actuators (fail close)

Table 8, row 14	**Fail close valve - Torque/Thrust validation and verification**							
Checks	**Responsibility**	**Torques/Thrusts**						
Valve torques/thrusts		**Break to open (BTO)**	**Run to open (RTO)**	**End to open (ETO)**	**Break to close (BTC)**	**Run to close (RTC)**	**End to close (ETC)**	**MAST**
Measured values / calculated values	Valve supplier	Measured	Measured	Measured	Measured	Measured	Measured	Calculated
Actuator torque/thrust		Maximum actuator output torque/thrust			Spring to start (STS)	Spring to run (STR)	Spring to end (STE)	Stall torque
Measured values / calculated values	Actuator supplier	Measured	Measured	Measured	Measured	Measured	Measured	Calculated
On demand correction factor based on fluid characteristics such as non-lubricating, clean or sticky service, operating temperatures, long stand still (ODCF)	Valve supplier	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	
Sizing safety factor (SSF)	Purchaser	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify
Validation	Valve supplier	**Maximum actuator output torque/thrust > BTO x ODCF x SSF**	**Maximum actuator output torque/thrust > RTO x ODCF x SSF**	**Maximum actuator output torque/thrust > ETO x ODCF x SSF**	**STS > BTC x ODCF x SSF**	**STR > RTC x ODCF x SSF**	**STE > ETC x ODCF x SSF**	**Stall torque < MAST**
Verification during FAT	Purchaser	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

Table F.8 — Torque/Thrust validation and verification on assembled units - Electric actuators (fail open)

Table 8, row 14	**Fail open valve - Torque/Thrust validation and verification**							
Checks	**Responsibility**	**Torques/Thrusts**						
Valve torques/thrusts		**Break to open (BTO)**	**Run to open RTO)**	**End to open (ETO)**	**Break to close (BTC)**	**Run to close (RTC)**	**End to close (ETC)**	**MAST**
Measured values / calculated values	Valve supplier	Measured	Measured	Measured	Measured	Measured	Measured	Calculated
Actuator torque/thrust		Spring to start (STS)	Spring to run (STR)	Spring to end (STE)	Maximum actuator output torque/thrust			Stall torque
Measured values / calculated values	Actuator supplier	Measured	Measured	Measured	Measured	Measured	Measured	Calculated
On demand correction factor based on fluid characteristics such as non-lubricating, clean or sticky service, operating temperatures, long stand still (ODCF)	Valve supplier	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	
Sizing safety factor (SSF)	Purchaser	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify
Validation	Valve supplier	**STS > BTO x ODCF x SSF**	**STR > RTO x ODCF x SSF**	**STE > ETO x ODCF x SSF**	**Maximum actuator output torque/thrust > BTC x ODCF x SSF**	**Maximum actuator output torque/thrust > RTC x ODCF x SSF**	**Maximum actuator output torque/thrust > ETC x ODCF x SSF**	**Stall torque < MAST**
Verification during FAT	Purchaser	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

Table F.9 — Torque validation and verification on assembled units - Pneumatic, hydraulic and electro-hydraulic actuators (fail close valves)

Reference	**Fail close valve - Torque validation and verification**								
Table 8, row 15	**Responsibility**	**Torques**							
Valve torques		**Break to open (BTO)**	**Break to open @ breakaway angle (BTOba)**	**Run to open (RTO)**	**End to open (ETO)**	**Break to close (BTC)**	**Run to close (RTC)**	**End to close (ETC)**	**MAST**
Measured values / calculated values	Valve supplier	Measured	calculated	Measured	Measured	Measured	Measured	Measured	Calculated
Actuator torque		Air to start (ATS) [a]	Air to run @ breakaway angle (ATRba) [a]	Air to run (ATR) [a]	Air to end (ATE)	Spring to start (STS)	Spring to run (STR)	Spring to end (STE)	Maximum air to start torque (ATSmax)
Measured values / calculated values	Actuator supplier	Measured	calculated	Measured	Measured	Measured	Measured	Measured	Calculated
On demand correction factor based on fluid characteristics such as non-lubricating, clean or sticky service, operating temperatures, long stand still (ODCF)	Valve supplier	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	
Sizing safety factor (SSF)	Purchaser	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify
Validation	Valve supplier	**ATS > BTO x ODCF x SSF**	**ATRba > BTOba x ODCF x SSF**	**ATR > RTO x ODCF x SSF**	**ATE > ETO x ODCF x SSF**	**STS > BTC x ODCF x SSF**	**STR > RTC x ODCF x SSF**	**STE > ETC x ODCF x SSF**	**ATSmax < MAST**
Verification during FAT	Purchaser	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

NOTE The motive force to operate the actuator shall be either air or hydraulic oil. Hence where "air" is indicated in the above table, shall be substituted with "hydraulic oil" based on selected actuator.

a Torque values are at minimum operating pressure available at actuator pressure port or if the actuator air supply is regulated and system is protected by safety valve, the maximum air supply is safety valve set point plus over pressure.

Table F.10 — Torque validation and verification on assembled units - Pneumatic, hydraulic and electro-hydraulic actuators (fail open valve)

Table 8, row 15	**Fail open valve - Torque validation and verification**									
Checks	**Responsibility**	**Torques**								
Valve torques		**Break to open (BTO)**	**Run to open (RTO)**	**End to open (ETO)**	**Break to close (BTC)**	**Run to close (RTC)**	**End to close @ breakaway angle (ETCba)**	**End to close (ETC)**	**MAST**
Measured values / calculated values	Valve supplier	Measured	Measured	Measured	Measured	Measured	Calculated	Measured	Calculated
Actuator torque		Spring to start (STS)	Spring to run (STR)	Spring to end (STE)	Air to start (ATS) [a]	Air to run (ATR) [a]	Air to run @ breakaway angle (ATRba) [a]	Air to end (ATE) [a]	Maximum air to start torque (ATSmax)
Measured values / calculated values	Actuator supplier	Measured	Measured	Measured	Measured	Measured	Calculated	Measured	Calculated
On demand correction factor based on fluid characteristics such as non-lubricating, clean or sticky service, operating temperatures, long stand still (ODCF)	Valve supplier	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	Supplier to specify	
Sizing safety factor (SSF)	Purchaser	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify	Purchaser to specify
Validation	Valve supplier	**STS > BTO x ODCF x SSF**	**STR > RTO x ODCF x SSF**	**STE > ETO x ODCF x SSF**	**ATS > BTC x ODCF x SSF**	**ATR > RTC x ODCF x SSF**	**ATRba > ETCba x ODCF x SSF**	**ATE > ETC x ODCF x SSF**	**ATSmax < MAST**
Verification during FAT	Purchaser	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

NOTE The motive force to operate the actuator shall be either air or hydraulic oil. Hence where "air" is indicated in the above table, shall be substituted with "hydraulic oil" based on selected actuator.

a Torque values are at minimum operating pressure available at actuator pressure port or if the actuator air supply is regulated and system is protected by safety valve, the maximum air supply is safety valve set point plus over pressure.

Table F.11 — Torque validation and verification on assembled units - Pneumatic, hydraulic and electro-hydraulic actuators (other)

Reference	Other torque verification / validation		
	Check	Pass	Fail
Table 8, row 14	Maximum actuator torque/thrust < ISO 5210/5211 flange torque/thrust	☐	☐
Table 8, row 15	Spring to start torque/thrust (STS) < ISO 5211 flange torque	☐	☐
Table 8, row 15	Maximum air to start torque/thrust (ATSmax) / Maximum hydraulic to start torque/thrust (HTSmax) < ISO 5211 flange torque	☐	☐

Add new Annex G

Annex G
(normative)

Coating systems for offshore and coastal applications

Table G.1 — Coating system for carbon steel, corrosivity class CX

Coating system data sheet	Actuators		
Environment corrosivity (ISO 12944-2)	CX (ISO 12944-9)		
Substrate material	Carbon steel		
Service	Atmospheric zone offshore and coastal Non-insulated		
Minimum/maximum operating temperature	-50 °C to +80 °C (-58 °F to +176 °F)		
Surface preparation			
Surface cleanliness	Sa 2 1/2 (ISO 8501-1), SSPC-SP 10		
Roughness	50 - 85 µm (ISO 8503-5), grade medium G (ISO 8503-2)		
Level of total water-soluble salts (max)	20 mg/m^2		
Steel preparation	Grade P3 (ISO 8501-3)		
Coating system			
Coat (minimum number of coats)	Type of coat/binder	DFT, µm (ISO 19840)	
		Minimum	Maximum
1 (primer)	Zinc silicate [a, b]	60	Maximum DFT for each coat and coating system shall be as qualified by the coating manufacturer.
2	Epoxy	Intermediate and top coat DFT as per qualified coating system	
3 (topcoat)	Non-isocyanate coat or polyurethane [c]		
Total minimum DFT		280	
Performance tests, qualification and inspection			
Performance tests (coating manufacturer)	ISO 12944-9:2018, Table 4, cyclic ageing test		
	ISO 12944-9:2018, Table 5 Supplementary requirements: 1. Chalking to ISO 4628-6, maximum rating 2		
Coating procedure tests (applicator)	1. Pull-off test ISO 4624 Method A or B, minimum single 5.0 MPa 2. Curing test to ASTM D4752, Level 4 to 5		

Table G.1 *(continued)*

Coating system data sheet	Actuators
Performance tests, qualification and inspection *(continued)*	
Inspection	1. DFT ISO 19840, as per qualified coating system 2. Pull-off test ISO 4624 Method A or B, maximum 50 % reduction from CPT minimum single 5.0 MPa 3. Curing test to ASTM D4752, Level 4 to 5

NOTE The temperature range given in the data sheet corresponds to the minimum and maximum operating temperature for a generic coating system. Additional restrictions may apply for specific products based on coating manufacturer's recommendations and qualification tests.

[a] If a tie-coat is applied according to the coating manufacturer's recommendations, it shall be performance tested as a part of the coating system.

[b] Zinc primer shall be in accordance with ISO 12944-5, 7.1.2. with minimum 85 % by mass zinc content in dry film.

[c] HSSE restrictions may apply in some jurisdictions on the use of polyurethane paint.

Table G.2 — Coating system for aluminium alloys, corrosivity class C1 to C5, CX

Coating system data sheet	Actuators		
Environment corrosivity (ISO 12944-2)	C1 to C5, CX (ISO 12944-9)		
Substrate material	Stainless steels, aluminium alloys [a]		
Service	Atmospheric zone offshore and coastal Non-insulated		
Minimum/maximum operating temperature	-50 °C to +80 °C (-58 °F to +176 °F)		
Surface preparation			
Surface cleanliness	SSPC-SP 16 (sweep blast)		
Roughness	25 - 85 µm (ISO 8503-5), grade fine G (ISO 8503-2)		
Level of total water-soluble salts (max)	20 mg/m^2		
Steel preparation	Grade P3 (ISO 8501-3)		
Coating system [b]			
Coat (minimum number of coats)	Type of coat / binder	DFT, µm (ISO 19840)	
		Minimum	Maximum
1 (primer)	Epoxy [c, d]	50	Maximum DFT for each coat and coating system shall be as qualified by the coating manufacturer.
2	Epoxy [c, d]	100	
3 (topcoat)	Non-isocyanate coat or polyurethane [e]	75	
Total minimum DFT		225	

Table G.2 *(continued)*

Coating system data sheet	Actuators
Performance tests, qualification and inspection	
Performance tests (coating manufacturer)	ISO 12944-9:2018, Table 4, cyclic ageing test
	ISO 12944-9:2018, Table 5
Coating procedure tests (applicator)	1. Pull-off test ISO 4624 Method A or B, minimum single 5.0 MPa
Inspection	1. DFT ISO 19840, as per qualified coating system 2. Pull-off test ISO 4624 Method A or B, maximum 50 % reduction from CPT minimum single 5.0 MPa

NOTE The temperature range given in the data sheet corresponds to the minimum and maximum operating temperature for a generic coating system. Additional restrictions may apply for specific products based on coating manufacturer's recommendations and qualification tests.

[a] Aluminium and stainless steel actuators shall be painted only when specified by the purchaser for HSSE reasons or color coding.

[b] Alternatively, aluminium may be coated with a 75 µm polyester powder coating. Surface preparation of the aluminium prior to powder coating shall include a chromate conversion coating.

[c] Coatings for stainless steels shall not contain zinc.

[d] For stainless steels, a high-solid, high-build epoxy coat with minimum DFT > 150 µm may be used in a two-coats system.

[e] HSSE restrictions may apply in some jurisdictions on the use of polyurethane paint.

Bibliography

Add to bibliography

[7] ISO 12944-1, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction*

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