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Industrial valves — Part-turn valve actuation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 153, *Valves*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The purpose of this document is to provide increased reliability and safety in automated on-off valve operation by defining and standardizing valve torque nomenclature used in actuator selection. The content is derived from Reference [15].

Industrial valves — Part-turn valve actuation

1 Scope

This document applies to part-turn actuated valve assemblies comprising valve (e.g. ball valve, butterfly valve, and plug valve), actuator and, when required, a mounting kit supplied as a package.

It defines the design considerations necessary for automating valves, the responsibilities for the information required and tasks to be completed, to ensure suitable actuator and mounting kit sizing, selection and assembly on the valve.

It applies to pneumatic, hydraulic, electro-hydraulic and electric actuators. An actuator coupled to a gearbox, as defined in ISO 5211, is included in the scope of this document. Lever or manual gearbox operated valves are excluded.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 273, *Fasteners — Clearance holes for bolts and screws*

ISO 5211:2017, *Industrial valves — Part-turn actuator attachments*

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

ISO 22153:2020, *Electric actuators for industrial valves — General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

MSS SP-101:2014, *Part-Turn Valve Actuator Attachment — FA Flange and Driving Component — Dimensions and Performance Characteristics*

ASME B18.2.8, *Clearance Holes for Bolts, Screws, and Studs*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
actuator
device designed for attachment to a general-purpose industrial valve in order to provide for the operation of the valve

Note 1 to entry: The device is designed to operate using motive energy which may be electrical, pneumatic, hydraulic, etc., or any combination of these. Movement is limited by travel or torque.

[SOURCE: ISO 5211:2017, 3.1]

3.2
breakaway angle
amount of *valve stem* (3.22) rotation before the *obturator* (3.9) breaks sealing contact with the seat

Note 1 to entry: The breakaway angle can be significant to *actuator* (3.1) sizing when more than 5° of rotation.

3.3
breakaway torque
maximum torque required to operate a valve at maximum pressure differential

Note 1 to entry: Breakaway torque is a general term that applies to the valve break to open torque and the valve break to close torque.

3.4
MAST
maximum allowable stem torque
maximum torque that can be applied to the *valve stem* (3.22) or coupling, as defined by the manufacturer, without causing permanent deformation or mechanical damage that prevents sealing or operation

3.5
cycle
movement of the valve *obturator* (3.9) from the fully closed position to the fully open position and back to the fully closed position, or vice versa

[SOURCE: ISO 12490:2011, 4.8, modified — The word "continuous" at the beginning of the definition has been removed.]

3.6
DN
NPS
nominal size
alphanumeric designation of size that is common for components used in a piping system, used for reference purposes, comprising the letters DN or NPS followed by a dimensionless number indirectly related to the physical size of the bore or outside diameter of the end connections

Note 1 to entry: The number following DN or NPS does not represent a measurable value and is not used for calculation purposes except where specified in a product standard.

[SOURCE: ISO 5208:2015, 2.7]

3.7
intermediate support
mechanical component (e.g., bracket, spool, adapter flange) being part of a *mounting kit* (3.8) that allows the attachment between a valve and *actuator* (3.1)

3.8
mounting kit
components that can include combinations of the following: intermediate support, coupling, drive key(s), dowel pin(s) and fasteners

3.9
obturator
part of a valve, such as a ball, clapper, disc, gate or plug that is positioned in the flow stream to permit or prevent flow

[SOURCE: ISO 14313:2007, 4.19, modified — The term "closure member" has been removed.]

3.10
differential pressure
Δp
pressure difference across the upstream and downstream sides of the *obturator* (3.9) seals when it is in the fully closed, partially open, or fully open position

3.11
maximum rated pressure
maximum pressure that can safely be applied in the pressure-containing parts of a pneumatic or hydraulic *actuator* (3.1) as defined by the actuator manufacturer

3.12
maximum supply pressure
maximum available pressure to supply at a pneumatic or hydraulic *actuator* (3.1) pressure inlet port as defined by the purchaser

3.13
minimum operating pressure
minimum required pressure to supply at a pneumatic or hydraulic actuator pressure inlet port to operate the *actuator* (3.1) as defined by the actuator manufacturer

3.14
minimum supply pressure
minimum available pressure to supply at a pneumatic or hydraulic *actuator* (3.1) pressure inlet port as defined by the purchaser

3.15
sizing safety factor
SSF
numerical value that is multiplied to the valve operating torque that is used when selecting an *actuator* (3.1)

3.16
stroke
travel of the valve *obturator* (3.9) from the fully closed to the fully open position, or vice versa

Note 1 to entry: End of stroke is predefined as the fully closed or fully open position.

[SOURCE: ISO 12490:2011, 4.25, modified — The Note 1 to entry has been added and the word "movement" has been substituted by "travel".]

3.17
travel
movement of the *actuator* (3.1) in driving a valve *obturator* (3.9), defined in terms of output turns, angular or linear distance, a percentage thereof or undefined when relating to general movements(s)

[SOURCE: ISO 22153:2020, 3.13]

3.18
valve dynamic torque
T_d
torque generated by flow of media through valve and around the *obturator* (3.9)

[SOURCE: Reference [14]]

3.19
C_t
valve dynamic torque coefficient
dimensionless coefficient used to determine the flow induced torque on the *obturator* (3.9) as a function of valve geometry, flow rate, and valve position

[SOURCE: Reference [14]]

3.20
valve operation time
period between when the signal is given for the valve to operate, starting from the fully open position and ending at the fully closed position or vice versa

3.21
valve response time
period between when the signal is given for the valve to operate until the *obturator* (3.9) starts to move

Note 1 to entry: With electric *actuators* (3.1), a valve response time is not relevant.

3.22
valve stem
part of the valve transmitting the driving torque to the *obturator* (3.9)

Note 1 to entry: This concept also referred to as valve shaft or valve spindle in product standards, is collectively identified herein as valve stem.

3.23
valve travel time
period between when *obturator* (3.9) starts to move starting from the fully open position and ending to the fully closed position or vice versa

3.24
valve torque
required input torque at the valve stem at the moment there is relative movement between the *obturator* (3.9) and seat(s)

Note 1 to entry: This torque can vary depending on the valve starting position and internal pressure.

4 Abbreviated terms

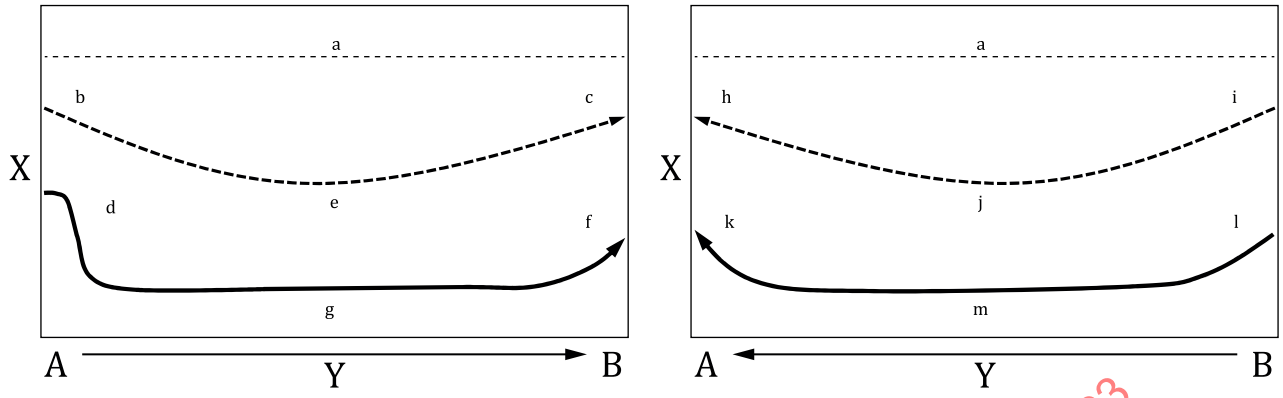
For the purposes of this document, the abbreviated terms given in Table 1 apply.

Abbreviated terms are preceded by the letter V when referring to the valve, and the letter A when referring to the actuator.

EXAMPLE VBTO is valve break to open, and ABTO is actuator break to open, with the exception for MAST where letters V and A are not used. See Figure 1.

Table 1 — Abbreviated terms

Abbreviated term	Term
BTO	break to open
RTO	run to open
ETO	end to open
BTC	break to close
RTC	run to close
ETC	end to close
MAST	maximum allowable stem torque



a) Valve opening **b) Valve closing**

Key

A	closed	a	Maximum allowable stem torque.
B	open	b	Break to open torque.
Y	valve position	c	End to open torque.
X	torque	d	Break to open torque.
———	valve	e	Run to open torque.
- - - - -	actuator	f	End to open torque.
		g	Run to open torque.
		h	End to close torque.
		i	Break to close torque.
		j	Run to close torque.
		k	End to close torque.
		l	Break to close torque.
		m	Run to close torque.

NOTE Figure 1 is an example. Actuator torque output and valve torque vary by type and design.

Figure 1 — Valve and actuator torque versus position

5 Responsibilities

5.1 General

Assignment of the responsibilities by role in the sizing, selection, assembling and construction of an automated valve shall be as defined in this clause. Each role can be performed by an independent entity or roles may be combined. For example, the actuator supplier could also be the mounting kit supplier and assembly contractor. Even when roles are combined, the responsibilities of this document shall be fulfilled.

Required information shall be provided by each defined role in the assembly sizing data sheet which shall be in accordance with Annex A.

NOTE In 5.2 to 5.5, the numbers in parenthesis are the corresponding row number in the assembly sizing data sheet in Annex A.

5.2 Purchaser

Following the processes described in this document, the purchaser receives the actuated valve assembly and required documentation. The purchaser of the automated part-turn valve assembly, or

their nominated agent, shall define requirements for the components of an automated valve assembly in a specification and/or purchase order. The purchaser shall provide the following information:

a) the assembly contractor's name;

b) the specified ambient temperatures (7);

c) the required level of ingress protection IP code according to IEC 60529 for the actuator, and the required external corrosion protection for the actuator and mounting kit, C2 through CX and Im 1 through Im 3 according to ISO 12944-2 (8-9);

d) the specified valve type: ball, butterfly, plug, etc. (10);

e) the specified actuator type: pneumatic, hydraulic/electro-hydraulic, or electric (11);

f) the required fail position for the valve upon loss of power source (e.g. supply pressure and/or electricity) to the actuator (12);

g) the specified valve operation time(s) (13);

h) the minimum and maximum supply pressure if specifying a pneumatic or hydraulic actuator, or the supply voltage if an electro-hydraulic or electric actuator (15);

i) the specified type of valve connection to the pipe, frequency of operation and the valve assembly configuration with respect to the pipeline and flow direction (16-18);

j) the process conditions including the media, flow rates, operating temperatures and pressures (19-26);

k) the sizing safety factor, SSF, to multiply to valve torque when selecting the actuator, typically a value between 1,1 and 1,5 (27);

l) the specified application and fluid characteristics (28-34) that identify the applicable on-demand correction factors. The purchaser shall specify on-demand correction factors to be used if different than the default values in this document (6.2 and Table 2).

5.3 Valve supplier

The valve supplier selects the valve to meet the purchaser's specification. The supplier of the valve sends the valve to the assembly contractor, and the supplier shall provide the following information to the actuator supplier, mounting kit supplier, and assembly contractor:

a) name of the valve manufacturer and a description of the valve type and characteristics (35-45);

b) breakaway valve torque data as a function of valve configuration, size, differential pressure, and travel, including applicable on-demand correction factors (46-51);

Valve dynamic torque, T_d, generated by flow around or through the obturator can be greater than the breakaway torque. Valve dynamic torque is calculated using Formula (1). Additional friction from bearings and packing are added to the valve dynamic torque to determine the valve operating torque at intermediary travel positions. In general, dynamic torque should be considered when valve size is DN 600 (NPS 24) and larger, and when flow velocity is greater than 5,3 m/s.

$$T_d = C_t \times \Delta p \times d_{vp}^{\ 3} \quad (1)$$

where

C_t is the valve dynamic torque coefficient;

Δp is the differential pressure;

d_{vp} is the valve minimum flow port size or diameter.

c) breakaway angles as a function of valve configuration and size (52);

d) the maximum allowable stem torque (MAST) for the valve (53);

e) on-demand torque correction factors if alternate valve manufacturers values are agreed by the purchaser (6.2 and Table 2);

f) dimensions of valve mounting interface with actuator or intermediate support and coupling (54);

g) external dimensions of valve body relative to mounting interface and end connections to ensure actuator and/or intermediate support do not interfere with valve flanges (55).

5.4 Actuator supplier

5.4.1 General

The actuator supplier selects an actuator that meets the purchaser's specification and is capable of providing the required valve torque including on demand correction(s) and sizing safety factor.

5.4.2 Pneumatic and hydraulic actuators

For pneumatic and hydraulic actuators, the supplier of the actuator shall provide the following information to the mounting kit supplier and assembly contractor:

a) the minimum operating pressure and maximum rated pressure (56-57);

b) the required volume needed for the open stroke and the closed stroke (58);

c) the media required to operate the actuator such as air, hydraulic oil, natural gas, etc., and the required quality of the media (59-60);

d) the style of actuator: scotch-yoke, rack and pinion, vane, etc. (61);

e) the manufacturer's name and actuator model number (62-63);

f) the manufacturer's product code or part number that identifies the size and/or number of springs (64), for actuators using spring(s) to achieve the designated fail position;

g) the minimum and maximum actuator torque versus position in tabulated data (66-71);

h) actuator mounting interface dimensional data including tolerances (72);

i) external dimensions of the actuator and the mass and dimensions to centre of gravity of the actuator (73).

5.4.3 Electric actuators

For electro-hydraulic and electric actuators, the supplier of the actuator shall provide the following information to the mounting kit supplier and assembly contractor:

a) the manufacturers name and actuator model number (74-75);

b) the required nominal electric supply voltage and tolerance range (76);

c) the required nominal electric supply frequency and tolerance range (77);

d) the number of phases in the electric supply (78);

e) the voltage of the control signal (79);

f) the rated torque and/or stall torque as defined in ISO 22153 (80-81);

g) for actuators with devices that limit torque output, the set torque and the set travel limit (82-84);

h) the actuator duty class per ISO 22153:2020, Table 1 (85);

i) actuator mounting interface dimensional data including tolerances (86);

j) external dimensions of the actuator and the mass and dimensions to centre of gravity of the actuator (87).

5.5 Mounting kit supplier

The mounting kit supplier selects a mounting kit that matches the valve and actuator mounting interfaces, can transfer the actuator torque, and complies with the purchaser's specification. The supplier of the mounting kit shall provide the following information to the assembly contractor:

a) materials of construction, including fasteners and any coatings such as plating or paint (90-92);

b) identification of any limitations in actuator mounting position orientation or additional support required for the actuator (93);

c) maximum allowable torque that can be applied to the intermediate support, at the mounting interface with the valve, the mounting interface with the actuator, and the coupling (94-97);

d) dimensions of the intermediate support and coupling including ISO 5211 or MSS SP-101 flange type, mounting hole sizes and bolt circle diameter, height, width, and thickness (98);

5.6 Assembly contractor

The assembly contractor receives the components and required documentation from the suppliers, builds and tests the automated valve assembly, and sends the actuated valve assembly and documentation to the purchaser. The assembly contractor is responsible for:

a) verifying the actuator size selection;

b) ensuring the actuator maximum torque output does not exceed the MAST of the valve or rated torque of the coupling, and does not exceed the torque capacity of the intermediate support and mounting interfaces;

c) assembling of the automated valve components in accordance with purchaser and manufacturer instructions;

d) inspecting, testing, and providing a final report for the final assembly;

e) preparing for shipment.

6 Valve torque data

6.1 Operating torque

The valve manufacturer shall establish the following valve torque values based on design qualification testing, type testing per an applicable standard, production sampling, or testing of the specific valve to be automated:

a) break to open (VBTO);

b) run to open (VRTO);

c) end to open (VETO);

d) break to close (VBTC);

e) run to close (VRTC);

f) end to close (VETC).

See Figure 1.

Valve torque testing shall be conducted to validate the adopted calculation method used to determine valve torque against differential pressure. Clean, unlubricated air, nitrogen or water shall be used to apply differential pressure. Except for plug valves that rely on a sealing compound to effect a closure seal, valve seat surfaces shall be free from oil, grease or compounds that may reduce friction. However, if necessary to prevent galling of surfaces in contact, surfaces may be coated with a film of oil whose viscosity is not more than that of kerosene.

Valve torque data shall be based on uniform, not abrupt, application of torque to attain typical valve operating speeds (a rough approximation of operating time for a 90° stroke can be calculated by nominal size times 0,02 s/DN or 0,5 s/NPS).

All torque values provided shall be net values and shall not include correction or other safety factors.

If valve torque values are established by measurement of production samples, reported torque shall be statistically determined using a 95 % confidence interval level.

WARNING — Assembled automated valve torque actually required can be higher due to misalignment of the valve to the actuator, stress on the valve body from incorrect alignment of pipe flanges, and downward forces on the valve stem from insufficient axial clearance in the coupling.

6.2 On-demand correction factors

Valve torque values provided by the valve manufacturer shall be increased with the applicable on-demand correction factor (ODCF) unless other values are specified by the purchaser. Alternate values may be used when the valve manufacturer has conducted testing or has actual operational data and provides different values that are agreed with the purchaser: see Table 2.

When more than one ODCF applies, they shall be combined by multiplication of the highest applicable fluid or media characteristic with the applicable long stand still time.

Table 2 — Typical on-demand correction factors

Media or operational characteristic	Typical examples	On-demand correction factor	On-demand correction factor applies to:					
			BTO	RTO	ETO	BTC	RTC	ETC
Lubricating liquid	Oil, silicone	0,8	A	A	A	A	A	A
Non-lubricating liquid	Water	1,0	A	A	A	A	A	A
Non-lubricating dry gas	Oxygen	1,3	A	A	A	A	A	A
Sticky, non-lubricating liquid	Molasses, tar	1,4	A	A	A	A	A	A
Dirty media containing particles, slurries	Fluid or air containing small percentage of sand	1,5	A	A	A	A	A	A
Crystallizing or polymerizing media	Sulfur, sugar, styrene	1,6	A	A	A	A	A	A
Long stand still time	1 month to less than 1 year between operations	1,3	A [a]	—	—	A [a]	—	—
	Greater than 1 year between operations	1,7	A [a]	—	—	A [a]	—	—

NOTE A = correction factor is applied when specified.

[a] On-demand correction factor for long standstill time applies only to the valve initial position when operation is first attempted. On a normally closed valve the on-demand correction factor only applies to the BTO. On a normally open valve the on-demand correction factor only applies to the BTC.

6.3 Maximum allowable stem torque (MAST)

MAST for the valve may be determined by test or by calculation. When MAST is determined by calculation, the manufacturer shall have validated the accuracy of the calculation formulae with a type test including all parts in the valve and any mounting interface transferring torque.

NOTE It is possible that the valve stem is not the limiting item for MAST. It is important to consider all parts and mounting interfaces transferring actuation torque.

MAST values provided by the manufacturer shall account for any reduction in material strength at the purchaser specified operating temperature.

7 Actuator data

7.1 Output torque

7.1.1 Pneumatic and hydraulic/electro-hydraulic actuators

Pneumatic and hydraulic/electro-hydraulic actuator manufacturers shall establish the following actuator torque values based on design qualification testing, type testing per an applicable standard, or testing of the specific actuator to be mounted on the valve:

a) break to open (ABTO);

b) run to open (ARTO);

c) end to open (AETO);

d) break to close (ABTC);

e) run to close (ARTC);

f) end to close (AETC).

See Figure 1.

Where the output torque varies during the stroke in a nonlinear manner, the actuator manufacturer shall provide the required data in tabular format or a graphed curve with enough resolution to accurately show transition points in output torque versus position.

Torque values at the minimum and maximum power supply given by the purchaser shall be provided.

7.1.2 Electric actuators

Electric actuator manufacturers shall establish the following actuator torque values in accordance with ISO 22153:

a) rated torque;

b) stall torque;

c) minimum and maximum setting torque.

7.2 Maximum rated pressure

The maximum rated pressure claimed by the manufacturer for pneumatic and hydraulic actuators shall have been verified by design validation testing.

8 Mounting components

8.1 General

On some assemblies, the valve design permits direct mounting of the actuator and/or combination of secondary gearbox and actuator onto the valve without the need for mounting kits or intermediate supports and other components besides couplings included with the actuator and fasteners.

On some assemblies, the valve design permits direct fitting of the actuator onto the valve stem, and only an intermediate support and fasteners are required.

All other assemblies require the use of a mounting kit that includes an intermediate support, coupling, and fasteners to connect the actuator to the valve. ISO 5640 provides requirements for metallic mounting kits for part-turn valves and actuator attachments.

NOTE Refer to ISO 5211:2017, Figure 1 for representation of direct interface, intermediate support interfaces, and interfaces with a secondary gearbox.

The requirements in this document shall apply if the mounting components or their function are separate or integral to other components in the automated valve assembly. For example, intermediate support requirements apply to valve designs that include an integral support for direct actuator mounting.

Unless agreed between purchaser and assembly contractor, stacking of two or more intermediate supports between the mounting interface of the valve and the actuator is not permitted.

Design temperature range of the mounting components shall be equal to or greater than the minimum and maximum temperatures specified by the purchaser.

Stress analysis for the mounting set shall be based on the transfer torque capacity of the lowest rated mounting interface of the intermediate support: the intermediate support-to-valve mounting interface or the intermediate support-to-actuator mounting interface. The torque transfer capability of bolted mounting interfaces shall be based on static friction. Shear strength of the bolts shall not be included.

Torque transfer capability of bolted mounting interfaces shall be determined by calculation using the formulae in ISO 5211:2017, Annex A, or MSS SP-101:2014, Appendix X1.

The design stress limit for an intermediate support made from a material with a defined minimum yield strength in tension shall be 67 % of the tensile yield strength. For an intermediate support made from a material with no defined yield strength, such as cast iron, the design stress limit shall be 50 % of the minimum material tensile stress. The torsional shear stress limit for the coupling shall be 53 % of the minimum tensile yield strength. Direct shear stress limit for a key shall be 57 % of the minimum tensile yield strength, and the bearing stress limit for a key shall be the minimum tensile yield strength.

8.2 Intermediate support

Intermediate support should comply with ISO 5640. When the valve and/or actuator mounting interface or torque required is outside the scope of ISO 5640, the following requirements apply.

The intermediate support shall be made from a metallic material with a melting temperature of 750 °C or higher, such as cast iron, ductile iron, carbon steel, stainless steel.

The intermediate support material and coating shall be suitable for the environmental conditions specified by the purchaser.

The torque transfer capability of the mounting interfaces between the intermediate support and the valve and the intermediate support and the actuator shall be greater than the maximum actuator output torque.

The intermediate support design shall be sufficiently strong by design and material selection to ensure no visibly discernible movement of the actuator from twisting or warping of the intermediate support during operation.

Intermediate supports with mounting interface bolt patterns greater than 140 mm in diameter may be fabricated from plate or plate and pipe by structural welding. Intermediate supports with mounting interface bolt patterns smaller than 140 mm in diameter shall be fabricated from a single piece of plate, structural tube, or casting. Unless approved by purchaser, welded fabrication shall not be used for intermediate supports with mounting interface bolt patterns smaller than 140 mm in diameter.

Height of the intermediate support shall be sufficient to:

— prevent any part of the actuator housing from contacting the valve;

— prevent hot and/or cold process temperatures from the valve from reaching the actuator and exceeding the allowable temperature limits of the actuator;

— enable visual observation of the valve position.

Shape of the intermediate support shall permit access to inspect and adjust the valve packing if the valve is so equipped.

As a minimum, the intermediate support shall be designed for installation with the valve stem vertical. The mounting kit manufacturer shall provide a warning regarding any prohibited installation orientation, such as stem horizontal, in their instructions. When specified by the purchaser, the intermediate support shall also be designed for external loads (e.g. stepping load, earthquake, wind loading, additional plant induced loads). For non-vertical valve stems and when additional external loads are specified, extra support of the actuator may be required and shall be provided by the mounting kit manufacturer.

Intermediate support shall be designed to be capable of installation onto and removal from the valve without loosening or removal of pressure boundary bolting such as bonnet bolts, flange bolts, packing gland bolts, etc.

Rain or washdown water shall freely drain from the intermediate support in any possible mounting position, so it cannot accumulate, freeze during cold temperature, and impede valve operation.

Holes for fasteners shall be drilled, punched, or precision laser cut and deburred and free of sharp edges and raised corners. Manual burning of fastener holes is not permitted. When agreed with the purchaser, slotting or joining of adjacent fastener holes to accommodate multiple mounting patterns is permitted. Elongation of fastener holes to eliminate interference due to misaligned holes is not permitted.

Clearance between the hole diameter and the fastener shall be in accordance with ISO 273 medium series for metric fasteners. Clearance between the hole diameter and the fastener shall be in accordance with ASME B18.2.8 for UN threaded fasteners.

8.3 Coupling

The coupling material of a mounting kit shall be made from a metallic material with a melting temperature of 750 °C or higher and consideration shall be given to low ductility at the minimum ambient temperature specified by the purchaser.

The coupling material and coating shall be suitable for the environmental conditions specified by the purchaser.

The maximum allowable torque for the coupling shall be greater than the maximum actuator output torque.

Axial movement or clearance of the coupling along the stem axis needs to be provided to prevent end loading of the valve stem or actuator drive. Axial movement needs to be limited so coupling does not disengage from the valve or actuator drive. Spacers shall not be used to limit the range of axial movement.

The range of axial clearance shall ensure that in all possible valve installation orientations, the required engagement between the valve stem and coupling, and between the coupling and actuator is enough to achieve the MAST.

The coupling shall not restrict access to valve packing adjustment, and shall not contact the intermediate support, any valve components other than the stem, or fasteners.

The coupling shall have an easily visible indicator that identifies the valve obturator position such as a machined groove, attached rivets, or similar. Position indicator on the coupling shall be parallel with the flow port through the valve when the valve is open.

Drive connection clearance between the valve stem and coupling plus the coupling and actuator shall limit the dead band to a maximum of 0,50°. Use of set screws to reduce dead band is not permitted. Any coating applied to the coupling shall not be damaged or degrade and cause the dead band to increase.

8.4 Fasteners

Unless otherwise specified by the purchaser, fasteners used for mounting components shall be plated alloy steel or stainless steel.

Fasteners shall be manufactured to a specification with defined minimum mechanical property requirements.

Do not use stainless steel susceptible to stress corrosion cracking for fasteners in environments causing chloride stress corrosion.

All fasteners used to affix mounting components shall have a means to prevent any loss of preload during normal conditions (e.g. vibration, temperature changes).

9 Actuator size selection

9.1 Selection criteria

The following criteria shall be met:

a) for a pneumatic or hydraulic actuator, the maximum supply pressure is less than the actuator allowable;

b) for an electro-hydraulic or electric actuator, power supply voltage and frequency are within the range allowed;

c) maximum actuator output torque in both directions of rotation is less than maximum allowable torque of the intermediate support mounting interface with the valve and interface with the actuator;

d) maximum actuator output torque in both directions of rotation is less than MAST of the valve and the rated torque of the coupling;

e) actuator output torque in both directions of rotation is greater than the valve torque, including on-demand correction factors, over the full travel in both directions.

NOTE 1 Pneumatic, electro-hydraulic and hydraulic maximum actuator output torque can be different when actuator travel stop settings are not 0° or 90°.

NOTE 2 Maximum output torque for an electric actuator is the torque produced at the maximum supply voltage or, if torque switch is used, it is the pre-set tripping torque.

9.2 Additional considerations for actuator

Additional actuator selection considerations are the following.

a) Fast operation less than 0,01 s/DN or 0,25 s/NPS may be detrimental to the reliability of the valve, actuator, and associated piping. Emergency shutdown and blowdown valves shall operate quickly and reliably for safety of the process, personnel, and plant. To limit damage caused by high speed impact of moving parts and to reduce potential for hydraulic shock (i.e. fluid or water hammer) in the pipeline, actuators may be equipped with speed controls and/or dampeners at the end of travel.

b) Fail safe action is most reliably provided by a mechanical spring. When this is not possible, a reserve air volume tank may be provided for double-acting pneumatic actuators or stored energy in a capacitor or battery for an electric actuator may be used. The quantity of air volume or stored energy shall be enough to operate the valve for a minimum of two cycles. Purchaser may specify an additional number of cycles.

c) Actuator output torque during normal operation can be different than output during failure stroke: for example, when supply pressure or electric power are used for normal operation, and a spring or separate pneumatic or hydraulic volume tank is used to provide the failure stroke. In such cases, the actuator output torque shall be sufficient to operate the valve in both normal operation and during failure.

d) Additional considerations for ancillary components that may be attached to the actuator are in Annex C.

10 Automated valve assembly

The assembly contractor shall confirm conformance with the actuator sizing requirements in Table 3.

The assembly contractor shall assemble the components following all purchaser and component manufacturer instructions.

During configuration and assembly of the automated valve, the assembly contractor needs to give additional consideration for maintenance according to Annex D.

Table 3 — Actuator sizing requirements

1	Pneumatic or hydraulic actuators: verify that the maximum supply pressure is less than the maximum rated pressure. Electro-hydraulic and electric actuators: verify that supply voltage is equal to the nominal voltage of the actuator.	
2	Verify that the MAST of the valve is more than the maximum actuator output torque.	
3	Verify that the torque rating of the coupling is more than the maximum actuator output torque.	
4	Verify that the torque capacity of the valve and actuator mounting interfaces are more than the maximum actuator output torque.	
5	Verify that the actuator output torque, in both open and closed directions, is more than the valve torque, including on-demand correction factors and sizing safety factor (SSF), over the full range of travel.	
	Fail close	**Fail open**
5.1	ABTC > VBTC × ODCF × SSF	ABTO > VBTO × ODCF × SSF
5.2	ARTC > VRTC × ODCF × SSF	ARTO > VRTO × ODCF × SSF
5.3	AETC > VETC × ODCF × SSF	AETO > VETO × ODCF × SSF
5.4	ABTO > VBTO × ODCF × SSF	ABTC > VBTC × ODCF × SSF
5.5	ARTO > VRTO × ODCF × SSF	ARTC > VRTC × ODCF × x SSF
5.6	AETO > VETO × ODCF × SSF	AETC > VETC × ODCF × SSF
6	If the maximum actuator torque output exceeds the MAST of the valve or rated torque of the coupling, change one or more of the following starting with option 1 as the preferred solution: 1) select a different actuator; 2) lower the maximum supply pressure, or for electric actuator, reduce the stall torque or pre-set tripping torque; 3) increase the MAST of the valve or rated torque of the coupling.	

11 Post assembly inspection and testing

11.1 General

After ensuring the automated valve assembly complies with the purchaser order, referenced standards, and manufacturer's assembly instructions, the assembly contractor shall complete the following inspections and testing and report the results to the purchaser.

11.2 Visual inspection

The following criteria shall be met:

a) visually inspect the assembly for any damaged components;

b) verify that the valve is free of foreign material;

c) verify that all open-end connections, including conduit entries, vent ports, air supply ports, valve ends, etc., are plugged or covered;

d) ensure electrical wiring conduit and air or hydraulic tubing is neatly and efficiently run close to the actuator whenever possible to avoid accidental bending, with minimal number of bends, correct bend radii, and within the overall envelope of the actuator and accessories;

e) verify all component marking is correct and matches purchaser's specification;

f) ensure that valves with a single or preferred flow direction are properly configured and marked for correct installation in the pipeline;

g) record inspection results in the test report that shall be provided with the assembly.

11.3 Function test

11.3.1 General

To conduct the function test, connect supply pressure and/or electric power to the automated valve assembly.

Check for pneumatic or hydraulic leaks at end caps, actuator drive/shaft pinion, accessory connections, tubing, and fittings.

11.3.2 Functional test procedure

Complete the following functional tests.

a) With the nominal specified electric voltage or minimum supply pressure to the actuator, cycle the valve fully open and closed to verify correct setting of the open and closed stops. For ball and plug valves, verify that the obturator seating surfaces are not projecting into the flow path when the valve is fully open.

b) On assemblies using a coupling, check for alignment of valve stem to actuator drive by verifying the coupling is free to move axially in both the fully open and closed positions. If the coupling is binding in either position, then it is not properly aligned.

c) Energize and de-energize the solenoid or electric motor to fully open and fully close the valve two times. Verify that the entire assembly functions smoothly.

d) Visually check the coupling for uneven rotation during operation. The coupling should freely move along the valve stem axis with no binding at both the open and closed positions.

e) Measure and record the valve operation time and travel time (see Annex B) to fully open the valve, and the same times for the valve to fully close. The test shall be done with minimum voltage for electric actuators. For pneumatic and hydraulic actuators, the test shall be done with the maximum supply pressure for spring stroke direction, and minimum supply pressure for spring compressing direction. Verify the valve operation and response time is within the range specified by the purchaser.

f) Fail action test:

   — electric signal failure test – de-energize the solenoid, or for electric actuators, send the failsafe command, and verify the automated valve moves to the desired fail position;

   — supply pressure failure test, or if electric actuator, motive supply power failure test – disconnect the supply pressure to the solenoid, or motive supply power to an electric actuator, and verify the automated valve moves to the desired fail position.

g) If installed, check settings and function of any position switches and/or position transmitter.

h) For actuators with a manual override, verify movement of the obturator when manual operation is used.

i) Check the function of any ancillary components such as quick exhausts, speed controls, mufflers, bug screens, volume boosters, pneumatic trip valve, air volume tank.

11.3.3 Optional function tests that may be specified by purchaser

Complete the following functional tests if required by the purchaser:

a) functional test with the valve pressurized, the test procedure being agreed with the purchaser;

b) valve closure test to measure seat leakage as specified in the purchase order;

c) valve signature test for pneumatic or hydraulic actuator. The valve signature test is a graph of actuator pressure versus degree or percent of valve travel in both the open and closed directions. Valve torque values BTO, RTO, ETO, BTC, RTC, and ETC shall be determined and reported from this test.

Record inspection results in the test report that is to be provided with the assembly.

12 Marking

When required by the purchaser, the automated valve assembly shall have a tag securely attached to the fasteners of the mounting kit or the intermediate support, marked legibly and indelibly with:

a) automated valve assembly tag number specified by the purchaser;

b) company name of the assembly contractor;

c) serial number of the automated valve assembly provided by the assembly contractor;

d) valve model number, and if provided by the manufacturer, the valve serial number;

e) actuator model number, and if provided by the manufacturer, the actuator serial number;

f) mounting kit number.

Tag and the means of fixing shall be in a metallic material which is resistant to atmospheric corrosion and suitable for the specified ambient temperature range.

13 Preparation for shipment

All open ports shall be blanked off for protection.

Automated valve assemblies shall be packed in a crate or secured to a pallet, and properly supported to prevent shifting and damage during shipment. Packaging shall be in a manner that avoids atmospheric corrosion to inside and outside surfaces or parts while in transit and during sheltered storage with 80 % maximum humidity and temperature controlled between 10 °C to 40 °C.

14 Documentation

The assembly contractor shall provide the following documentation to the purchaser:

a) sizing data sheet (Annex A);

b) inspection and test reports (Clause 11);

c) valve and actuator test certificates from the manufacturers;

d) valve and actuator installation and maintenance instructions from the manufacturers;

e) conformance certificates, as applicable;

f) any other purchaser requested items such as assembly dimensional drawings.

Annex A
(normative)

Assembly sizing data sheet

The assembly sizing data sheet shall be in accordance with Table A.1, keeping the parameters applicable to the valve or actuator type. The format and content can be changed to address parameters that are unique to the valve or actuator type.

Table A.1 — Assembly sizing data sheet

Category	No.	Parameter		Value			Data provider
				Min.	Max.	Units	
Identification	1	Tag					Purchaser
	2	Service					
	3	P&ID					
	4	Line number					
	5	Purchase order/requisition					
	6	Remarks					
Ambient conditions	7	Ambient temperature	min./max.			°C	Purchaser
	8	Actuator ingress protection, IP code					
	9	External corrosion protection, C and Im code					
Application	10	Valve type					Purchaser
	11	Actuator type					
	12	Fail position	open / close / as is				
	13	Valve operation time	min./max.			s	
	14	Valve travel time	min./max.			s	
	15	Actuator supply pressure or supply voltage	min./max.			bar(g) V	
	16	Valve connection to pipe					
	17	Frequency of operation				Cycles/year	
	18	Installation orientation					

Table A.1 *(continued)*

Category	No.	Parameter		Value			Data provider
				Min.	Max.	Units	
Process	19	Medium					Purchaser
	20	State/phase					
	21	Mass flow rate				kg/h	
	22	Volume flow rate				m^3/h	
	23	Density				kg/m^3	
	24	Fluid operating temperature	min./max.			°C	
	25	Max. differential pressure when shut				bar(g)	
	26	Design pressure				bar(g)	
	27	Sizing safety factor (SSF) for actuator sizing					
	28	Long stand still time applicable	yes/no				
	29	Long stand still period	month/year				
	Fluid characteristics:						
	30	Lubricating liquid	yes/no				
	31	Non-lubricating dry gas	yes/no				
	32	Sticky, non-lubricating liquid	yes/no				
	33	Dirty media containing particles, slurries	yes/no				
	34	Crystallizing / polymerizing media	yes/no				
Valve	Specified on demand correction factor (ODCF)						Purchaser
	35	Manufacturer					
	36	Configuration					
	37	Type / model					
	38	Design					
	39	Port type					
	40	Shut-off flow direction					
	41	Seat designation (material)					
	42	Seating method					
	43	Pressure Class					
	44	Tightness rate/Class					
	45	Valve size	DN/NPS				
	Valve torque:						Valve manufacturer
	46	Break to open (VBTO) × ODCFs				Nm	
	47	Run to open (VRTO) × OCDFs				Nm	
	48	End to open (VETO) × ODCFs				Nm	
	49	Break to close (VBTC) × ODCFs				Nm	
	50	Run to close (VRTC) × ODCFs				Nm	
	51	End to close (VETC) × OCDFs				Nm	
	52	Breakaway angle				degree	
	53	Maximum allowable stem torque (MAST)				Nm	
	54	Valve mounting interface dimensions and tolerances (drawing to be provided)					
	55	Valve body dimension relative to mounting interface (drawing to be provided)					